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THE RELATIONSHIP BETWEEN NOISE AND ANNOYANCE AROUND ORLY

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Translation of "Liaison entre le bruit et la gene autour d'Orly", Report, Institut Francais d'Opinion Publique, Paris, France, January 1973, pp 1 - 76

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16. Abstract

The purpose of this report is to study the extent to which annoyance estimated by an isopsophic index is a good forecaster for annoyance perceived near airport approaches. An index of sensed annoyance is constructed, and the relationship between the annoyance index and the isopsophic index is studied.

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ABSTRACT

In order to direct actions for protecting airport approaches against disturbances caused by aircraft noise, it is very important to have an instrument ennabling measurement of the annoyance caused by aircraft.

For this purpose, isopsophic indices have been evaluated. While they attempt to estimate annoyance caused by noise, their validity has not always been correctly demonstrated.

The purpose of the present research is to study the extent to which annoyance estimated by an isopsophic index (the French index N) is a good forecaster for annoyance perceived near airport approaches.

Therefore, the following tasks were set:

-- Construct an index of sensed annoyance: Based on 5,000 interviews performed by the IFOP-ETMAN around Orly Airport in the spring of 1971, a factorial analysis has ennabled definition of an annoyance index (GO) whose validity and sensitivity have been demonstrated.

-- Study the relationship between GO and the isopsophic index (whose values were calculated by S.T.N.A.) within the inquiry zone.

This document describes the original methodology of research and its first results. It appears that the isopsophic index N is a good estimate of annoyance, but a critical analysis of this index based on obtained results will improve its validity. Formulated in this report are first critical evaluations and hypotheses.

Research is continuing at the present time, and a subsequent document will present all of the results and conclusion can be drawn.

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INTRODUCTION

A. OBJECTIVES OF RESEARCH /1*

For several years, one of the major desires of services in charge of environmental protection has been the finding of solutions to problems caused by noise.

Particularly in aeronautics, the urgency of these problems has increased since 1960, when there was the massive introduction of jet aircraft into international commercial fleets. Work on research coordinated on a world scale, especially by the O.A.C.I., encounters substantial technical and economic obstacles. While some solutions have already have been implemented, they have usually been long-range solutions and not very significant. In most cases, implementation requires substantial funds.

Primary ways in which action can be taken at present can be classified into three categories:

1) Action to make aircraft less noisy

A number of measures are being considered that would make aircraft less noisy, and a first step that has already been begun is the acoustic certification of aircraft. The following steps now being discussed require substantial funds, sometimes deemed inappropriate with relation to achieved results. It seems that the noisiest of aircraft now in use are expected to cease operation between 1980 and 1990, depending on the importance of accomplishing this and the expenses entailed.

*Numbers in the margin indicate pagination of original foreign text.

2) <u>Direct action on areas surrounding airports</u> /2

At present, two forms of action are being considered: participation in the financing of sound-proofing of apartments and assistance in moving.

These two types of action would have only a long-term effect and would require substantial funds.

3) <u>Operational actions</u>

These provide special measures for use of airports and aircraft, so as to impose a minimum disturbance on the environment. They are known as "least noise procedures." They avoid overflight of urbanized areas, reduce thrust after take-off, use runways on a preferential basis, observe a nighttime blackout, etc.

While these have a relatively limited effect, their effect is immediate. In general, they are not costly, but they must be optimized from the viewpoint of perceived annoyance.

It is necessary to optimize the costs involved and actions undertaken in a general manner, taking into account the reduction in disturbance one wishes to achieve. Until one knowns how to make exact measure of these noise variation, however, it will not be possible to have an exact method of finding corresponding variations in annoyance.

In effect, there is poor knowledge of the relationship between the noise and annoyance experienced around airports.

Isopsophic indices, which are used for lack of a better instrument, represent the annoyance without being assured of validity.

This is why the present inquiry is primarily oriented toward establishing the relationship between the isopsophic indices and perceived annoyance. This research will allow formulation of constructive criteria of noise indices used at present. Also, it will be possible to determine a method of noise measurement to improve prediction of noise caused by aircraft.

The operational purpose of this research is to provide elements to allow evaluation of the efficiency of actions, by relating variations of annoyances brought about by variations of noise exposure. /3

This inquiry is not the first element of this research. It has been preceded by othersof similar direction, e.g. the CSTB inquiry (1968), the report by Mr. Alexandre (1970) and the American inquiries (TRACOR). However, our inquiry differs in the methods used and intends to obtain new elements for studying annoyance be developing a new methodology adapted to needs of research in this area.

B. METHODOLOGICAL PROCEDURE /4

1. Location of the study.

The airport studied in this inquiry is Orly Airport (Paris) It is in its vicinity that the annoyance is the greatest due to its intensity (heavy aviation traffic) and because of the numerical magnitude of the population involved. As an inquiry zone we defined the zone in the map in the Appendix (see page 51) and a sufficiently extended zone (about 110Km2) selected to show large variations in noise exposure and annoyance.

The purpose of this study was to find the relationship between noise and the global annoyance, at the level of the defined zone. In a more detailed manner we wished to examine the local variations of these variables. This large zone was therefore divided into squares having reduced dimensions, so as to be able to consider the noise exposure homogeneous to each square. The sector studied was divided into squares, nine squares per square kilometer (i.e. squares having a side length of 333 m). Therefore, we had to carry out a measurement of noise and a measurement of annoyance within each square with a 333 m side length.

2. Noise measurement.

Noise was expressed using noise exposure units which are presently used: the isopsophic index. We did not make any a priori critical analysis. We preferred to base our opinion on the examination of research results in order to study this index critically. From the precise information about the validity of this information, this analysis then led to the present report and will be pursued in a following publication.

The value of the isopsophic index in the center of each square with a side length of 333 m was expressed by the calculation (see page 62 for the accuracies of the calculation method). An index based on measurements, of course, would have been preferable, but this would have required a substantial amount of preliminary work.

It is known that the estimation method used for the calculation gives results which are rather well correlated with those which would have been obtained from measurements themselves. However, in this study, it is not possible to take into account all the particular cases of propagation which occur, considering the extent of the inquiry zone. Of course, it would be necessary to take this inaccuracy into account when interpreting the results of the inquiry.

3. Measurement of annoyance. /5

Previous studies showed that the annoyance perception caused by aircraft noise often varies strongly from one individual to another, independent of noise exposure. Because of the requirements for precise analysis of the correlation of variations of noise and annoyance, it was not sufficient simply to measure the annoyance of a single individual in each square. It was necessary to define average annoyance levels at each point of the territory.

Therefore, five interviews per square with a side length of 333 m were carried out, i.e. 45 interviews per Km^2. In total, 5,000 persons were interrogated. The distribution of the interviews was carried out in a uniform manner in the zone under study(1). Considering the objective of the study, it was not useful to distribute the sample in proportion to the real density of population.

The persons interviewed were selected by means of stratified sampling, called the quota method. (See page 52 for the description of the method used.)
The questionnaire used was taken from the OCDE questionnaire, which has become a classic for noise measurements, with slight modifications. This questionnaire is attached to the Appendix (page 58).

The following step consisted of measuring the annoyance expressed by the persons interrogated. For this measurement, the method was to extract a question such as, "Do aircraft annoy you?", and to classify the persons interviewed into two categories (those annoyed and those not annoyed) or into several categories, by taking a question which had several possible responses. This use of the rather complex questionnaire would be very incomplete and very poor, as well.

Another method would have consisted of using a hierarchical scale of Guttman, which allows one to establish an annoyance note and ten scales by classification of the questions. But this involves problems because this is an incomplete utilization of the questionnaire,and also, the interpretation of the annoyance levels is delicate.

