



# Research action on aircraft noise impact, perception and community annoyance

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## Outlook

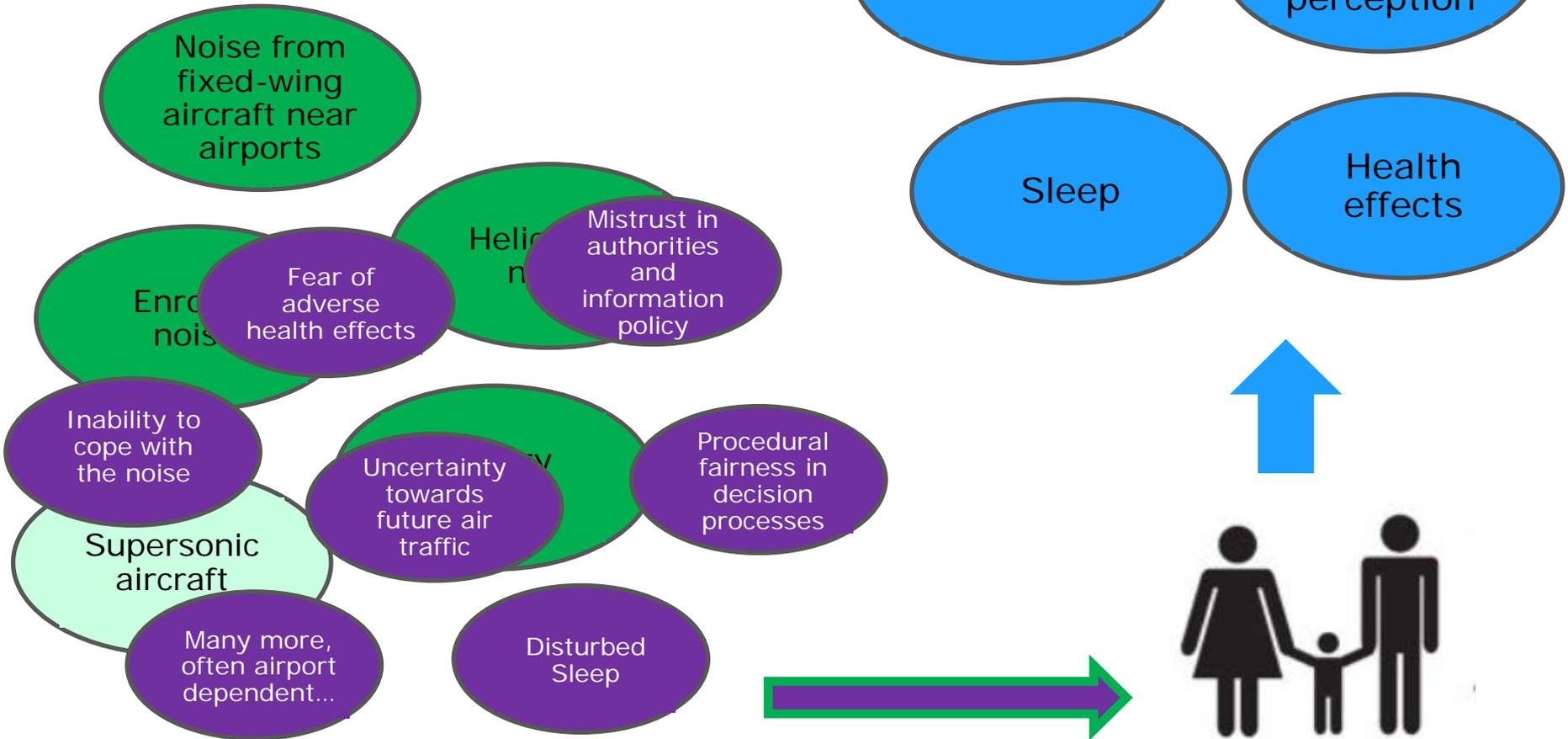
- Annoyance
- Health
- Sleep
- Link between Impact and Source
- En-route noise
- Dissemination of „Lessons Learned“
- Final Remarks

