



Quality of Life
Health
Development

NORAH

Knowledge No. 13

NORAH Noise Impact Study Quality of Life Study: Traffic-noise-related annoyance and quality of life **Results**

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NORAH Noise Impact Study

Traffic-noise-related annoyance
and quality of life

Results

“NORAH Knowledge” provides information on the methods and results of the NORAH noise impact study. The aim of this series is to communicate to as many people as possible what exactly NORAH researched. This is why there is an explanation in the glossary at the end for all terms marked “glossary”.

If you would like to receive further issues of “NORAH Knowledge”, please use the enclosed order form.

The NORAH Study investigated the effects of aircraft, road and rail traffic noise on humans.



NORAH (“Noise-Related Annoyance, Cognition, and Health”) is the most extensive investigation into the effects of exposure to aircraft, road and rail traffic noise that has ever been carried out in Germany. It was conducted by nine independent scientific institutes from all over Germany. The client was the Umwelt- und Nachbarschaftshaus, a subsidiary of the state of Hessen and part of the “Forum Flughafen und Region”. Alongside the state of Hessen, communities, Fraport AG and Lufthansa were also involved in the financing.

The NORAH Study examined the long-term effects of traffic noise on health, quality of life and early childhood development in the Rhine-Main Region. The initiator of the study was the Airport and Region Forum (ARF). The scientists were accompanied from the start by an external Scientific Advisory Board for Quality Assurance (WBQ). This is what distinguishes NORAH from similar, predecessor studies. The study addressed some of the most topical issues currently being dealt with by international noise impact research. It also covered a wider range of investigation aspects than previous studies. In order to find out more about how human beings respond to traffic noise, the NORAH scientists also looked at the medical histories of around one million people, and reconstructed the noise exposure at around 900,000 addresses in the Rhine-Main Region.

A total of five sub-studies form the core of the NORAH Study. Each one builds on the current international state of research. In addition to this, highly complex and innovative techniques were used to calculate the acoustic exposure. In this edition of “NORAH Knowledge” we present the results of the Quality of Life Study, one of the five sub-studies.

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Further information on the NORAH Study is available on the Internet at www.laermstudie.de. There you can also subscribe to the newsletter “NORAH Brief”.

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OVERVIEW OF THE QUALITY OF LIFE STUDY

Whether rail, road or air – a lot of people are annoyed by traffic noise. When people perceive noise as disturbing, the scientists call this “annoyance”. To what extent a person feels annoyed by traffic noise is subjective, i.e. it differs from person to person. We make a distinction between “annoyance” and “exposure” – the objectively measurable sound level ([📘 glossary](#)). If the noise exposure increases, then the annoyance also increases. Or, in other words: the louder it gets, the greater the annoyance. This is not surprising and has been scientifically proven. But other factors, including the type of noise source and the personal noise sensitivity, can also influence how severely annoyed someone feels. Although several studies have already investigated which factor accounts for which proportion of the annoyance, not all of the scientific questions have been answered here.

The NORAH Quality of Life Study therefore tried to answer a number of these open questions on noise-related annoyance and quality of life. To do this, the NORAH team surveyed almost 19,000 people in the Rhine-Main Region as well as more than 10,000 in the environs of the airports Cologne/Bonn, Stuttgart and Berlin-Brandenburg. In terms of its content, the study was divided into three sub-areas: a time comparison, a location comparison and a noise source comparison.

Special attention was paid to the so-called “change effect”. This is what noise researchers call the phenomenon that people react not only to the noise exposure in itself, but also to changes in the noise exposure by feeling more annoyed by an increase in noise and less annoyed by a reduction in noise than one would expect them to feel at the respective sound level (*more about this on page 6*).



Jörg Hackemann/shutterstock

Time comparison: change effect confirmed in the Rhine-Main Region

Frankfurt Airport's new north-west runway began operations in October 2011. This gave the NORAH team an opportunity to identify a possible change effect. The study results do, in fact, suggest that such a change effect took place around Frankfurt Airport: in 2012, the year after the new runway was opened, the people felt substantially more annoyed by higher sound levels than residents whose homes were subject to similar noise levels before the opening of the runway. In 2013 the annoyance had fallen again slightly, but was still above the level of 2011. The scientists suspect that the persons concerned got used to the new noise situation to a certain degree, but not entirely.

The comparison with an older study from the Frankfurt region also suggests that the annoyance has increased generally over the last ten years. According to this, the residents felt substantially less annoyed by noise at the same sound level in 2005 than in 2011.

Location comparison: annoyance is highest in Frankfurt

The four airports around which the NORAH team carried out surveys of the residents differ considerably from each other – in terms of their size, planned construction projects, and also in terms of the occurrence of night-time air traffic. It was shown that people in the Frankfurt region subject to the same long-term energy equivalent sound level ([glossary](#)) experience a higher degree of annoyance than the people around the other airports. This is followed in second place by Cologne/Bonn Airport. People living around Stuttgart Airport are subject to the lowest degree of annoyance due to air traffic noise. However, the annoyance at all four investigated airports was higher than the EU standard graphs developed in 1998 to estimate annoyance would suggest – the graphs thus appear to underestimate the present-day level of annoyance.

Noise sources comparison: planes cause more annoyance than cars or trains

Alongside the air traffic noise, the NORAH Study also calculated the road and rail noise in the Rhine-Main Region, and asked the residents to what extent they felt annoyed by which type of noise. It was shown that many people already found air traffic noise at relatively low sound levels more annoying than considerably louder rail and road traffic noise. In addition to these results on annoyance, the NORAH scientists also gained further insights – for example about how the residents around Frankfurt Airport assess their own quality of life, or what effects there are when people are exposed to more than one source of noise. We will present these and other results in more detail in the following pages.