Therefore, we preferred to use a factorial analysis /6

(1) Interviews were not performed in squares where there were fewer than five inhabitants.

method discussed later on. It allows the establishment of a notation system, using weighting which is best synthesized with the information obtained in the responses to a large number of questions. In this way, we can attribute an annoyance note to each person interviewed.

4. Analysis of the relationship between noise index and annoyance.

At the beginning of this work, we therefore had 5,000 results in the following form for each individual:

- a noise exposure index (estimation calculated at the noise level in the center of the square of residence);

- an annoyance note;

- a geographical position (defined by the coordinates of the residence square).

After this, we performed a noise-annoyance correlation analysis as a function of these results. This was essentially a statistical study of a cloud of points in a two-dimensional space: noise, annoyance. We voluntarily restrained this study to the part of the inquiry zone where the exposure was homogeneous, in order to have a local correlation between the index and the annoyance. Comparisons of the various correlations corresponding to each type of traffic provided the beginning of a critical study of the isopsophic index. In this way, we could conclude both on the validity of the noise exposure index which was utilized and on the correlation laws.

It seemed interesting to present the results in the form of maps for the entire inquiry zone, even though they were only the topic of a partial analysis. Therefore, this study represents the first step in a long task, which is being pursued continuously.

This will allow the presentation of the work undertaken, the methodology employed and first results, which will give an idea of the final results and the validity of the procedure.

I. DEVELOPMENT OF AN ANNOYANCE INDEX /7

A. METHOD

1. Factorial analysis.

The inquiry questionnaire[1] has primary purpose of developing a sensed annoyance index. This questionnaire was therefore relatively short and contained questions essentially concerned with the annoyance caused by aircraft noise. Most of the questions used had already been posed in previous studies (especially in the OCDE study) and were selected among those which seemed to best cover annoyance and the phenomena closely related to it.

Annoyance caused by aircraft noise is a phenomenon with many factors. Therefore, a battery of questions was posed. Each person interviewed gave a series of responses which translated the intensity of annoyance and certain manifestations of it.

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(1) See the quetionnaire in the Appendix (page 58).

Methodologically, it was not preferable to define an annoyance index a priori (and therefore in a somewhat arbitrary manner); we intended to construct one from the responses of the persons interrogated. To do this, it was necessary to determine the weight each question would have in the composition of this index.

The most adequate method for resolving this type of problem is factorial analysis. It is known that factorial analysis allows one to find the main factors which take into account the variance of the results. In other terms, it demonstrates the sub-dimensions as a function of which the responses to the questions are organized. In this way, one can summarize information collected from an individual, not only by studying the collection of these responses to the various questions but also by establishing every person's position along the axis or the factors which make up the latent variables in some sense.

This information treatment was especially adapted to the objective, because it allows the determination of the weighting coefficients of each question, and to calculate the "note" obtained by each individual on the various factors found.

As it was known a priori the questions which were the basis of the factorial analysis would lead to an expression of the annoyance to various degrees, we were assured that the main factor of this analysis would translate the intensity of sensed annoyance. A simple transformation, then, allows one to construct an annoyance index from this factor. /8

a) Calculation method.

The questions used for this analysis are given below. The various responses of each question were given notes varying from 1 to the maximum number of responses, ranked according to the order of an annoyance or an increasing discomfort. In addition, we assigned an average note to the persons who did not give a response to the question.

Question 2 (Q. 2)

- Judgment about the general living conditions in the quarter.

Question 3D (Q. 3D)

- Degree of satisfaction with tranquillity of the quarter from the point of view of ambient noise.

Question 4A and B (Q. 4), summarized as follows:

- Have considered or are presently considering leaving the quarter due to aircraft noise,
- Because of noise in general (without the mention of aircraft),
- For other causes.

Question 5 (Q. 5)

- Frequency of annoyance due to ambient noise.

Questions 6 and 7 (Q. 6-7), summarized as follows:

- Hearing aircraft was mentioned spontaneously,
- Was heard and was mentioned after it had been suggested,
- Aircraft noise not heard.

Question 8 (Q. 8) /9

- Order of various noises perceived, relative to the annoyance which they produce.

Question 9 (Q. 9)

- Note 0 to 10 attributed to the annoyance caused by aircraft noise.

Question 11 (Q. 11

- Intensity of annoyance caused by aircraft noise.

Question 12 (Q. 12)

- Frequency of annoyance caused by aircraft noise.

Question 13 (Q. 13)

- Intensity of aircraft noise.

Questions 14A to F (Q. 14A, 14B . . . 14F)

- Different circumstances of annoyance occasioned by aircraft noise.

Questions 16 and 17 (Q. 16-17A . . . 17E)

Counteractions against the aircraft noise, for each action we distinguished the following:

- Those who already took action,
- Those who had not taken action but declared that they would like to,
- Others.

Factorial analysis consisted, in this case, of finding a linear relationship between the various questions (or variables Q_i) in the following form: /10

$$F = \Sigma_i \; a_i \; Q_i$$

and such that F constitutes the best summary of information contained in the collections Q_i.

In this formula, we considered that the variables Q_i are reduced (centered around their averages and having a standard deviation equal to one) and also this was done to give all the variables an equal weight.

The computer calculates the coefficients A_i by maximizing the variance of F: $\Sigma_i \; a_i^2$ constant.

The maximum of the variance of F was achieved, and then the coefficients A_i are the correlation coefficients between the questions and the factor or the saturation coefficients of Q_i in F [1]

[1] Strictly speaking, the coefficients A_i are, except for a multiplication constant, the correlation coefficients between Q_i and F. In the adapted formula, $F = \Sigma a_i \; Q_i$, 1 is taken as a multiplication constant, even though A_i is effectively the correlation coefficient between Q_i and F".

The ratio $$\frac{100\Sigma_i \ a_i^2}{n}$$

where n is the number of questions Q_i, and is the average percentage of variance of F. This ratio takes into account the quality of F and summarizes the information contained in the variables Q_i.

The program utilized is based on the method of Hotelling, calculated for as many factors F (i.e. linear combinations among variables) which are independent as there are variables introduced. The program is an iteration program, and the factors obtained are classified according to their explicitive power (PVE) on a decreasing scale.

This factorial analysis was carried out for responses for the collection of 5,000 individuals interrogated, who lived in the inquiry zone and were therefore exposed to various degrees of aircraft noise.

The results obtained seemed very satisfactory: the factor which one wished to isolate is clearly separate from the others.

The average percentages of explicit variances are, in effect, the following:

Factor I	37.5 %
Factor II	8.5 %
Factor III	7.1 %
Factor IV	5.2 %
Factor V	4.3 %
Etc.	

b) <u>Interpretation of factors</u>:

In order to understand the significance of the factors isolated by the factorial analysis, we have to examine the "content" of these factors. Each factor is a linear combination among variables of the following type:

$$F_1 = a_1 Q_1 + a_2 O_2 + a_3 O_3 \ldots .$$

The coefficients a_i (correlation coefficients between the the questions and and the factor) allow one to find the weight of each question in the factor. The questions having the largest coefficients are those which occur most in this factor. There are also those whose responses influence the position of an individual the most, with respect to this factor. Therefore, the examination of the coefficients a_i allows one to interpret the significance of the various factors.

<u>Significance of the factor I</u>

The reader of the following page (page 12) will find a table showing the values of the coefficients a_i corresponding to the first factor, for all of the questions used in the factorial analysis.

We can observe that the variables which are involved /13
most in the first factor are Questions 11, 12, 13, 14C and 14D. Examination of the content of these questions shows that this factor does measure the intensity of annoyance caused by aircraft noise by synthesizing the importance, frequency and nature of this annoyance.

The fact that all the coefficients a_i are positive

THE COEFFICIENTS a_i CORRESPONDING TO THE FIRST FACTOR

Reduced variables, Q_i (1)		a_i
Q. 11	- