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THE INFLUENCE OF RESIDUAL NOISE ON COMMUNITY DISTURBANCE FROM AIRCRAFT NOISE AROUND GLASGOW AIRPORT

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1. INTRODUCTION

This paper describes the results of a study to assess the degree of disturbance from noise in the community around Glasgow Airport. It originated as part of a 1983 Commission of European Communities (CEC) initiative to evaluate the potential for harmonising the design of studies into the impact of environmental noise around airports. The study was carried out in conjunction with studies in France and The Netherlands which used the same design.

There are both methodological and substantive aspects to the paper. The methodological aspects consider the problems in designing a study of this type and make recommendations for future studies. The substantive aspects considered are, firstly, the impact of residual noise on community disturbance as a result of aircraft noise; and secondly, the relationship between overall annoyance from noise in general with that from aircraft noise alone.

2. DESIGN OF THE STUDY

Informed policy-making on environmental noise issues requires a good scientific understanding of the relationship between individuals' disturbance from noise and the noise they experience. Therefore the study design involved both a social survey and a series of noise measurements.

The core of the design was the designation of three common noise areas (CNAs) in each country, within which the social survey and noise measurement programme were undertaken. The CNAs were defined as areas within which noise levels from a particular aircraft varied by no more than around 3 dB. The CNAs had target levels of L_{Aeq} (0700-1900 BST) of 75, 65 and 55 dB respectively. In addition, each CNA was divided into two Residual Noise Zones (RNZs), one experiencing high levels of residual noise (L_{Aeq} around 65 dB) and the other low (L_{Aeq} around 50 dB). In its broadest sense, residual noise is taken to mean all noise except aircraft noise; in practice, road traffic noise was the predominant "other" source in all the zones.

The identification of suitable CNAs around Glasgow Airport proved to be a problem, as a number of possible CNAs did not have a sufficiently large sample size in the high RNZ. The areas finally chosen were Whitecrook (high CNA), Johnstone (medium CNA) and Knightswood (low CNA). Within each of the two RNZs in these CNAs a social survey of a representative sample of the residents was carried out. At the same time, noise measurements of both aircraft noise and residual noise (predominantly road traffic) were taken. These were taken concurrently so as (a) not to influence the responses to the social surveys, while (b) maximising the correlation between the survey answers and the actual noise exposure at the time of the survey. As a specific aim of the study was

the comparison of disturbance between the zones, the sample size in each zonewas targetted to be 120, which would be large enough to permit sound statistical comparisons. The achieved sample sizes and noise measurements for each zone are included in Table 1.

As with many studies of this type, the questionnaire was introduced as a study of the local environment and the respondent was initially given the opportunity to respond spontaneously that a noise source was a cause of disturbance. Subsequent questions asked the respondents about their reactions to noise at different times of the day and week, and to assess the extent to which certain activities were disturbed.

The social survey and noise measurement programmes were carried out between May and July 1984. Further details of the design can be found in Diamond *et al* (1986) [1]. Studies using the same basic design were also carried out successfully in France and The Netherlands. The next section, while concentrating on the results of the Glasgow survey, will also demonstrate that this programme has confirmed the potential for internationally comparable studies of community reaction to environmental noise around airports.

The results for Glasgow should be interpreted under two caveats. First, it has been common in aircraft noise studies to suggest that people living close to the airport will identify with the airport as they or their neighbours may be economically dependent on the airport. They will thus be less disposed to complain about the noise. This may be true around large airports such as Heathrow, but is less relevant around smaller airports such as Glasgow, which are less important to the economy of the community in its immediate surroundings.

Second, the CNAs were chosen so as to identify sufficiently large areas with high and low residual noise. This constraint imposed some restrictions on the social composition of the sample which in Glasgow is predominantly from social classes III to V, who traditionally have been less likely to complain about their environment than their counterparts in social classes I and II. The sample is representative of the population in each CNA but not necessarily of the population around Glasgow Airport. Therefore it is likely that the overall levels of disturbance reported will be lower than those in the overall population exposed to noise around Glasgow Airport.

3. RESULTS

The initial questions on individuals' perceptions of their environment demonstrated that the high CNA (Whitecrook) was the least desirable area. To illustrate these perceptions of the environment, Table 2 lists those items mentioned by at least 20% of respondents as contributing to their like or dislike of that area. A measure such as this is at best subjective, but two trends are clear. Environmental features liked by the respondents are common across areas whilst noise is considered to be detrimental to the environment by those experiencing the highest levels.

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The comparison of levels of annoyance from various sources between high and low RNZs is initially undertaken by single noise sources. Table 3 gives the means and standard deviations of a number of annoyance indices by zone, and Figures 1 to 3 show the proportions annoyed in each zone plotted against the relevant aircraft and residual noise levels. A number of points are apparent. First, it is clear that road traffic noise is not a great source of annoyance to the respondents in this survey. Although there is a significant difference between high and low RNZs in the medium and low CNAs, annoyance from road traffic rarely exceeds 20% of the respondents reporting they are very highly annoyed. Second, there is no evidence that annoyance due to aircraft noise varies systematically between RNZ. Respondents in Johnstone are more annoyed in the low RNZ whereas in the other two CNAs respondents are more annoyed in the high RNZs. Third, respondents in the low RNZ at Whitecrook were less annoyed by aircraft noise as a group than their counterparts in the low RNZ at Johnstone. Results such as these have been found previously and have two complementary interpretations. Those living in a high CNA may have chosen to do so in the knowledge that the aircraft noise will be a distinctive feature of the environment and will thus be less annoyed as a group than those in the medium CNA into whose environment the aircraft noise may be more of an intrusion. Additionally there are differences in the social composition of the two CNAs which account for some of the differences.

With regard to overall levels of noise there was evidence that respondents in Whitecrook were less likely to reply at the extremes of the scale (10/10) than their counterparts at Johnstone. Figure 3 shows the direction of the relationship change when the proportions answering 8-10 rather than 10 were considered. For this latter group it is clear that annoyance is directly related to aircraft noise level but that road traffic noise plays a less important role.

These figures provide visual evidence of the relationship between disturbance and noise levels. It is also necessary to test statistically whether the observed differences in the proportions annoyed in High and Low RNZs are significant. It has already been stated that many of these differences are not significant. Clear evidence is provided by Table 4, which gives the sample sizes that would have been required in each zone for differences of the magnitude of those observed here to have been significant. These sample sizes are, in general, much larger than those obtained in this study. In fact, those for Knightswood are much larger than those possible had a "census" rather than a sample survey been undertaken. The conclusion is that the differences are not significant.

To quantify the relationship between disturbance due to aircraft noise and levels of aircraft and road traffic noise a number of regressions were performed. With only three levels of aircraft noise there is little opportunity to test the relevance of any non-linear relationship. The regression equations for annoyance due to aircraft and overall noise are as follows:

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Aircraft: Annoyance = −17.14 + 0.35 ALEQ24 − 0.01 RLEQ24
(1.91) (0.01) (0.01)

Overall Noise: Annoyance = −13.77 + 0.21 ALEQ24 + 0.08 RLEQ24
(2.04) (0.03) (0.01)

(ALEQ24 and RLEQ24 represent the $L_{Aeq,24\ h}$ for aircraft and road traffic respectively.)

The conclusions are clear. There is no evidence that levels of road traffic noise play an important role in determining an individual's annoyance due to aircraft noise, and are less important than aircraft noise in determining their annoyance with the overall level of noise in their environment. The regressions for aircraft noise annoyance may be summarised as demonstrating than an increase in ALEQ24 of around 10 dB, similar to that between Knightswood and Johnstone, will lead to an increase in annoyance of around 3 points on a 10 point scale.

4. RELATIONSHIPS WITH OTHER STUDIES

Figures 4 and 5 compare the results in the previous section with those in other studies. Figure 4 gives the proportion very much annoyed in the six zones in this study together with those in the ANIS study (1982) [2]. It is clear that the results for Knightswood and Johnstone are very comparable, while the respondents in Whitecrook report less annoyance as a group than would be expected. Some reasons for this have been discussed earlier. Figure 5 compares the Glasgow study with those in France and The Netherlands and demonstrates the success of the international study. It includes the fitted regression line which is similar to that for the British data alone.

5. CONCLUSIONS

This paper has demonstrated that there is no consistent evidence that the disturbance due to aircraft noise is influenced by residual noise. There is clear evidence, however, that annoyance due to aircraft noise increases as the level of aircraft noise increases; typically an increase of around 10 dB in 24 h Aircraft L_{Aeq} increases annoyance by around one third of the range of the scales used in this study.

Although there were few significant differences in the proportions annoyed between high and low RNZs, the direction of the relationship changed between CNAs. Respondents in the low RNZ in Johnstone were more annoyed than those in the high RNZ in contrast to their contemporaries in Knightswood and Whitecrook.

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REFERENCES

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2. P. BROOKER, J.B. CRITCHLEY, D.J. MONKMAN, G.C. RICHMOND 1985 Directorate of Research DR Report 8402. United Kingdom Aircraft Noise Index Study: Main Report. Chief Scientist's Division, Civil Aviation Authority, London.

Table 1: Summary statistics for Glasgow study.

CNA / RNZ	Whitecrook High	Whitecrook Low	Johnstone High	Johnstone Low	Knightswood High	Knightswood Low
Sample size	77	126	86	109	105	104
24 h aircraft L_{Aeq}	68.2		66.7		55.7	
24 h residual L_{Aeq}	63.6	53.9	67.5	52.4	68.8	51.2

Table 2: Area characteristics mentioned as contributing to liking or disliking an area by more than 20% of respondents

	Whitecrook High	Whitecrook Low	Johnstone High	Johnstone Low	Knightswood High	Knightswood Low
Reasons for liking an area	Public Services Quietness Friendliness Attractive neighbourhood Shopping facilities	Public Services Quietness Friendliness	Public Services Quietness Friendliness Attractive neighbourhood Shopping facilities	Quietness Friendliness Attractive neighbourhood	Public Services Friendliness Attractive neighbourhood	Public Services Quietness Friendliness Attractive neighbourhood
Reasons for disliking an area	Aircraft noise	Aircraft noise Crime	Aircraft noise Traffic noise		Traffic noise	

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Table 3: Means and standard deviations of annoyance measures by zone (scale: minimum 1; maximum 10)

	Whitecrook		Johnstone		Knightswood	
	High	Low	High	Low	High	Low
A24A	7.58(2.37)	6.67(2.73)	7.93(2.59)	8.36(2.32)	4.02(3.02)	3.93(2.79)
R24B	3.90(2.76)	1.84(1.79)	5.45(2.94)	2.03(1.73)	5.36(3.04)	2.00(1.82)
N24D	7.19(2.42)	6.01(2.99)	6.10(3.31)	5.34(2.29)	5.23(2.96)	3.34(2.39)

A24A - overall feelings: aircraft noise
R24B - overall feelings: road traffic noise
N24D - overall feelings: noise in general

Table 4: Sample sizes for differences observed in this study to be signifcant

Annoyance Measure	Whitecrook	Johnstone	Knightswood
Overall feelings about noise	168	608	177
Annoyance from aircraft noise			
- at weekends	240	1850	2318
- at night	2474	293	1538
- in general	281	563	1538

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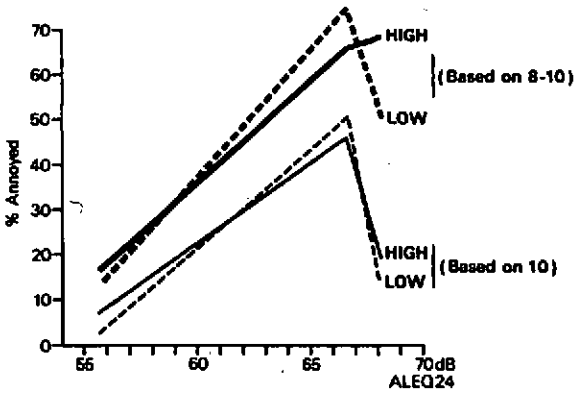

Figure 1 Overall feelings towards aircraft noise (A24A)

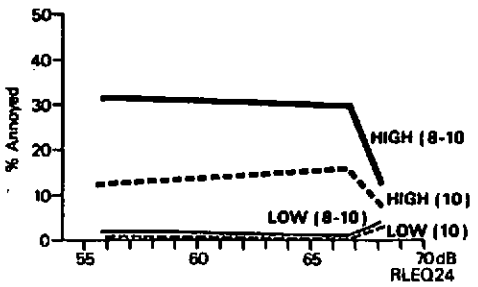

Figure 2 Overall feelings towards road traffic (R24B)

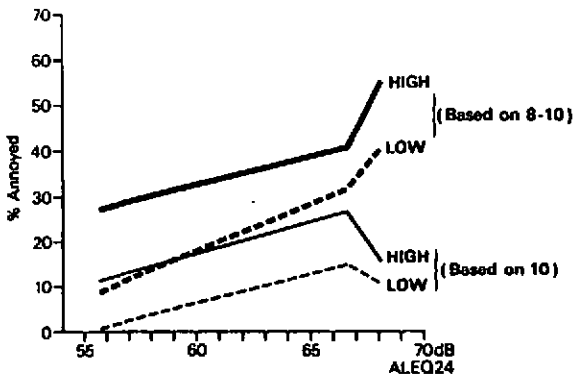

Figure 3 Overall feelings towards noise in general (N24D)

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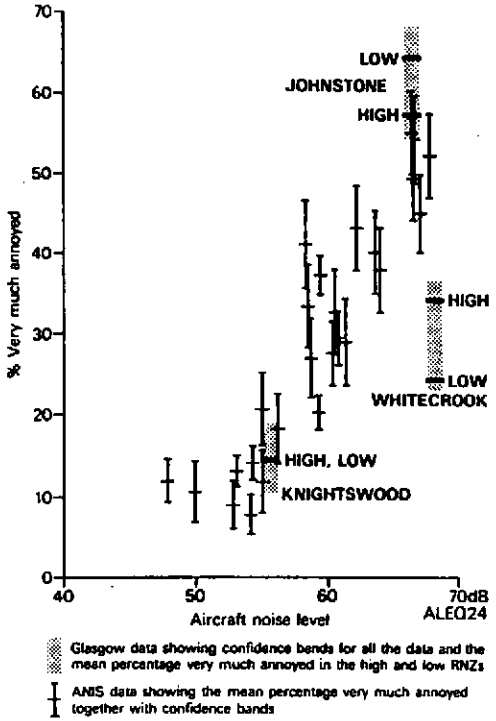

Figure 4 Comparison of results of Glasgow study (Q19) with those of the ANIS study (Q11a) (from Figure 9.4 of Ref. 2)

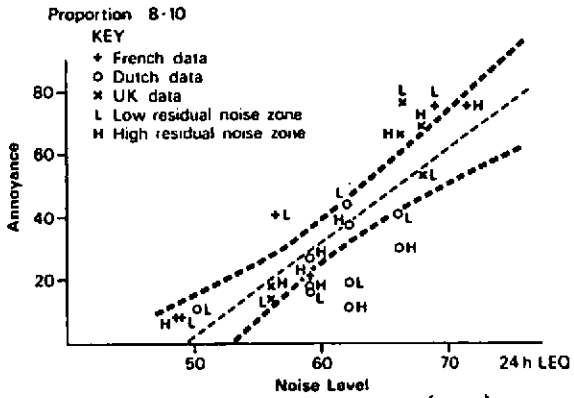

Fig 5 Proportion expressing high annoyance (≥8/10) with aircraft noise by level of noise from aircraft