ICANA - Frankfurt 12 to 13 November 2015

NORAH project M1
Belästigung & Lebensqualität

Noise Annoyance and Quality of life

External speaker:
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Exposure-response relationships
to establish or update **exposure-response** curves between reported aircraft noise **annoyance** (*belastigung*) and reported **quality of life** (*lebensqualitat*) and standard **acoustic parameters** such as LAeq and Lden

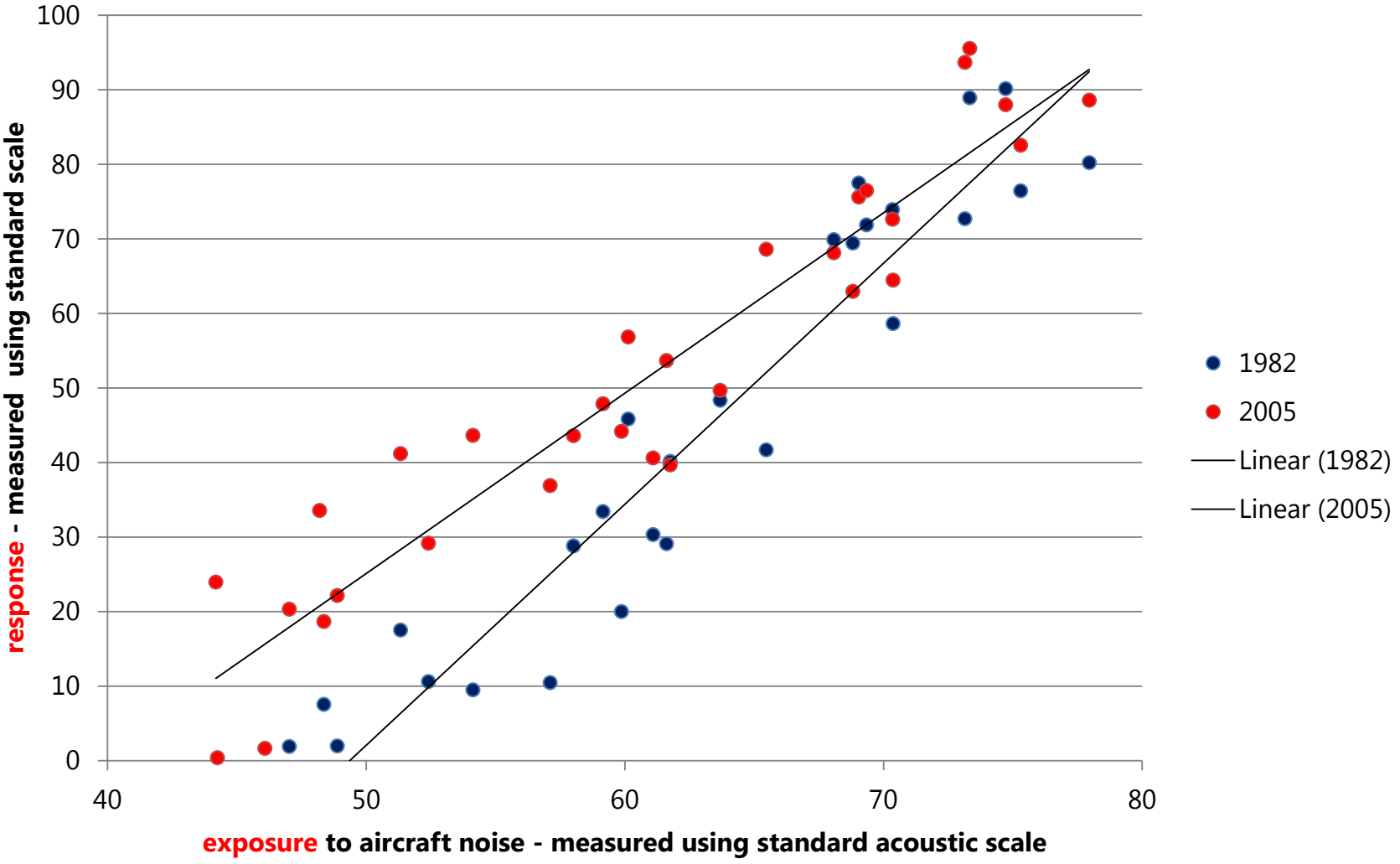
why do this when a considerable amount of similar research has been carried out already?

because the situation at every airport is different and we know that exposure-response curves can vary considerably

comment: exposure-response curves vary when different metrics are used

Hypothetical comparison between two studies

(theoretical randomly generated data example)



Our hypothetical example shows;

1. a **general trend** for higher response (**outputs**) at higher exposure levels (**inputs**).
2. a considerable amount of **scatter** (variance) above and below the regression lines which indicate the **average exposure-response relationships**.
3. significant **differences** between the exposure-response relationships for the two studies.

CAN the observed relationships be used to **predict** changes in response to changes in exposure?

in any real comparison study **WHAT** particular changes **caused** the observed differences in response (outputs)?

Methodological questions;

1. does the **exposure metric** (used on the chart) represent the most relevant **features** of the actual exposure (inputs) to **explain variation** in the measured output variable?

There is increasing evidence that **LAeq** type metrics do not fully represent the effect of changes in the **number** variable.

2. does the **response metric** (used on the chart) represent the most relevant **features** of the actual response?

What does 'aircraft noise annoyance' (*fluglarmbelastigung*) really mean?
Do respondents always **understand** the response scales in the same way?

