Noise Action Planning at Airports under Difficult Political Conditions – Technical Methods and Procedures for Successful Support

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Summary
In 2002 the European Environmental Policy required the Member States amongst others to determine regularly the noise situation at major roads, major railways and major airports by introducing the Environmental Noise Directive. In addition, the responsible competent authorities–appointed in national rules–are committed to prepare noise action plans. This raises difficulties in particular when measures for reducing aircraft noise exposure are necessary, which leads to an expectation of having different effects on several neighboring communities.
By carrying out the project *Framework for noise action planning around the Berlin Brandenburg Airport* the Ministry of Rural Development, Environment and Agriculture (former Ministry of Environment, Health and Consumer Protection) of the Federal State of Brandenburg, Germany has attempted to provide expert support and coordinate the responsible surrounding Brandenburg municipalities of Berlin Brandenburg Airport in relation to the aspect of aircraft noise within the communal action planning.
Within the project, hotspots were determined as trans-communal, taking into account the background noise caused by other traffic sources. Amongst other things the noise reduction potential and area specific effects of flight operational measures were investigated and evaluated. For this purpose, the procedure for total noise consideration and the assessment of noise from roads, railways and air traffic, described in the Guideline VDI 3722-2 [1], was applied.

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1. Introduction

The Airport Berlin-Schönefeld will remain in operation until the new Berlin Brandenburg Airport (BER) is completed. The opening is expected for end of 2017. Both airports are major airports according to the Environmental Noise Directive, which is why Strategic Noise Maps were prepared and aircraft noise has to be considered within the Noise Action Plans (NAP) of the surrounding communities (responsible authorities according German regulations).
The responsibility of the surrounding communities for preparing a NAP raises difficulties in particular when measures for reducing aircraft noise exposure are necessary, which leads to an expectation of having different effects at several neighboring communities.
Therefore the Ministry of Rural Development, Environment and Agriculture (former Ministry of Environment, Health and Consumer Protection) of the Federal State of Brandenburg decided to carry out a *Framework for noise action planning around the Berlin Brandenburg Airport* with technical support provided by noise experts from ACCON GmbH.

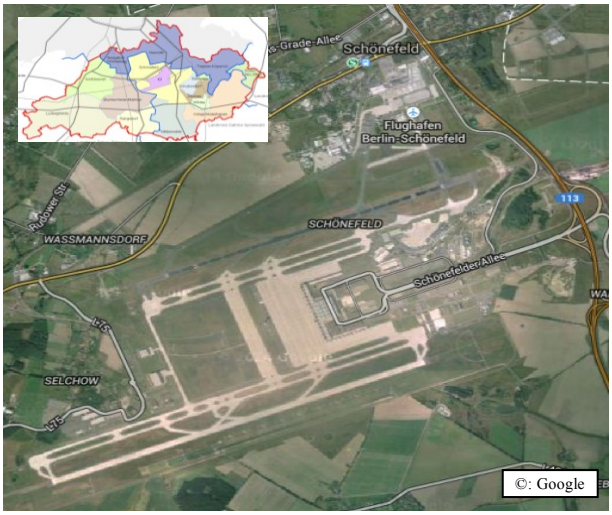

Figure 1. Airport Berlin-Schönefeld and Berlin Brandenburg Airport BER (under construction)

Within the framework a review was carried out, where the actual and expected future noise situation, former and future noise protection measures based on legal constraints, evaluation and monitoring procedures and possible noise abatement measures were considered. This framework should then constitute a consistent basis for the NAPs, prepared by the responsible surrounded communities.
This paper focusses on the analysis of the total noise situation, on a trans-communal hotspot detection and on evaluation of area specific effects of flight operational measures.

2. Total Noise Situation

Relevant noise sources within the area under investigation are major roads, major railways and the Berlin Brandenburg Airport. The source specific noise maps were calculated for the strategic noise indicators L_{den} and L_{night}. A rough overview of the various noise distributions is shown in Figure 2.