THE QUESTIONS AND METHODS OF THE QUALITY OF LIFE STUDY

Almost 30,000 people took part in the Quality of Life Study. Each of them answered extensive questionnaires; some of them even took part in the surveys over three successive years. A team of acoustics experts calculated for all study participants how much air, road and rail traffic noise could be heard at their addresses in the respective year before the surveys.

The scientists then put the answers from the surveys in relation to the individual noise exposures of the participants. This allowed them to calculate so-called exposure-effect graphs – an important objective of NORAH. Exposure-effect graphs state how people on average will respond to which noise exposure – for example, how annoyed the residents feel at a certain loudness or how they assess their quality of life in this situation.

Overview of surveys and participant numbers in the Rhine-Main Region

2011	2012	2013	Totals
1st survey wave 9,244 persons	2nd survey wave 4,867 persons from wave 1	3rd survey wave 3,508 persons from waves 1 and 2	9,244 persons
No additional survey	Survey focused on rail, road, multiple noise: 7,113 persons	New group of persons: 2,400 persons	9,513 persons
Total number surveyed: 18,757 persons			

In this chapter we only provide a brief overview of the questions and methods of the Quality of Life Study. If you would like to know more about it, we recommend “NORAH Knowledge” no. 7 – *Research questions and methods of the Quality of Life Study*.

Who took part?

With the aid of information from the resident registration authorities, as of 2011 the NORAH team made contact with people living in the environs of the airports Frankfurt, Stuttgart and Cologne/Bonn and in the proximity of the planned Berlin-Brandenburg Airport, and invited them to take part in the Quality of Life Study. This procedure was previously approved by the data protection officers of the participating federal states. Some of the respondents in the Rhine-Main Region took part again every year after 2011. In 2012 the scientists surveyed a further group of participants who also answered additional questions on combinations of various traffic noise sources. The NORAH team took great care to select sufficient participants with different levels of noise exposure in each investigation area.

The NORAH team carried out one survey around each of the airports Cologne/Bonn, Stuttgart and Berlin.

Overview of participant numbers at the other airports:

Cologne/Bonn	Stuttgart	Berlin	Total
2,955 persons	1,979 persons	5,548 persons	10,482 persons

The questionnaire

Each questionnaire took around 20 to 25 minutes to complete. The participants were able to answer the questions either on the telephone or online. In order to receive robust and valid results, NORAH only used questionnaires that have already prove their quality in many studies and are regarded as the scientific standard. The questions covered three theme areas:

- ▶ Questions on traffic noise reactions: here the participants stated, for example, to what extent and at what times they felt disturbed or annoyed by traffic noise.
- ▶ Questions on possible influencing factors: this was about details of the personal residential and life situation that could have an influence on the perception of noise – for example, whether the home has noise insulation, how many hours the respondents spend at home daily, and whether they have a positive or negative attitude towards air traffic.
- ▶ Questions on the health-related quality of life: here the respondents gave their assessment of their own mental and physical health.
- ▶ Questions on sociodemographic data: NORAH also asked for a series of personal details, such as the educational status, income or possible migration background. This made it possible to determine whether certain social groups react differently to noise.
- ▶ Some of the participants completed another questionnaire on the extent to which they feel annoyed by noise from multiple sources.

The Social Science Survey Center (SUZ) in Duisburg carried out a telephone survey using standardised questionnaires (an extract is presented here). Questions were asked, among other things, about the noise annoyance due to air, rail and road traffic.

Noise annoyance		
	Please substitute phrases in blue in random order.	
19	Thinking about the last 12 months, when you are at home, how much does the overall noise bother, disturb, or annoy you?	
20	Thinking about the last 12 months, when you are at home, how much does noise from road traffic bother, disturb, or annoy you?	
21	And what about the noise from ...	
22	... rail traffic	1# not at all 2# slightly 3# moderately 4# very 5# extremely
23	... air traffic	
24	The transportation noise at your address taken as a whole: Thinking about the last 12 months, when you are at home, how much does noise from all transportation noise sources together – road, rail, and aircraft traffic – in total bother, disturb, or annoy you?"	
25	And what about industrial and commercial noise ?	

NOISE ANNOYANCE AND QUALITY OF LIFE OVER TIME

The analysis of the noise annoyance over a period of three years was one of the central tasks of the Quality of Life Study. The first surveys took place before the opening of the new north-west runway at Frankfurt Airport in October 2011. The curfew on scheduled take-offs and landings between 11 p.m. and 5 a.m. also only came into effect as of this month.

In 2011, 2012 and 2013 the NORAH team asked people in the Rhine-Main Region to what extent they felt annoyed by the noise of aircraft in the previous twelve months. The respondents selected their answers on a scale of 1 to 5: 1 stood for “not at all annoyed”, 5 for “extremely annoyed”. The scientists used the answers to calculate how severely on average the respondents felt at which long-term energy equivalent sound level ([glossary](#)). It was found that there were very different degrees of annoyance in the three years. The respondents felt most annoyed in 2012, the year after the opening of the new runway.

The change effect

When people believe that it is going to get louder in their environment, or when the sound levels actually do increase, then they feel disproportionately more annoyed by noise – experts call this a (negative) change effect. The change effect, however, also works in reverse: when people believe that the noise will be reduced due to measures taken, or when the noise is actually reduced, then they feel less annoyed than would have been expected on the basis of the reduction in noise (“positive change effect”).