Specific aims of NORAH study 1:

longitudinal comparison over **time** (*zeitvergleich*)

2011 FRA before NW runway brought into use
2012 FRA after
2013 FRA after

longitudinal comparisons assist understanding of **cause and effect** BUT only if **significant changes occur** in only a small number of variables while all other relevant input variables remain constant.

it is necessary to measure **all potentially relevant** input variables to identify which might have changed. **Co-variance** can then be an issue.

the design of field studies is always a **compromise**, learning from previous research.

Specific aims of study 2:

cross-sectional comparison **between airports** in 2012 and 2013 (*standortvergleich*)

Frankfurt-am-Main	FRA
Berlin Schonefield	BER - under development -2012
Cologne/Bonn	CGN - heavy night traffic - 2013
Stuttgart	STR - 2013

cross-sectional comparisons are always interesting but might not increase understanding of **cause and effect** because there are too many **potentially relevant input variables** to able to determine the **actual cause** of any differences in response.

HOWEVER, it is interesting to see **if exposure-response relationships vary** between the airports included in the comparison.

Specific aims of study 3:
compare effects of different noise **sources** (*quellenvergleich*)

- **aircraft** noise (*fluglarm*)
- **railway** noise (*schienenverkehrslarm*)
- **road traffic** noise (*strassenverkehrslarm*)

previous comparisons suggest that aircraft noise is **more annoying** than road traffic or railway noise at the same LAeq.

HOWEVER, these 'differences' are **dependent** on the type of acoustic metric and method of analysis used, and are not necessarily particularly meaningful.

Specific aims of study 4:

investigate **other variables** (*weitere wirkungen*)

e.g. speech interference
disturbance to relaxation/concentration
general sleep quality
noise coping capacity
experience of procedural fairness
satisfaction with the residential area
socio-economic status

these analyses are potentially the most interesting as they could help to illuminate the **causes of annoyance** and thereby help to inform mitigation policy.

Methods : 1

define study areas according to calculated day and night L_{Aeq} aircraft noise contours at 2.5 dB increments from 40 dB

identify all residential addresses with each defined study area

select **random samples** of addresses within each study area for data collection

these are all **standard procedures** and follow industry best practice.

HOWEVER, the sample stratification does impose some **limitations** on the types of analyses which could be carried out.

Methods : 2

carry out **quantitative survey** of resident's attitudes and opinions by telephone interview - online questionnaire option also provided. Postal invitations to participate first.

these are all **standard procedures** and follow industry best practice.

telephone interviews are a **good compromise solution** for simple quantitative questionnaires where it is desirable to achieve large sample sizes.

online questionnaires are less reliable, except perhaps where offered as **an option** in this case.

Response rates

Frankfurt-Rhein-Main **total population** - more than 1-2 million depending on the definition of the area included.
much smaller **target sample** selected in 2.5 dB LAeq bands.
actual respondents are only a **fraction** of the target sample.

are respondents **representative** of the target sample and therefore representative of the overall population???

statistical checks:

1. compare **socio-demographics** of respondents against the total population
2. compare **weighted vs. unweighted** data

nevertheless:

the possibility that **non-participants** refused because they were less interested in the survey because of being less affected than **participants,** (or vice versa), cannot be ruled out.

Methods : 3

calculate **standard acoustic metrics** for each individual participant address

greater precision than industry standard which is for calculated metrics for centroid of each small sampling area.

Comments

1. calculation **uncertainties** can exceed the differences/variance between area centroid and individual address data.
2. sound levels **vary in different locations** around the address.
3. standard acoustic metrics do not necessarily reflect all **relevant features** of the noise environment.

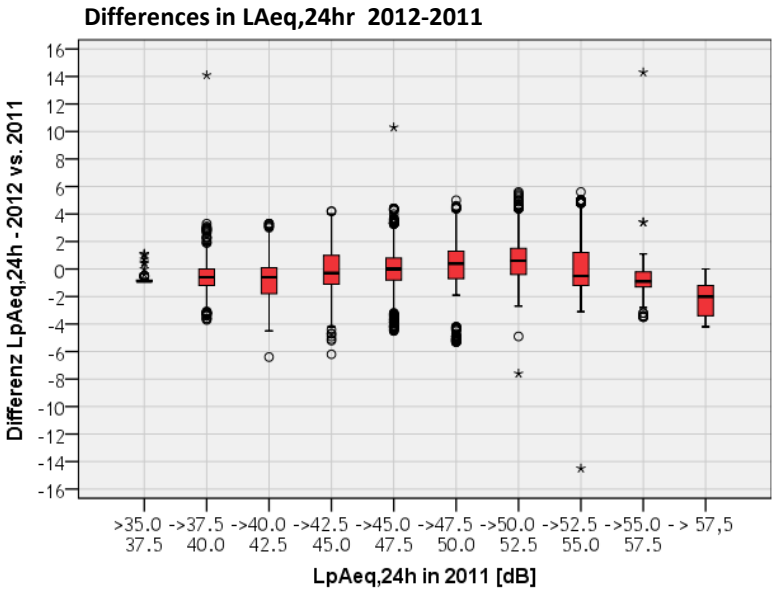
Findings : 1

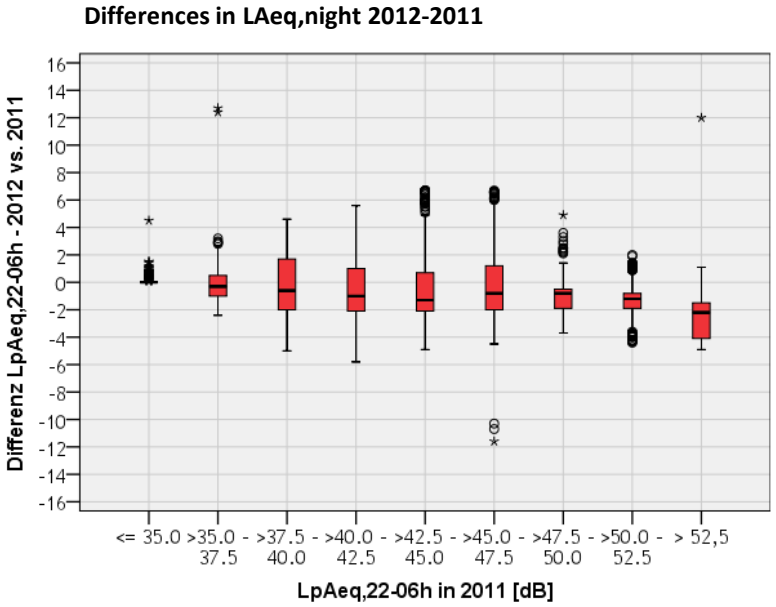
changes in aircraft noise sound levels (LAeq) from 2011 (before NW runway) to 2012 (after NW runway)

calculated average aircraft noise sound levels (LAeq) have **reduced** slightly from 2011 to 2012

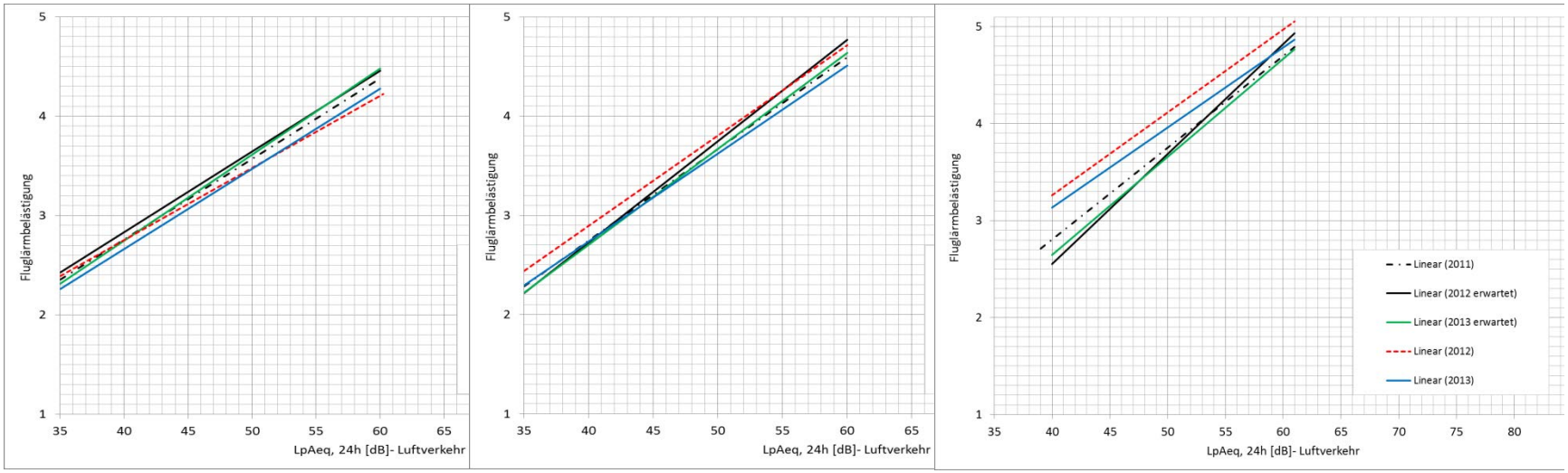
these charts show the average differences in sound level **within each 2.5 dB band** in 2011.

they conceal, by averaging, a complex pattern of **increases and decreases** in different areas





Findings: 2 Changes in annoyance 2011-2013



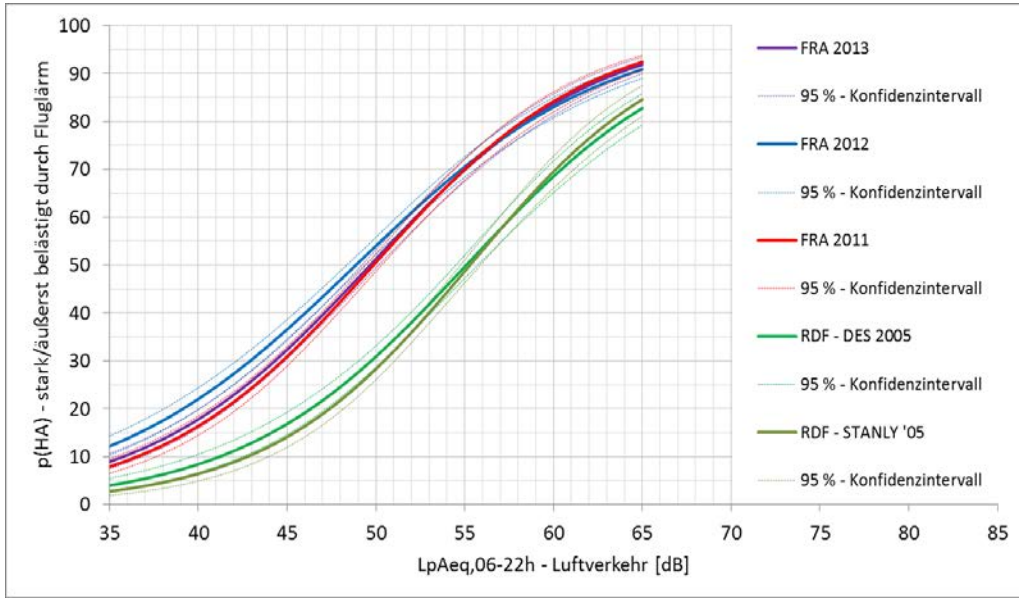
reduced aircraft noise **stable aircraft noise** **increased aircraft noise**

1. small reductions in reported annoyance when aircraft noise is reduced
2. no change in reported annoyance when aircraft noise is stable
3. increased reported annoyance when aircraft noise is increased

typically, people do not **notice** reductions in aircraft noise as much as they **notice** increases. This finding is consistent with **qualitative** research carried out in the UK.

Findings : 3

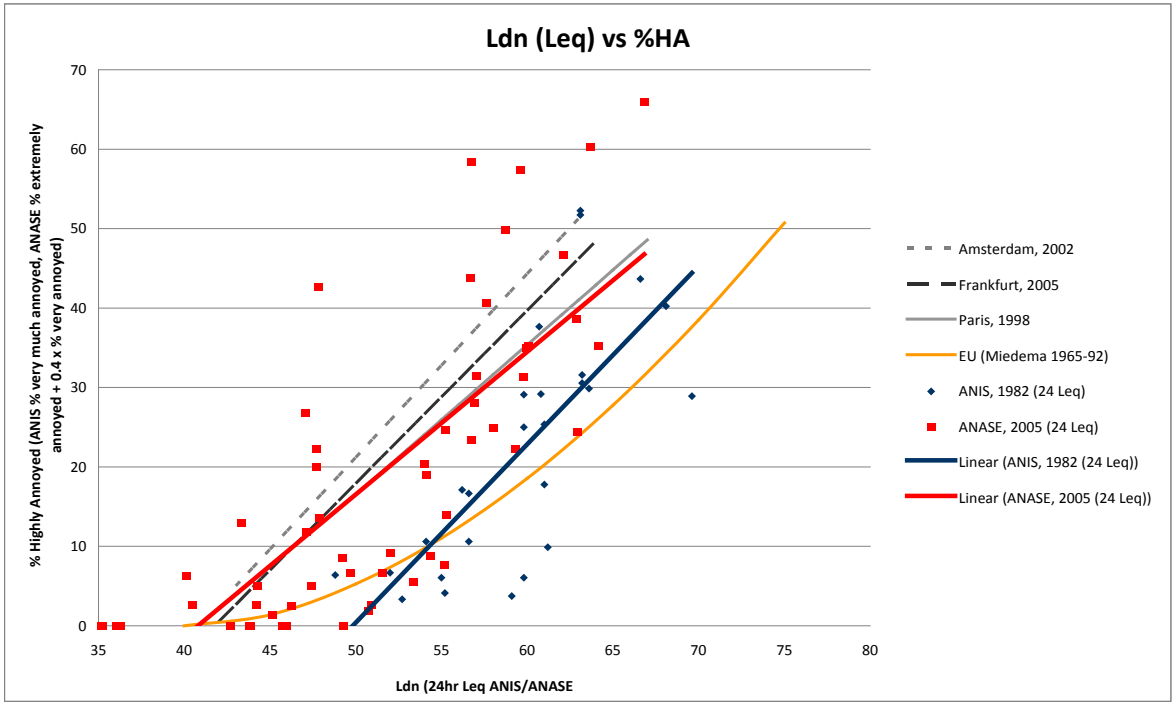
comparison **over time** of reported annoyance at Frankfurt (FRA-NORAH) 2005, 2011, 2012, 2013.



1. very **small** differences in average annoyance from 2011, 2012, 2013. Opening the new NW runway appears to make **no difference** when averaged across the whole airport.
2. significantly increased **annoyance** at the same sound levels, LAeq, from 2005 to the average of 2011, 2012, 2013. **What** is the reason for this?
3. Note: this chart averages over all responses within each aircraft noise sound level band. It does **not** compare individual responses.

Findings : 4

comparison against **previous studies** of reported annoyance at Frankfurt and other airports.



1. considerable **differences** between different studies
2. general trend towards **increasing annoyance** (at the same sound levels, LAeq) over time.
3. the EU curve **underestimates** more recent annoyance

Possible explanations (??)

residents have become ***more annoyed*** (on average) over time

OR

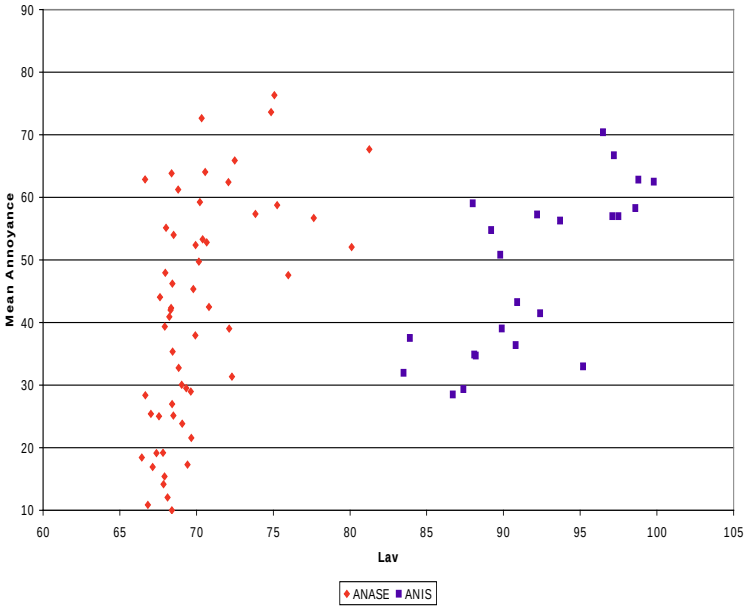
residents annoyance (at the same sound level) has ***not changed BUT*** the metrics used on either the vertical or horizontal axes of the charts do not ***properly*** reflect the changes which ***have*** taken place

Comment:

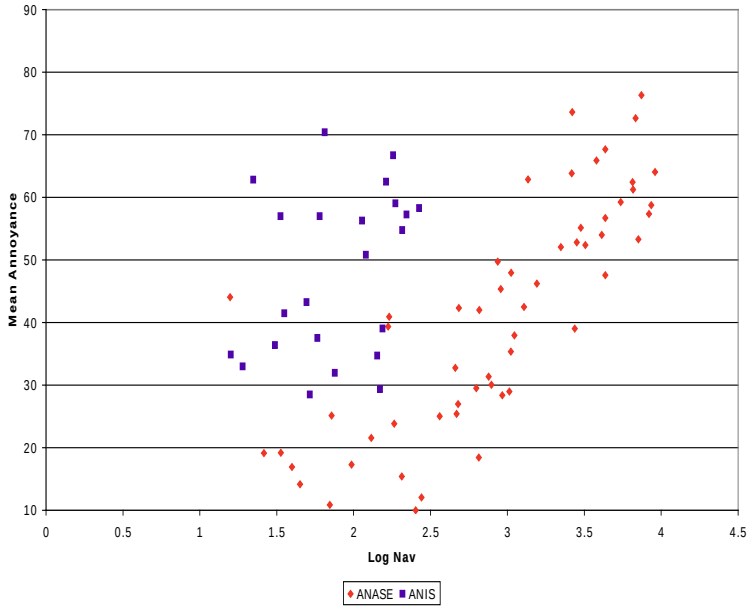
1. all curves are averages and interpretation depends on assuming **homogeneous populations**
2. individual respondents are **not homogeneous**

The problem of metrics - data from UK studies

the effect of average event sound level



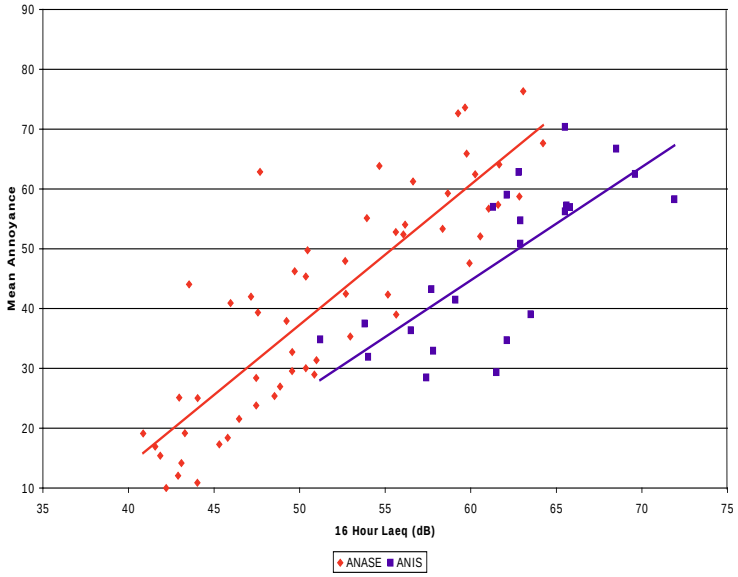
the effect of number of events



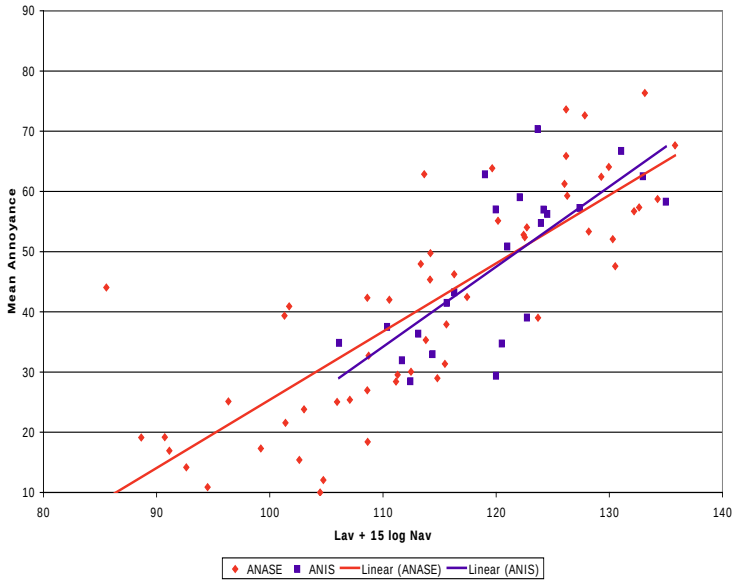
both ANIS (1982 - blue dots) and ANASE (2005 - red dots) were stratified according to both **average event sound level** and **number of events**

event sound level had a stronger effect in 1982 than in 2005
number of events had a stronger effect in 2005 than in 1982

Metrics combining average event sound level and number of events - data from UK studies



annoyance against 16 hr LAeq



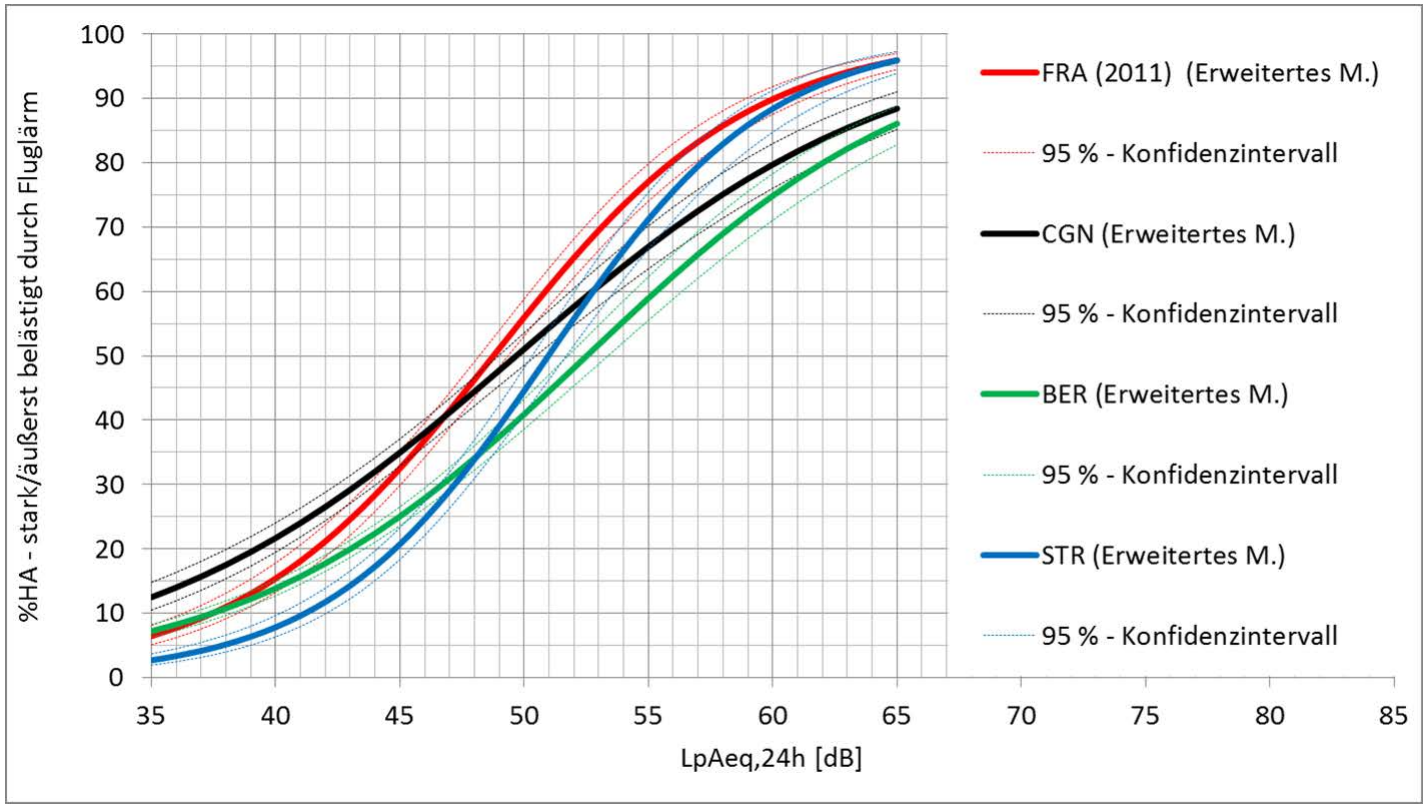
annoyance against Lav + 15 log Nav

either metric performs equally well (or badly?) when analysing 1982 and 2005 data separately.

Lav + 15 log Nav (equivalent to the old NNI or **Noise and Number Index**) performs much **better** than LAeq when analysing both sets of data together.

Findings : 5

Percent 'highly annoyed' at Frankfurt, Koln, Berlin, and Stuttgart

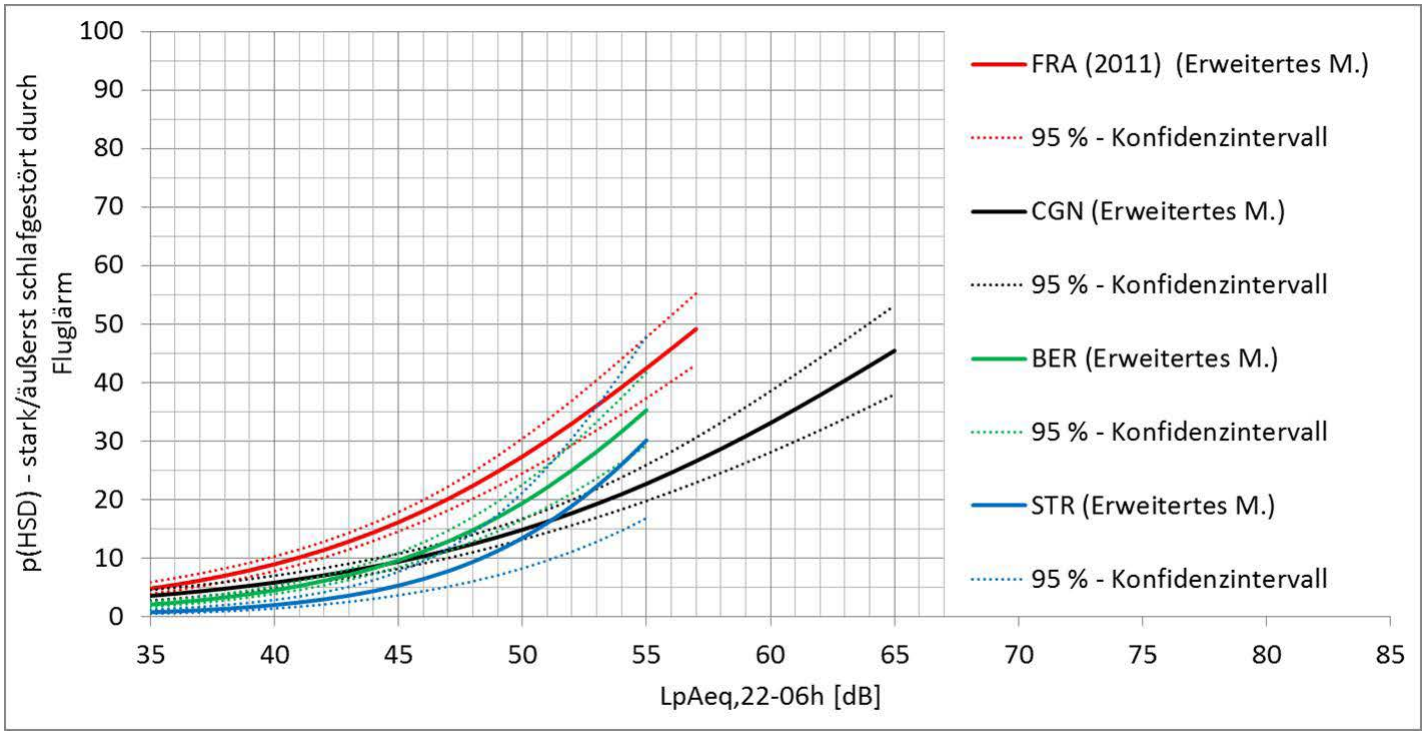


Respondents were relatively **more annoyed** at higher sound levels at Frankfurt and Stuttgart than at Koln and Berlin.

Why was this??

Findings : 6

Percent 'highly sleep disturbed' at Frankfurt 2011, Koln, Berlin, and Stuttgart



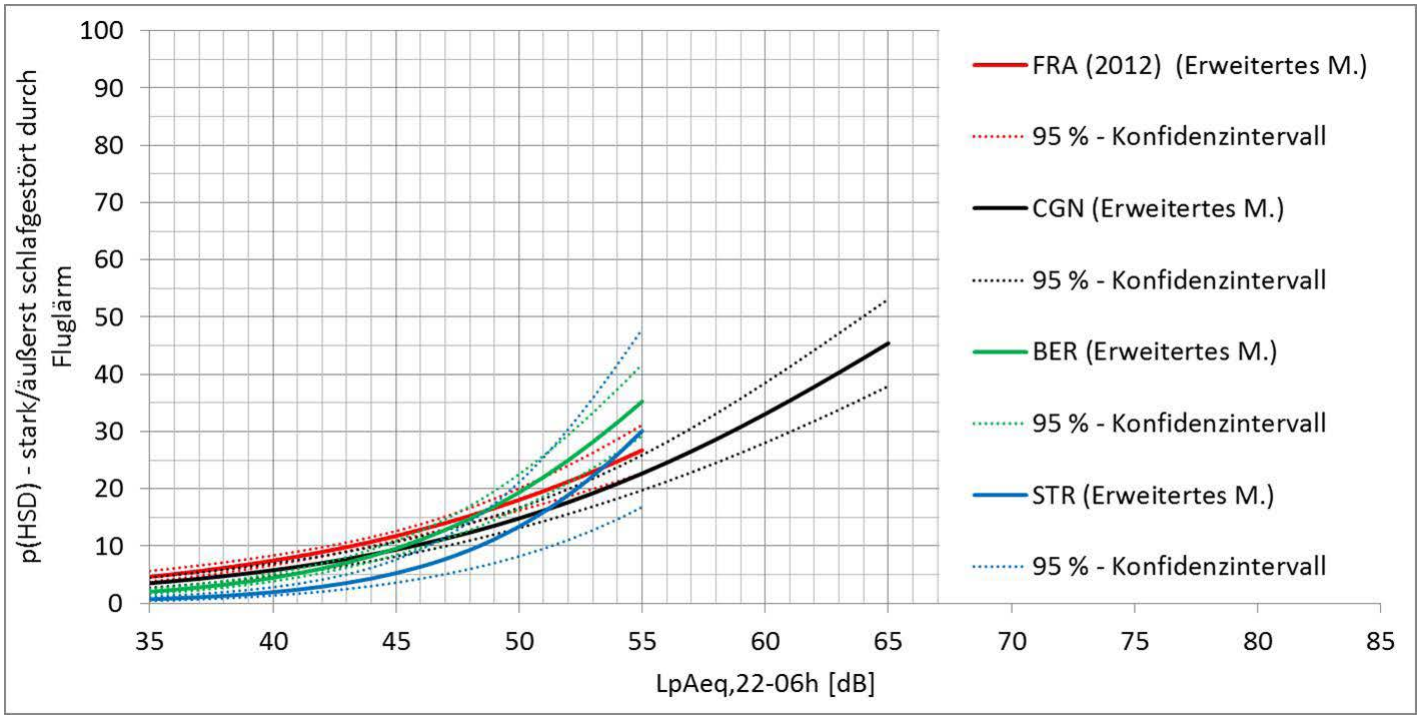
Respondents were **more sleep disturbed** at the same night-time sound levels at Frankfurt than at Koln, Berlin, and Stuttgart.

BUT note that the maximum percent highly sleep disturbed at Frankfurt is **similar** to that at Koln at much **lower** night-time sound levels.

Perhaps night-time LAeq is not the best metric for this purpose?

Perhaps respondents at Koln have become more adapted to night-time noise?

Percent 'highly sleep disturbed' at Frankfurt 2012, Koln, Berlin, and Stuttgart

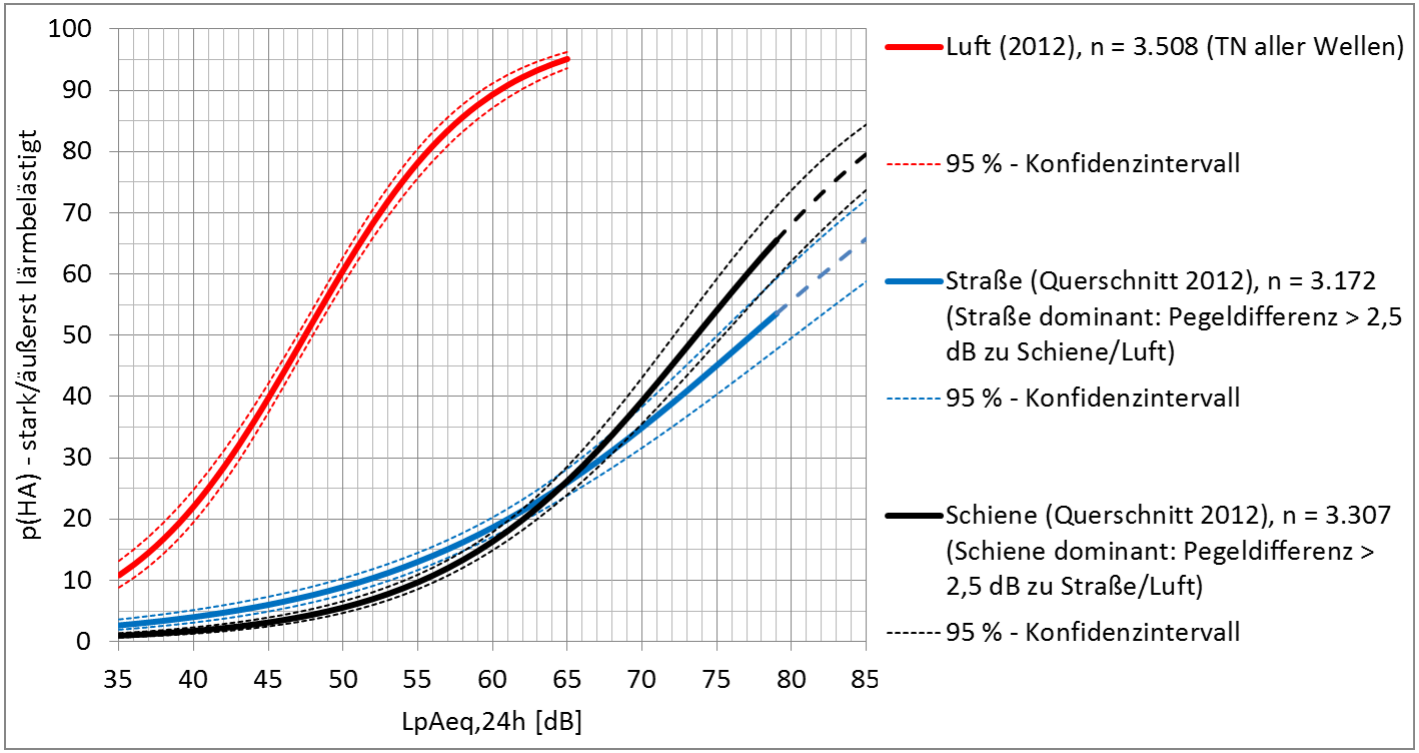


Frankfurt introduced a **night-time 'rest-phase'** from 2300 to 0500 between the 2011 and 2012 surveys.

it would be surprising if this had had no effect on reported sleep disturbance.

Findings : 7

Percent 'highly annoyed' at Frankfurt by aircraft, road traffic, and railway noise



respondents were **much more annoyed** at the same LAeq sound levels by aircraft than by road traffic or railway noise.

this finding is **common** to many other studies, although nobody knows what to do about it.

clearly, while LAeq is a good metric for **physical sound** (*schall*) it is a poor metric for **subjective noise** (*larmempfinden*).

Findings : 8

self-reported health related **quality-of-life** (mental and physical health) was negatively associated with higher reported annoyance.

many of the **non-acoustic factors** tested had strong associations with reported annoyance

these findings suggest that greater attention to non-acoustic factors involved in **public engagement** such as:

- **trust** in institutions responsible for noise, and
- perceived **procedural fairness** of decision making procedures,

could help to reduce **perceived annoyance** and disturbance, and

thereby improve self-reported health related **quality-of-life.**

What next?

NORAH has confirmed that aircraft noise continues to be a **significant issue** for many residents around major airports.

NORAH has also shown that:

- people, on average, report **higher annoyance/disturbance** at the same LAeq at some airports than at others and for aircraft noise compared to other transportation sources.
- many **non-acoustic factors** are important in addition to physical sound levels.
- people are **complicated**!!

aircraft noise is just one of the **environmental effect**s associated with airports.
airports also provide many **social and economic benefits** to travellers, to workers, and to the surrounding regions.
the **future of civil aviation** depends on finding an appropriate **balance** between all these many variables.

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