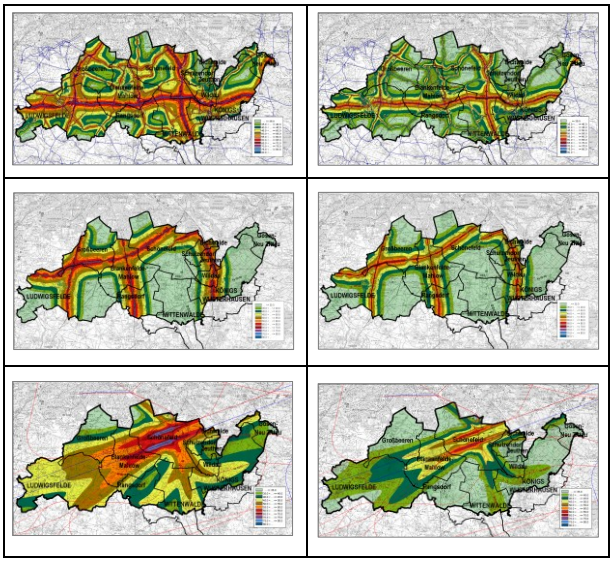

Figure 2. Road, Rail, Aircraft Noise (L_{den} / L_{night}) from top down.

Based on single source day-evening-night rating levels the total annoyance and the self-reported total sleep disturbance can be described as the result of the energetic addition of the effect equivalent continuous sound pressure levels of the single types of sources. In doing so the effect equivalent levels are converted to road traffic noise levels which are added.

The equivalence of effects are expressed by the percentage of impacted persons (e.g. %HA) estimated for each single source from exposure-response relationships for the equivalent continuous sound pressure level and converted to a substitute level for road traffic noise. Subsequently, the substitute levels of the types of sources are energetically added to the effect related substitute level. The impact of total exposure at night is assessed in relation to its effect by means of the self-reported sleep disturbance. According to [1] the percentage of highly annoyed persons (%HA) and the percentage of self-reported highly sleep disturbed persons (%HSD) can be determined by the following correlations, shown in Figure 3.

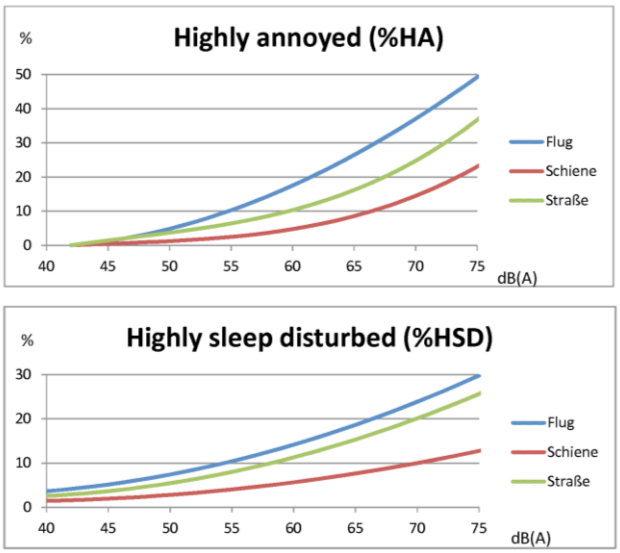

Figure 3. Source specific correlation between noise level and %HA and %HSD [2]

Figure 4 shows the effect equivalent total noise distribution of the noise indices L_{den} and L_{night} in the surrounding area of Berlin Brandenburg Airport:

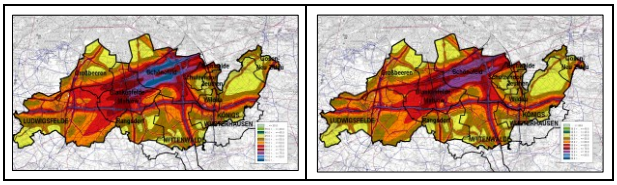

Figure 4. Effect equivalent total noise distribution L_{den} and L_{night}

3. Hotspots with significant aircraft noise contribution

Based on the *effect equivalent total noise maps* areas can be identified, which are characterized by a high total noise rating level and significantly influenced by the effect equivalent aircraft noise rating level as shown in Figure 5. The green colored area shows the effect equivalent total noise rating levels above 65 dB(A) L_{den} and for above 55 dB(A) L_{night} with a (significant) effect equivalent aircraft noise contribution of a minimum 1 dB(A).