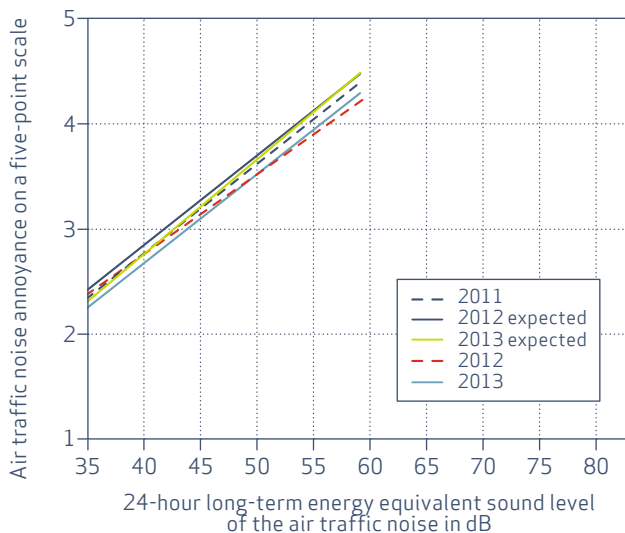
Changed noise background

The NORAH team also wanted to know whether the changed noise exposure in the Rhine-Main Region had led to a change effect (see box). For this purpose they divided the study participants into three groups. In one group the long-term energy equivalent sound level had decreased between the surveys, in the second group it had stayed the same, and in the third group it had increased. The scientists then looked at the average annoyance for each group.

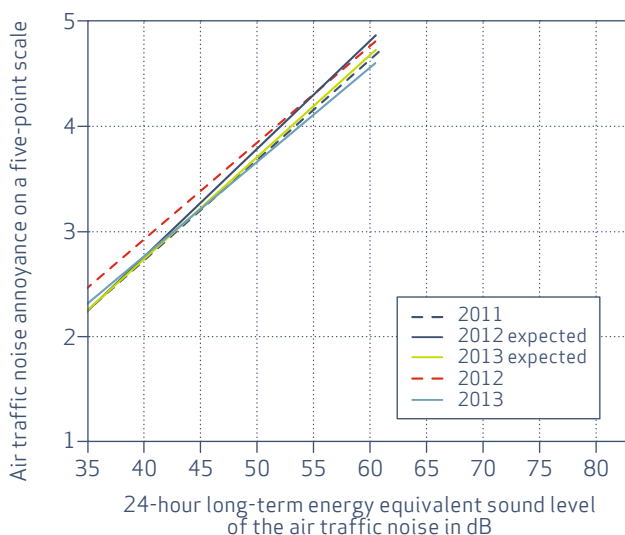
The result:

- ▶ In persons, at whose address the noise decreased from one year to the next, the NORAH team was able to establish a positive change effect. In these persons the annoyance was reduced to a somewhat greater degree than the actual reduction in air traffic noise would have suggested.
- ▶ In the study participants whose noise exposure had remained the same, a slight negative change effect was observed: although nothing had changed compared with 2011, in 2012 the persons concerned felt somewhat more annoyed. In 2013 the annoyance fell again to some extent.
- ▶ A more pronounced change effect occurred in persons at whose addresses the noise had actually increased. They felt more annoyed by the new sound level ([glossary](#)) than people who had already been exposed to similar sound levels for years.

Aircraft noise annoyance on reduction of the noise exposure after the start-up of the north-west runway

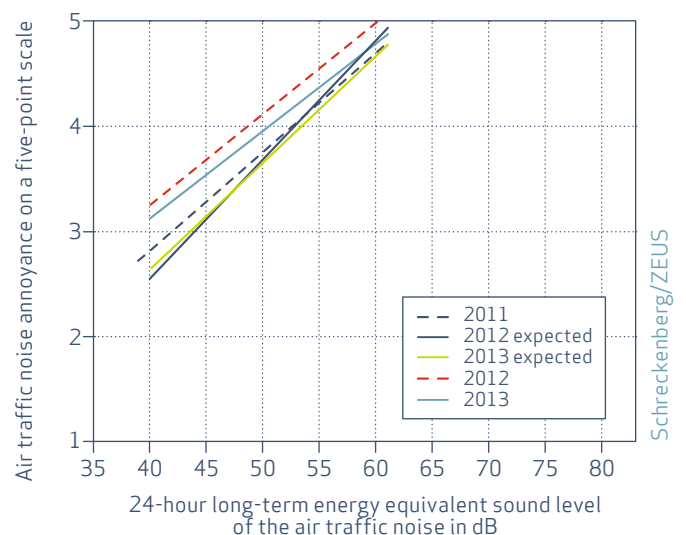


Aircraft noise annoyance on unchanged noise exposure after the start-up of the north-west runway



The NORAH team was interested in finding out whether changing noise exposures led to a change effect. The most pronounced change effect occurred in persons at whose addresses the noise had actually increased. They felt more annoyed by the new sound level than people already exposed to a similar noise level for years.