## What aims should a “Research action on impact, perception and community annoyance of Aircraft noise” in the EU have?

- Protect airport residents from adverse **health effects**
- Understand and reduce **annoyance reactions** around airports
- Support aircraft industry in **developing new sustainable products** (focussing on sound quality/ psychoacoustic research)
- Disseminate **“Lessons Learned”** in noise impact research within EU member states

# Annoyance

- Aircraft **noise annoyance** is a still increasing problem in the densely-populated areas of the EU member states.
- There is also evidence that noise annoyance is a **risk-factor for health**.
- Despite existing regulations, **without reducing residents' annoyance**, it will **become more and more difficult** to increase the number of aircraft movements, or to build new runways or other airport infrastructure.



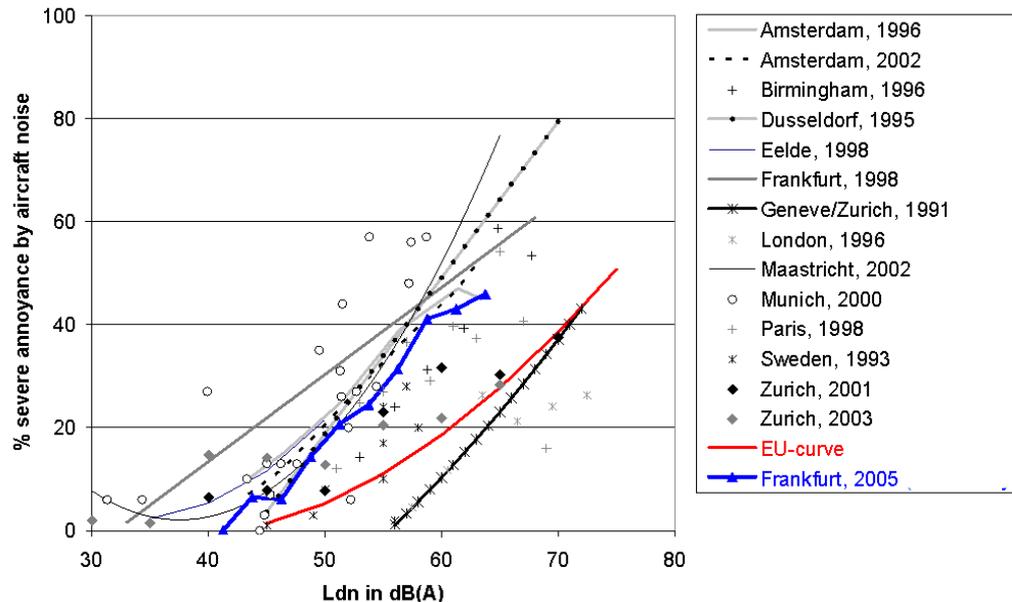
- In recent studies less than 30% of the variance in the annoyance ratings could be explained by acoustical measures (mostly  $L_{eq}$ ).
  - Other factors become even more important in explaining the variance in the annoyance judgments.
  - However, these other factors do also depend on aircraft movements in the residents' neighbourhood. It is clear that these effects can be reduced, when latest aircraft technology and flight management are used and this information is communicated by independent institutions.
- ⇒ **Reducing noise at source and optimised flight management must remain key actions undertaken!**

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⇒ However, considering the increasing number of aircraft movements and aircraft lifecycles from 20–30 years,

**this alone will definitely NOT solve the growing annoyance problem and its consequences.**

## How is annoyance measured today?



Source: van Kempen & van Kamp 2005, p. 25, Fig.3b, modified and supplemented  
 Source of Zurich 2001/03: Brink et al. 2006

**The EU curve** meta-analysis of all available and comparable survey data collected in 20 different separate research studies carried out in Europe, North America and Australia from 1965 to 1992 (altogether including 34,214 respondents).

## What are the reasons for the discrepancies of the different exposure-response curves of studies?

- Quite inaccurate mapping of external noise exposure
- The assessment of annoyance was not standardised
- In these older studies the whereabouts during working-time were not often considered
- The character of aircraft noise has changed very much since then, less noisy, but increased frequency of movements
- Other factors determining annoyance, mostly non-acoustic, were not considered

## What are the reasons for the discrepancies of the different exposure-response curves of studies?

Most of these discrepancies **can NOT be overcome by a meta-analysis** as a result of recent studies, e.g. since 2000!