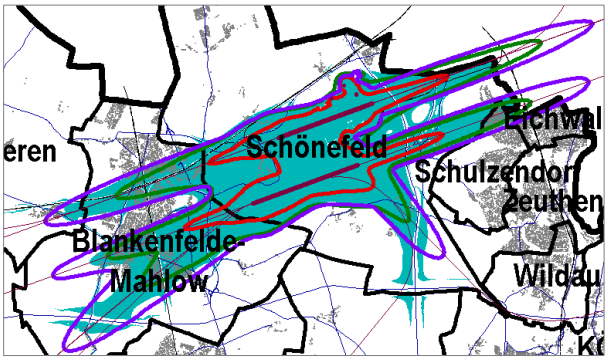

Figure 5. Area with high total noise rating level and significantly influenced by the effect equivalent aircraft noise rating level.

Taking into account the area specific distribution of inhabitants (affected people) the distribution of number of persons highly annoyed (based on L_{den}) or self-reported highly sleep disturbed (based on L_{night}) can be calculated. Figure 6 shows the hotspots of high annoyance in the surrounding area of the Berlin Brandenburg Airport.

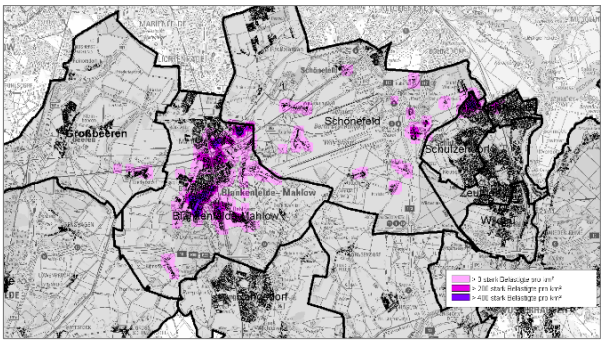

Figure 6. Detected hotspots based on distribution of number of persons highly annoyed within the area with significant aircraft noise contribution

The prepared noise maps, the detected hotspots and the noise prediction model which has been created enables the development and evaluation of potential noise reduction measures as detailed in Section 4.

4. Noise reduction potentials of flight operation measures

The existing *aircraft noise study commission* (Fluglärmkommission) with noise experts and representatives of the surrounding communities, public authorities, the national action group against aircraft noise, the airport management and airline operators discusses possible horizontal flight route optimizations.
Within the *framework for noise action planning around the Berlin Brandenburg Airport* the so-called *"Reflected Hoffmann-Curve"* for westbound departures from the southern runway and the so-called *"passing flight track Blankenfelde-Mahlow"* for westbound departures from the northern runway of the Berlin Brandenburg Airport were evaluated by using the noise prediction model and the evaluation method described above.

To analyze the noise effects of westbound departures from the southern runway by shifting flight movements from a Standard Departure Route to the *Reflected Hoffmann-Curve* flight route, the aircraft noise contribution in the vicinity of the flight routes were calculated and presented (see Figure 7).

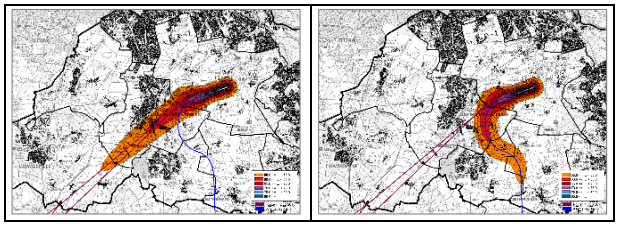

Figure 7. Aircraft noise distribution for westbound departures from the southern runway along the Standard Departure Route and the *Reflected Hoffmann-Curve* flight route

Figure 8 identifies the noise difference map (based on L_{den}) and shows, which areas, in the case of using the alternative flight route navigation which result in higher or lower noise polluted areas compared to the use of the standard departure route.

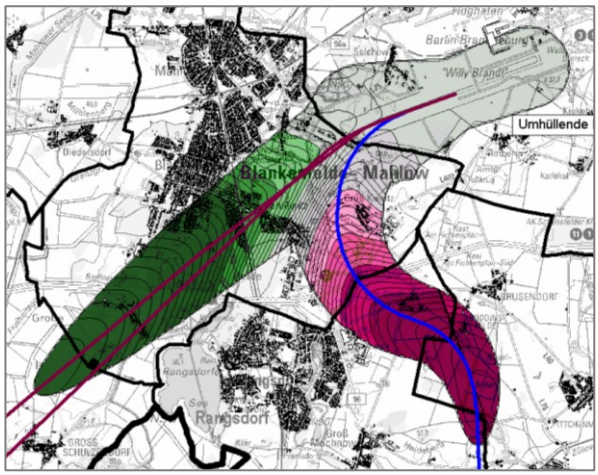

Figure 8. Difference noise map (L_{den}) showing effects by using the Reflected Hoffmann-Curve flight route

For a sound evaluation of the alternative *Reflected Hoffmann-Curve* flight route the number of highly annoyed and self-reported highly sleep disturbed persons were calculated based on the distribution of number of persons and the dose-response-relationships for aircraft noise shown in Figure 3 and [2]. In a second step the benefit of the alternative *Reflected Hoffmann-Curve* flight route was evaluated taking into account (i) the total noise contribution from all flight movements (according to the approved Datenerfassungssystem DES) of the Berlin Brandenburg Airport and (ii) the total noise contribution of the additional ambient noise sources of major road and major rail.

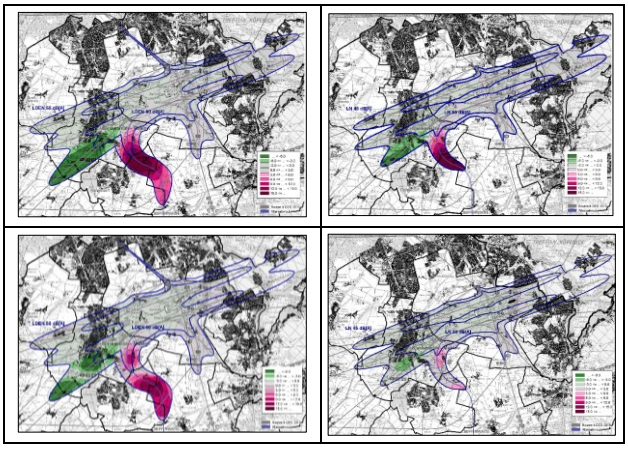

Figure 9. Difference noise maps (L_{den}/L_{night}) showing effects by using the *Reflected Hoffmann-Curve* under consideration of the noise contribution of all flight movements (top row) and all major noise sources (bottom row)

It is obvious, that recognized positive effects will be reduced by taking the ambient noise into account, as shown in Figure 9, with consideration of the total aircraft noise from the air traffic.

Table I table shows the effects of the use of the alternative flight route *Reflected Hoffmann-Curve* and additionally (i) in combination with the total aircraft noise and (ii) in combination with all major noise sources.

Table I. Number of persons HA and HSD for different westbound departure routes from the southern runway.

Departure flight routes	*HA*	*HSD*
Departure_25R_Standard	1.235	322
Departure_25R_Reflected Hoffmann-Curve	519	71
(i) Approved DES	6.989	2.253
(i) Modified DES (with Reflected Hoffmann-Curve)	6.916	2.175
(ii) Approved DES with major roads and rails	14.236	8.619
(ii) Modified DES with major roads and rails	14.042	8.569

The benefit of the alternative *Reflected Hoffmann-Curve* can also be more effectively described as the change of number of persons affected in 5 dB classes, as shown in Table II where the approved DES and the modified DES will be compared.

Table II. Comparison of number affected persons approved DES and the modified DES.

Level Intervall in dB(A)		*Affected persons*			
		DES		*Modified DES with alt. route*	
from	*to*	L_{den}	L_{night}	L_{den}	L_{night}
45	50	-	26.700	-	24.600
50	55	-	5.900	-	5.400
55	60	28.300	200	29.700	200
60	65	8.300	0	6.300	0
65	70	300	0	300	0
70	75	0	0	0	0
75		0	0	0	0
Sum		**36.900**	**32.800**	**36.300**	**30.200**

The identified standard westbound departure route from the northern runway passes directively over the detected hotspot "Commune Blankenfelde-Mahlow" with a disproportionate inhabitant density, as shown in Figure 6. Therefore the previously discussed alternative departure route, the so-called *passing flight track Blankenfelde-Mahlow*, is a subject of the aircraft noise study commission (Fluglärmkommission) and is favored in particular from the representative of the Commune Blankenfelde-Mahlow.

The following noise maps (L_{den} and L_{night}) and difference map (based on L_{den}) show, which areas in case of using the alternative flight route navigation result in higher or lower noise impact compared to the use of the standard departure route.

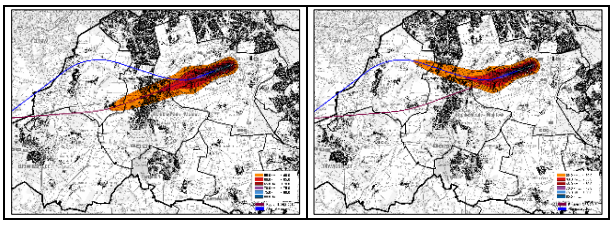

Figure 10. Aircraft noise distribution for westbound departures from the northern runway along the standard departure route and the *passing flight track Blanken-felde-Mahlow* flight route

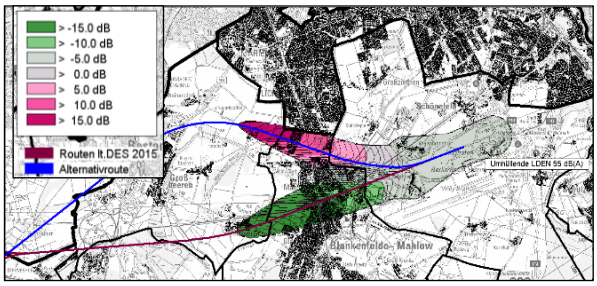

Figure 11. Difference noise map (L_{den}) showing effects by using the *passing flight track Blankenfelde-Mahlow* flight route

Table III summarizes the "single number values" HA and HSD for departures from the standard route compared to the alternative *passing flight track Blankenfelde-Mahlow* together with additional consideration of ambient noise from (i) air traffic and (ii) other major noise sources.

Table III. Number of persons HA and HSD for different westbound departure routes from the northern runway.

Departure flight routes	*HA*	*HSD*
Departure_25R_Standard	2.094	488
Departure_25R_passing flight track Blankenfelde-Mahlow	2.433	361
(i) Approved DES	6.989	2.253
(i) Modified DES (with passing flight track Blankenfelde-Mahlow day and night)	7.310	2.406
(ii) Approved DES with major roads and rails	14.236	8.619
(ii) Modified DES (only at night) with major roads and rails	14.236	8.597

The results show, that the singular consideration of the alternative flight route leads (only at night time) to predicted lower total self-reported sleep disturbance from westbound departures from the northern runway of the Berlin Brandenburg Airport. This basic approach allowed the alternative departure route to appear as a low noise flight route by night. It was only when taking into account the ambient noise contribution that the favored *passing flight track Blankenfelde-Mahlow* was identified as not a realistic alternative for reducing annoyance of the surrounding population.

5. Conclusions

For a robust evaluation of alternative flight routes, which is likely demanded by most noise affected communities in the surrounding area of an airport, the identified evaluation method can assist in providing an objective evaluation of the effects for further weighting with other aspects (safety, fuel costs, air pollution, etc.) to the respective interests of those interested parties.

References

[1] VDI 3722 Part 2: Effects of traffic noise, Characteristic quantities in case of impact of multiple sources.

[2] European Environment Agency: Good practice guide on noise exposure and potential health effects. Copenhagen: 2010 (EEA Technical report No 11/2010)