Aircraft noise annoyance on an increase of the noise exposure after the start-up of the north-west runway



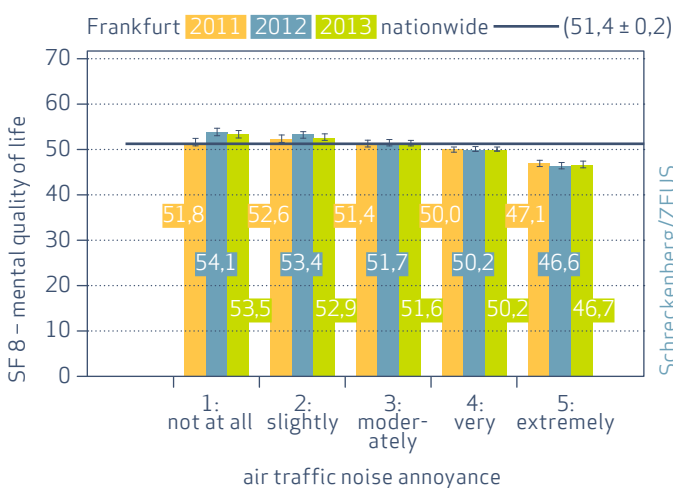
- 1 → not at all annoyed
- 2 → slightly annoyed
- 3 → moderately annoyed
- 4 → very annoyed
- 5 → extremely annoyed

Quality of life and traffic noise

Noise can influence quality of life – both mentally and physically. In order to identify a possible connection between traffic noise and quality of life, the NORAH team used several scientifically established questions. From the answers of the study participants they then calculated a point score for the mental and for the physical quality of life. They looked at the results over the course of time from 2011 to 2013, but also in comparison with the average value for the whole of Germany.

Particularly with regard to the mental quality of life, but also for physical quality of life, the scientists were able to establish a clear correlation between noise and quality of life: people who felt very or extremely annoyed by noise had a lower assessment of their mental and, in some cases, physical quality of life than persons who suffer less from traffic noise. They also assessed their quality of life lower compared with the national average.

Mental quality of life in relation to air traffic noise

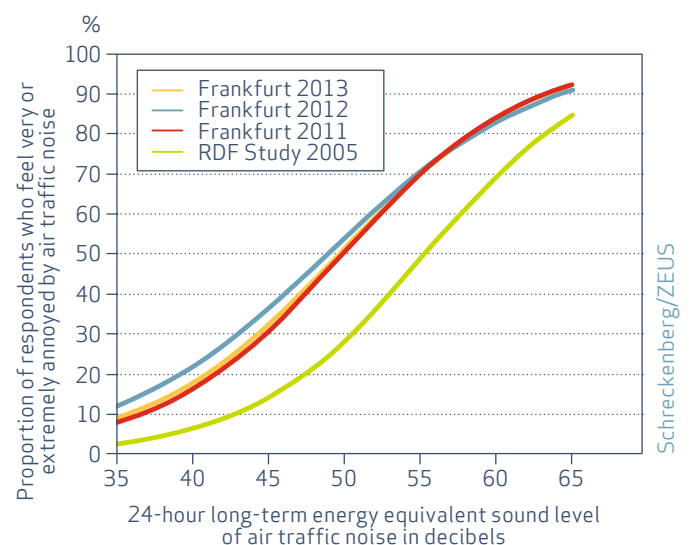


The graph shows the correlation between the air traffic noise annoyance and the personal assessment of the mental quality of life in the three study years. The blue line marks the national average for Germany. This shows that, in particular in 2012 and 2013, people who did not feel annoyed by noise assessed their quality of life as higher than the average, extremely annoyed persons as lower.

Noise annoyance increased since 2005

NORAH is not the first study to investigate to what extent people in the Rhine-Main Region are annoyed by traffic noise. As far back as 2005, the so-called RDF Study commissioned by the Regional Dialogue Forum Frankfurt Airport asked the residents living in the environs of the airport to assess their noise annoyance on a scale of 1 to 5. Anyone who selected 4 or 5 was automatically included in the group of the “highly annoyed”. The NORAH team adopted a similar approach to calculate the proportion of “highly annoyed” persons for the different noise levels. The result of the comparison: in 2005 there were substantially fewer people highly annoyed by aircraft noise. At the three other airports investigated by NORAH the proportion of “highly annoyed” persons was also above the values measured in 2005 in the Frankfurt region.

Annoyance increased since 2005



The NORAH team also compared the data with the RDF Study. The result of the comparison: in 2005 there were considerably fewer people who felt very or extremely annoyed by air traffic noise.

LOCATION COMPARISON: EVERY AIRPORT IS DIFFERENT

A central element of the Quality of Life Study is the comparison of four airports in Germany. The scientists wanted to find out whether people living near Frankfurt, Cologne/Bonn und Stuttgart Airports and around the planned Berlin-Brandenburg Airport felt equally annoyed at similar noise levels. The four airports differ in several respects:

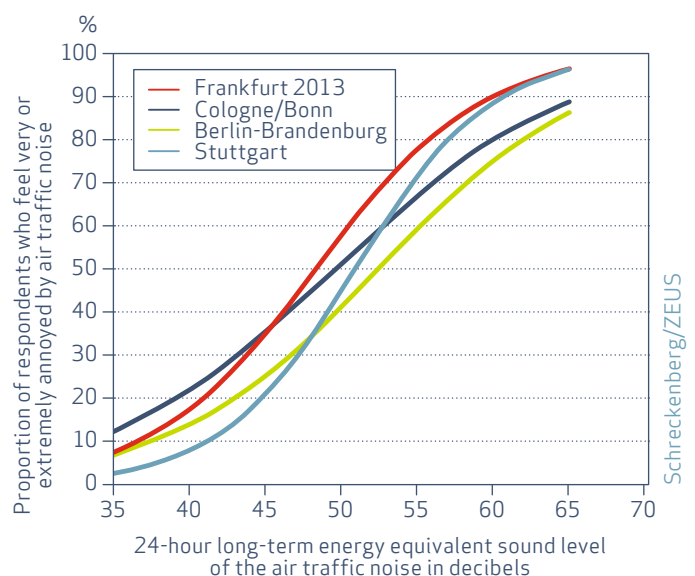
- ▲ In Frankfurt there has been a curfew on scheduled take-offs and landings between 23:00 and 05:00 hrs since October 2011. In addition to this, the noise background changed in the same month because a new runway went into operation. This is why a change effect was expected here.
- ▲ There are no flight movements as yet at Berlin-Brandenburg Airport – at the time of the survey the only air traffic noise in the region came from Berlin's Schönefeld Airport. But when the airport is opened there will be a change in the noise background in the region. This could lead to a change effect.
- ▲ In Cologne/Bonn there are also take-offs and landings at night. There are no plans for expansion.
- ▲ In Stuttgart there are no flights at night and, as in Cologne/Bonn, there are no plans for expansion.

The NORAH team asked several thousand people in the environs of the four airports how annoyed they felt on a five-point scale by the air traffic noise over the previous twelve months, and how they assessed their own quality of life and sleep quality. 1 stood for “not at all annoyed” and 5 for “extremely annoyed”. Acoustic experts also calculated the long-term energy equivalent sound level ([glossary](#)) for the specific addresses of the study participants.

Where do most of the “highly annoyed” persons live?

As already shown in the time comparison in the Rhine-Main Region, the proportion of “highly annoyed” persons also played an important role in the location comparison. All participants who evaluated their noise annoyance with either 4 or 5 are regarded by the scientists as “highly annoyed”.

Annoyance at four airports



The proportion of very or extremely persons differed at the various locations. In Cologne/Bonn, for example, there were more “highly annoyed” persons at 52 dB than in Stuttgart or Berlin-Brandenburg.

How residents around airports assess their sleep quality

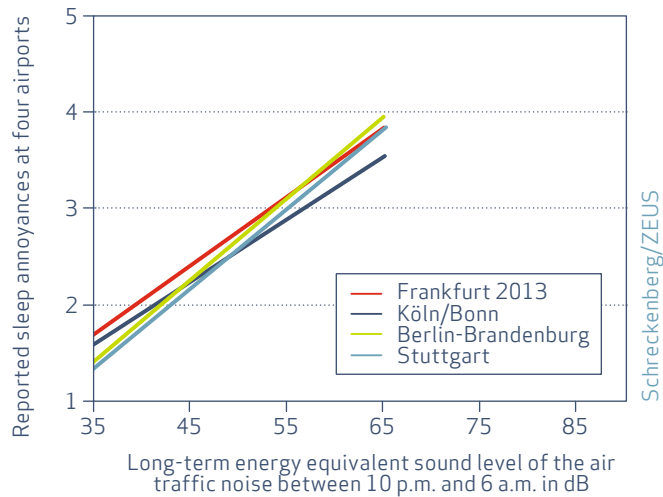
In this way the NORAH team found out that the people at the different locations felt annoyed to very different degrees: more people in Cologne/Bonn feel annoyed by long-term energy equivalent sound levels up to about 52 dB ([📖 glossary](#)) than in Stuttgart and Berlin-Brandenburg. With increasing loudness, the proportion of “very annoyed” persons rises in Stuttgart. The proportion of “very annoyed” persons is even higher in the environs of Frankfurt Airport: as of a sound level ([📖 glossary](#)) of around 45 dB, more people in the Rhine-Main Region in 2013 felt very or extremely annoyed than at the other airports.

In 2011 there were more “very annoyed” persons in Frankfurt at sound levels over 47 dB than in Cologne/Bonn. In 2012 the annoyance in Frankfurt was especially high compared with the other three locations – probably due to the change effect. Even at a long-term energy equivalent sound level from around 42 dB, considerably more people in the region felt “very annoyed” by air traffic noise than at the other three locations. However, at all four investigated airports the noise annoyance is higher than would be expected on the basis of the standard graphs used in the European Union to calculate air traffic noise annoyance.

A somewhat different picture emerged when the scientists analysed the answers on sleep quality at the various locations. Within the framework of the Quality of Life Study, the NORAH team did not directly examine the sleep quality of the study participants, but rather asked them to what extent their sleep was annoyed by traffic noise. A five-point scale was again used here. The result: in 2011, i.e. before the introduction of the curfew on scheduled flights between 11 p.m. and 5 a.m. at Frankfurt Airport, the people in this region felt considerably more annoyed in their sleep by air traffic noise than those at other airports – at both low and high long-term energy equivalent sound levels. In the two following years, the sleep annoyances decreased somewhat from the point of view of the people concerned in the Frankfurt region: at long-term energy equivalent sound levels from around 57 dB, the people here perceived their sleep as less annoyed than the respondents in the environs of the planned Berlin-Brandenburg Airport. At lower long-term energy equivalent sound levels the people in the Rhine-Main Region still felt most annoyed in their sleep, followed in second place by the respondents in the environs of Cologne/Bonn Airport.

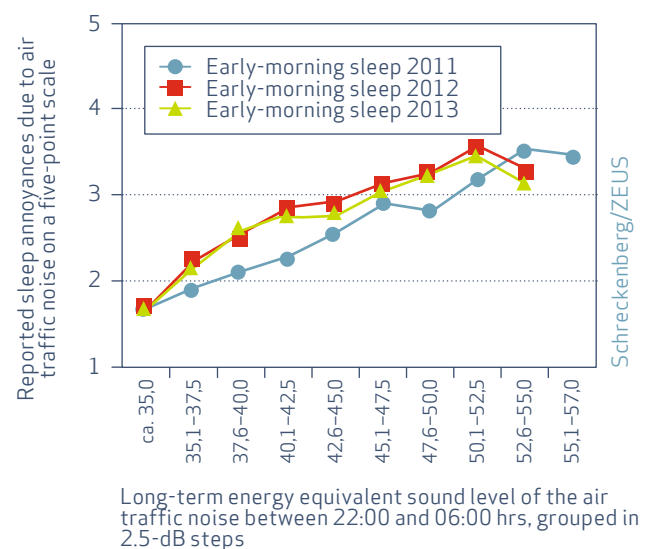
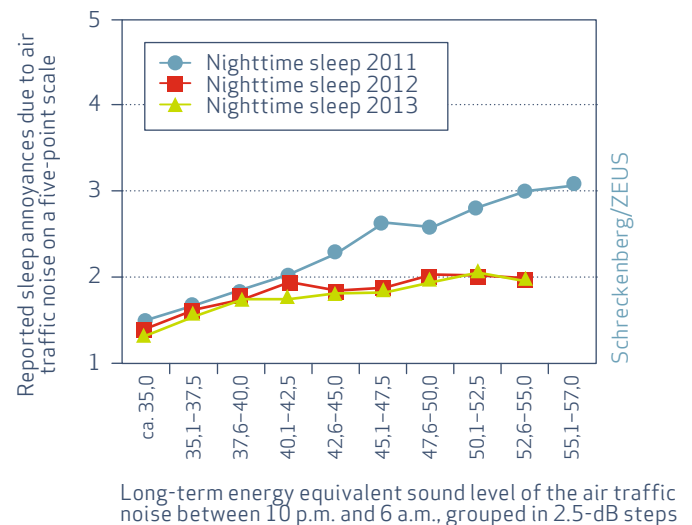
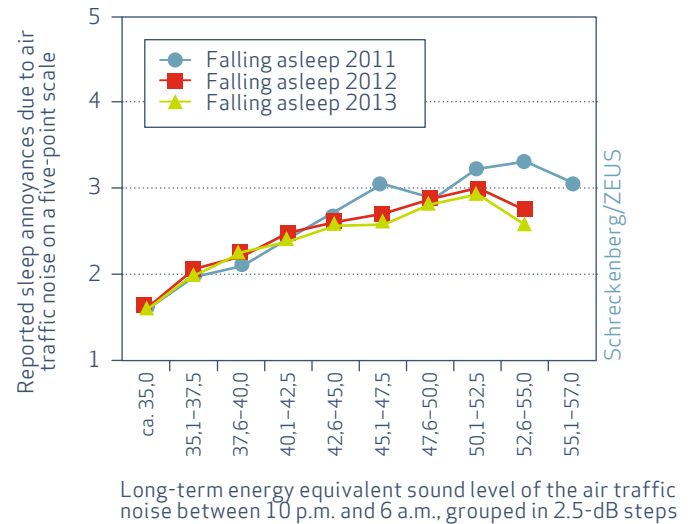
A further analysis of the answers showed that the respondents were mainly of the opinion that they slept better through the night after the introduction of the night flight curfew at Frankfurt Airport. Their assessments of the disturbances when falling asleep and in the early morning differ substantially less in the three years. For further results on the sleep quality in the Rhine-Main Region, please refer to the NORAH Sleep Study (see “NORAH Knowledge” no. 10 – results of the Sleep Study).

Reported sleep annoyances in relation to air traffic noise



The respondents provided details on their own sleep quality. In regions with slightly less air traffic noise exposure, residents around Frankfurt Airport gave the poorest assessment of their sleep quality.

- 1 → not at all annoyed
- 2 → slightly annoyed
- 3 → moderately annoyed
- 4 → very annoyed
- 5 → extremely annoyed



- 1 → not at all annoyed
- 2 → slightly annoyed
- 3 → moderately annoyed
- 4 → very annoyed
- 5 → extremely annoyed

For all three sleep phases, the answers of the respondents in the three investigation years showed some substantial differences.

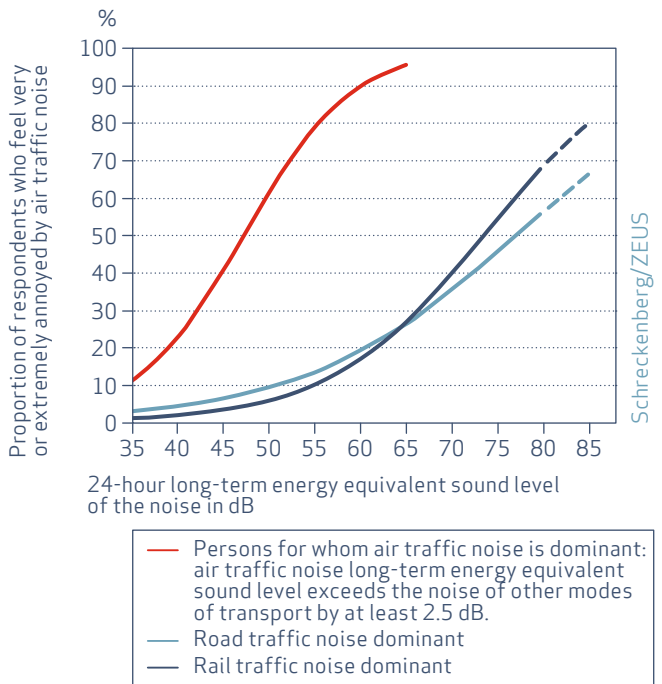
SOURCE COMPARISON: THE LOUDEST NOISE DOES NOT CAUSE THE MOST ANNOYANCE

Not all traffic noise is the same: busy roads tend to generate a constant hum of traffic, while it can be perfectly silent in the intervals between two trains or planes. But the noise of trains and planes also differs – for example because the sound of a passing train increases more quickly than the sound of a passing aircraft. In order to find out to what extent people feel annoyed by the three modes of transport – car, train and plane – the NORAH team carried out a survey in 2012 on 7,113 persons in the Rhine-Main Region who had not participated in the other surveys. All of the study participants stated on a scale of 1 to 5 how severely they were annoyed by road, rail and air traffic noise in their homes.

The NORAH acoustics experts also calculated how much noise from which noise source could be heard at the specific addresses of all participants. The scientists then put these values in relation to the answers of the respondents.

The NORAH team found out that the respondents reacted differently in particular to air traffic noise than to rail and road traffic noise: even at very high long-term energy equivalent sound levels (see [glossary](#)) between 70 and 80 dB (see [glossary](#)), the average annoyance for road and rail noise rose only slightly above the scale value 3 (“moderately annoyed”). In the case of air traffic noise, however, the average annoyance level rose to 4 as of around just 55 dB – this means that the respondents felt on average “very annoyed”.

Air traffic noise causes the most annoyance



Considerably more people felt “very annoyed” by air traffic noise than by similarly loud rail or road traffic noise.

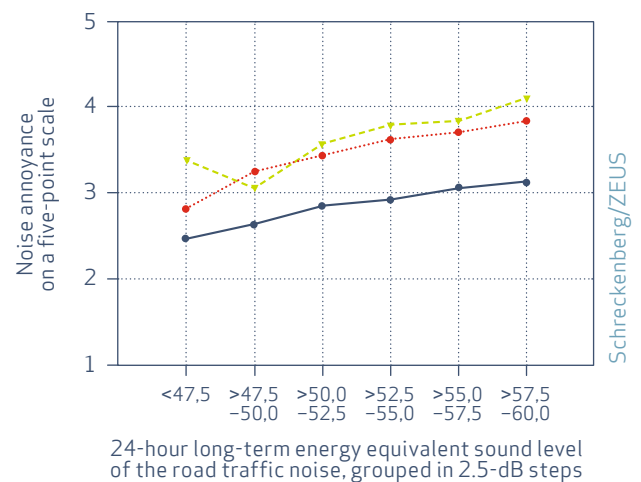
Combined noise: when more than one kind of noise can be heard

Noise impact research has spent a lot of time trying to find out how individual noise types – e.g. road or air traffic noise – affect people. The NORAH Study goes a step further and attempts to investigate the real noise situation on site: in real life we are exposed to several different traffic noise types at many places. The sound of passing cars is joined by the noise of planes or trains. Physical formulae allow us to calculate how this changes the sound level. It has never been explained, however, how this combined noise affects humans.

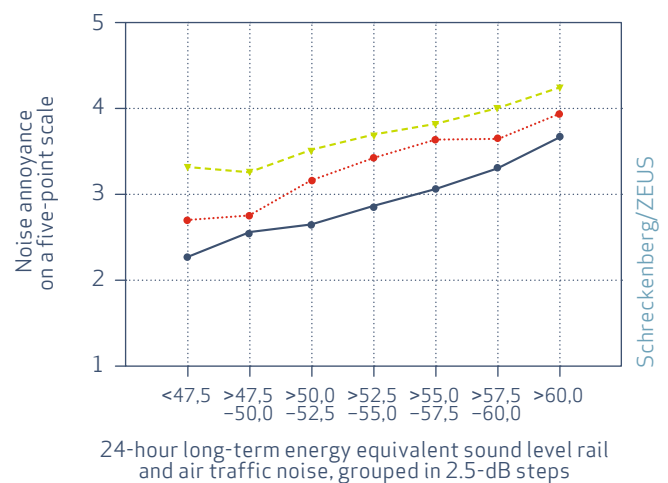
This is why the NORAH team carried out a survey in 2012 on more than 7,000 people at whose homes both air traffic noise as well as either rail or road traffic noise could be heard. The scientists proceeded as follows: they asked the study participants how severely they felt annoyed by air traffic noise alone, by rail or road traffic noise alone, and by the combination of two noise sources. They also noted whether both types of noise were equally loud at the address of the respondents or whether one of the two noise sources dominated. Then they compared the answers.

They found out that the air traffic noise had an especially large influence on the degree of annoyance. This means: when, in the environs of an airport, someone hears air traffic noise plus another noise source, the degree of annoyance has much more to do with the air traffic noise, regardless of the sound level, than with the other type of noise. The scientists concluded from this that if we simply add the physically measurable sound level from the two traffic noise sources, there is a risk of underestimating how annoyed people feel due to the combined noise.

Air and road traffic noise combined



Air and rail traffic noise combined



Total noise annoyance
 --- when the air traffic noise level is higher
 --- when the road or rail traffic noise level is higher
 --- when both noise levels are equally high

- 1 → not at all annoyed
- 2 → slightly annoyed
- 3 → moderately annoyed
- 4 → very annoyed
- 5 → extremely annoyed

When two traffic noise types were combined, the degree of annoyance differed: for example, the combined noise of aircraft and trains caused more annoyance, regardless of the measurable sound level, when the air traffic noise was dominant.

INTERVIEW WITH STUDY DIRECTOR DIPL.-PSYCH. DIRK SCHRECKENBERG: “INTEGRATING THE RESIDENTS TO A GREATER EXTENT”

Dirk Schreckenberg was the director of the Quality of Life Study. In this interview the psychologist talks about the change effect and the practical conclusions that can be drawn from his study. He also tells us whether his work has changed his own reaction to noise.



Gemeinnützige Umwelthaus GmbH

Director of the Quality of Life Study Dipl.-Psych. Dirk Schreckenberg of ZEUS GmbH in Hagen. He was also, alongside Prof. Dr. Rainer Guski, overall director of the NORAH Study.

NORAH Knowledge: Your study shows that the long-term energy equivalent sound level – i.e. the average level and quantity of noise – can only partially explain how severely annoyed people feel. Does that mean that people are exaggerating their degree of annoyance?

Dirk Schreckenberg: Definitely not. In our surveys the people are not asked to guess how many decibels they are hearing. They simply say if what they hear causes them annoyance. This means that they assess their own situation: the noise itself, i.e. how loud and how long the sounds are in their perception, how often they occur. But the time of day also plays a role, as well as whatever they happen to be doing at that time. If I am mowing the lawn in the afternoon, the sound of a plane will bother me less than on a summer evening when I'm sitting with friends on the patio. All of this goes into the answers.

The “human factor” becomes particularly apparent in the so-called change effect. Why is it that a whole region will feel more annoyed when an airport expansion is imminent?

Science can only speculate on that at the moment. What we do know is that this is not a one-off phenomenon that only occurs in Frankfurt or only for air traffic noise. There are also studies that have observed a change effect in relation to road traffic noise. One possible explanation is that people always react more strongly to changes than to something that is constantly there. When a noise situation changes, the people notice it and are especially attentive. And that is then reflected in their assessment of the annoyance.

Another possible explanation is that non-acoustic factors can also have an influence on how strongly someone feels annoyed. This includes their attitude towards the noise source, i.e. whether, for example, they generally regard aircraft or cars as useful. And the attitude towards the responsible institutions also plays a role: whether regional politicians, the airlines, or the local authorities are taking the living situation of the people seriously and protecting them from the noise. Our investigations indicate that people feel less annoyed if they have trust in these institutions.

Can we draw any practical conclusions from this finding?

Yes, it could certainly be used for noise abatement planning in the future, for example by integrating the residents to a greater extent in the process. A concrete example: since April 2015 there have been so-called noise breaks at Frankfurt Airport. Alongside the six-hour night flight curfew, this is an attempt to provide a further hour of relief in some areas by restricting the use of certain runways in the evenings in the hour before or in the mornings in the hour after the curfew. This means that some regions are relieved between 10 and 11 in the evening and others between five and six in the morning. This is not possible everywhere or all the time, because it depends, for example, on the direction of the wind and which runways are available. I still think it is a good idea to inform the residents about such measures. Ideally they should also participate wherever possible in the decisions on noise abatement measures.

In conclusion, a personal question: you have been working for a long time on the effects of traffic noise. Has this changed how you react to noise yourself?

Yes and no. Where I live, for example, there is no loud air traffic noise. But I do tend to notice more than before when a plane flies over me. Then I look up and think: that's still OK. Let's see what it's like in 10 years. This means that I have become more attentive, but the noise doesn't bother me any more than it ever did.

Mr Schreckenberg, thank you for this interview!

OUTLOOK: WHAT COMES AFTER THE QUALITY OF LIFE STUDY?

The NORAH Quality of Life Study found answers to many questions in noise impact research. The answers, however, have only thrown up new questions – as is often the case in science. Answering these new questions will be the job of future studies.

Different measures for the assessment of noise in the future?

The physical measure which the scientists used in the Quality of Life Study is the long-term energy equivalent sound level ([glossary](#)). Most of the previous noise impact studies also used this measure. The results of the NORAH Study, however, suggest that the long-term energy equivalent sound level alone may not be sufficient to describe all facets of the noise exposure that are relevant for the noise annoyance. The reason: air traffic noise has changed dramatically in recent years. Aircraft have become quieter, but there are many more of them in the air than, for example, in the 1990s.

The long-term energy equivalent sound level is a kind of average of all long and short, loud and quiet noise events within a certain period. It does not, however, take into consideration other properties of noise. This is why at one place the road traffic noise can reach a 24-hour long-term energy equivalent sound level of 50 dB ([glossary](#)) and at another place there can be an air traffic noise long-term energy equivalent sound level of the same strength, and still the noise background is completely different to the human ear. As the annoyance of people over the course of years has less and less to do with the long-term energy equivalent sound level, future studies should examine whether it makes sense to take other physical factors into consideration, for example the maximum noise level ([glossary](#)) of the number of flight movements, in order to investigate the effect of noise on humans.

How much annoyance will noise cause in the future?

The Quality of Life Study established that the annoyance due to air traffic noise in the Rhine-Main Region rose substantially between 2005 and 2013. It is not possible, however, to predict any future trend from this, in particular as it is not clear what caused this sharp increase. This is why the authors of the NORAH Study recommend that regular investigations are carried out – e.g. every three years – on how the annoyance trend is developing.

In future we should carry out investigations at regular intervals – e.g. every three years – on how the annoyance trend is developing.

Glossary

You will find further explanations in the glossary on www.laermstudie.de.

Long-term energy equivalent sound level

The long-term energy equivalent sound level (in short: L_{pAeq}) is a measure for the average noise exposure over a certain period in which frequency, duration and level of the individual sound events are taken into account. The L_{pAeq} is the basis for the determination of noise protection zones pursuant to the aircraft noise act – separated according to day (6 a.m. – 10 p.m.) and night (10 p.m. – 6 a.m.). The L_{pAeq} is stated in dB.

Decibel

The decibel – “dB” or “dB(A)” – is a measure of sound pressure level and thus of loudness. The decibel scale from 0 to 120 dB(A) reflects the range from the absolute threshold of hearing to the pain threshold. The scale is not linear. We perceive an increase of ten decibels as roughly a doubling of the loudness – in the lower and at the upper ends of the range.

Maximum noise level

The maximum noise level is the highest sound pressure level measured during a noise.

Sound level

This shortened expression generally refers to the sound pressure level, the value that describes the strength of the sound waves.

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