(See current FAA activities in the U.S., where there are annoyance studies at 20 U.S. airports with the objective of updating the US-curve (2013–2016).)

## Necessary research action

### Up-to-date exposure response curves are needed in order to:

- Identify areas where actions must be taken (e.g., noise insulation, restrictions on older aircraft, restrictions on number of movements, re-routing, modifications of procedures)
- Show evidence for people moving to these areas

### Exposure-response curve(s) has to be updated!

It must be considered whether different curves, describing different kinds of airports:

- Steady-state vs. Changing
- Hubs vs. Regional Airports
- With or without night-time traffic
- With or without propeller aircraft

are required and politically feasible.

Necessary research action

Exposure-response curve(s) has to be updated!

A EU-US cooperation would be sensible!



However, updating exposure-response curve(s) alone will NOT solve the increasing annoyance problem!

## Necessary research action

Working on these additional factors, that nowadays considerably determine the annoyance judgement of airport residents, are likely to be able to reduce noise annoyance around airports on a much shorter timescale than reducing aircraft noise alone can do!



Key point for such a research action would be explicit enhanced, authority- and airport-independent, understandable, open, continuous and documented **communication** with airport residents!

## Necessary research action

### Possible ideas:

- **Make noise understandable for lay persons**  
(including any new indices, metrics?)
- **Make current and future air traffic experienceable**  
(acoustically and visually using a virtual environment that can be adapted to the individual's own home environment)



**Source:** Gemeinnützige Umwelthaus GmbH, Kelsterbach



**Source:** Virtual Community Noise Simulator (VCNS) at the Dutch National Aerospace Laboratory NLR

## Necessary research action

### Possible ideas:

- independent, easy-to-understand and comprehensive information on current knowledge on possible adverse health effects
- comparison with other risk factors that lead to the same disease endpoints (in this case mainly cardiovascular risks) such as smoking, high bodymass index



„Aircraft noise sickens and kills“

„Fluglärm macht krank und tötet“

Offenbach Post  
09.04.2013



# Health

- Knowledge is consolidating around increased risks of hypertension and myocardial infarction due to aircraft noise
- The German study NORAH (2011-2015) and the French study DEBATS (2011-2018) will come up with further, statistically better affirmed epidemiological data of possible risk factors.

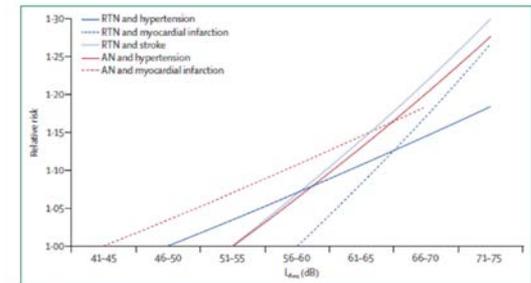


Figure 3: Exposure-response curves of road and aircraft noise and cardiovascular endpoints RTN and hypertension (24 studies, noise indicator  $L_{Aeq}$ ); RTN and myocardial infarction (five studies, noise indicator  $L_{Aeq}$ ); RTN and stroke (one study, noise indicator  $L_{Aeq}$ ); AN and hypertension (five studies, noise indicator  $L_{Aeq}$ ); and AN and MI (one study, noise indicator  $L_{Aeq}$ ). RTN=road traffic noise; AN=aircraft noise.

Source: Basner, M., Babisch, W., Davis, A., Brink, M., Clark, C., Janssen, S., Stansfeld, S.: *Auditory and non-auditory effects of noise on health – Review*. The Lancet, 2013

## Necessary research action

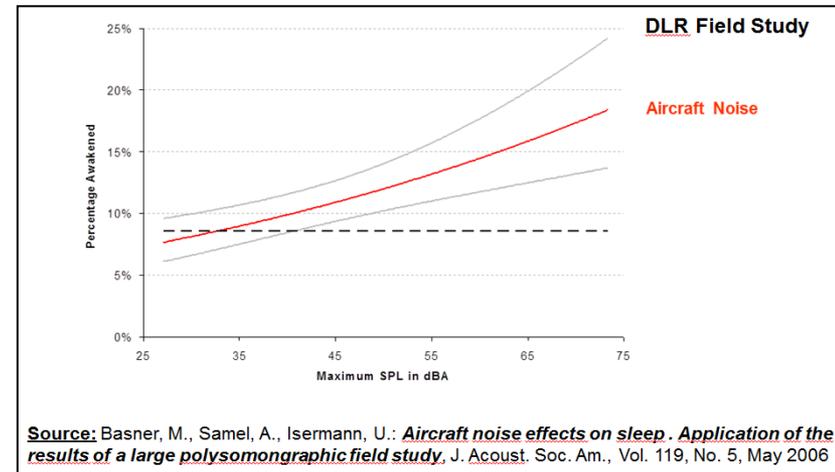
- Non-aural diseases due to noise exposure usually develop over many years and there are many confounding factors that might lead to similar diseases.

Very little is known about the bio-psychological pathways leading to the above mentioned diseases. Research in this area should be intensified to discover further strategies to prevent such diseases alongside the reduction of aircraft noise.



# Sleep

- A possible risk factor for non-aural diseases caused by aircraft noise is disturbed sleep.
- There are quite a few studies trying to assess sleep quality by using questionnaires the following morning. Such studies cannot reveal possible health risks.
- On the other hand, there are very few studies worldwide that objectively measure sleep quality by polysomnography, the „gold standard“ in sleep research, and, therefrom derive exposure-response curves.



## Necessary research action

Very little is known about different exposure-response curves for sleep disturbance associated with different movement patterns and night curfews at different airports. Research in this area should be intensified, particularly with respect to disturbed sleep being a possible factor for the generation of disease.

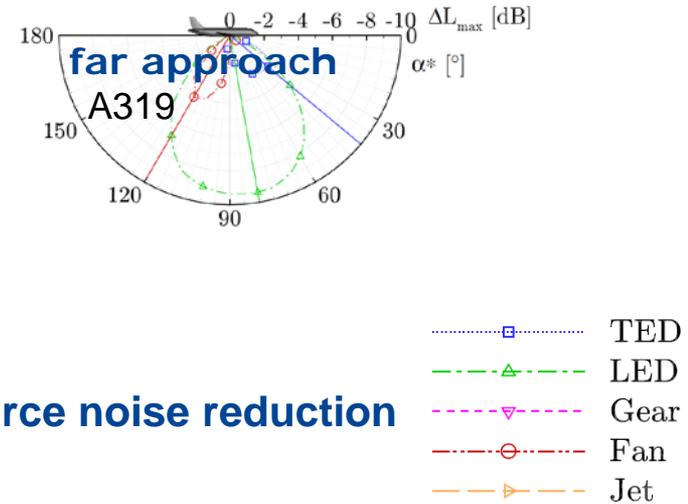
# Link between Noise impact and source

- Up to now, source noise optimisation is mainly done for the configuration at the certification point (around 2 km away from runway) and **not for the whole approaching and departing procedure** which is relevant for airport residents.

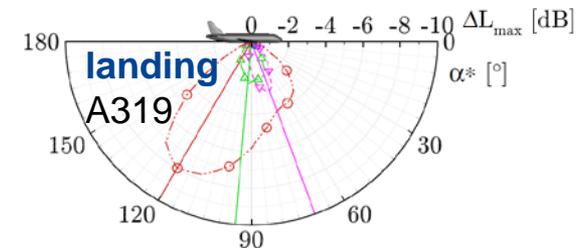
## Necessary research action

Derive source noise reduction requirements for each component based on **overall** a/c noise impact

- for targeted source reduction
- for conceptual aircraft design: „noise-to-design“ process

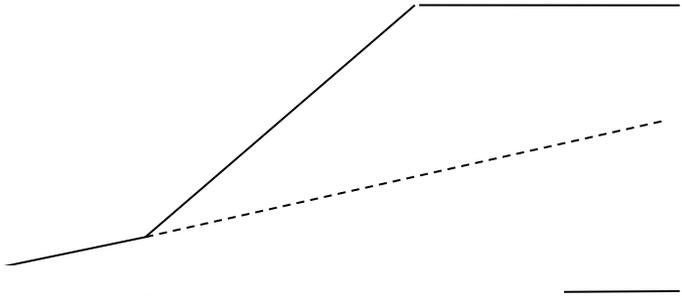


### source noise reduction



\*) Blinstrub, Bertsch, 2014 submitted

- **Idea: Optimize Approach and Departure procedures primarily based on noise impact**
  - Based on local population density
  - Take time of the day into account



Necessary research action:

Optimize procedure by Residents' perception

Cues for

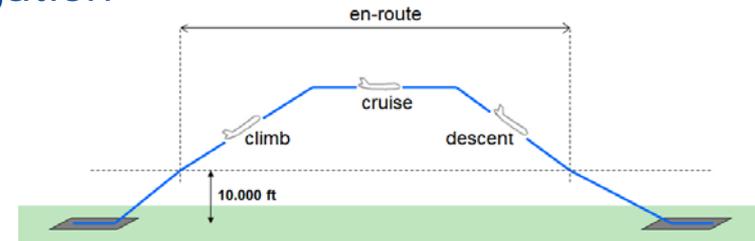
Optimized in time (4D)  
Change Configuration  
when/where noise impact is minimized



Laterally optimized

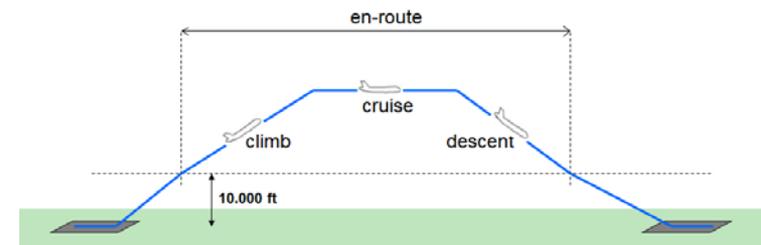
# En-route noise

- Under the EU 7<sup>th</sup> Research Framework programme, NINHA addressed the issue of en-route noise. The project was organized around 3 main challenges:
  - Adapt existing models for long-range propagation and validate them
  - Predict noise levels on ground generated by CROR en-route
  - Assess ground noise impact of CROR with reference to conventional powerplant, including turboprops
- A Final Project Workshop organised September 2013 with participants from EASA as well as other countries involved in CROR developments and en-route noise related research (US, Russia, Ukraine) reviewed the results and discussed future work needs / requirements, including International Collaboration opportunities.



## Necessary research action

- Further international benchmarking of long range propagation models
- Assessment of uncertainties for all steps of predictive process
- Altitude reference acoustic source experiment
- Investigation of acceptability criteria
- Definition of standard atmospheric profile



# Dissemination of „Lessons Learned“

- Until now there have been done just some annoyance case-studies at East and South East European airports
- Mistakes are still made in landuse planning in several EU member states

## Necessary research action

- Mistakes in landuse planning
  - summarizing good vs. bad practices,
  - enforce dialogue with stakeholders and local regulators
- Big databases in order to forecast aircraft traffic and operation procedures, community annoyance and behaviour, airport statistics



# Final Remarks

- So far, whether in the National Research Programmes or in former EU projects on research actions on noise impact, France, Germany, the Scandinavian Countries, The Netherlands and the UK were the driving forces.

**More South and East European countries** should be involved in forthcoming EU-projects to ensure knowledge transfer (including the mistakes) and prevent costly adverse developments there.

- Worldwide, the U.S. has the most common research interests with the EU on aircraft noise impact, perception and community annoyance, resulting in similar roadmaps.

However, due to cultural differences and differences in housing design, results from studies will not be directly transferable. However, close cooperation between Europe and the U.S. for methodology and analysis of the data is still advisable.



**Thank you to everyone who  
contributed to this presentation!**

**Thank you very much for your  
attention!**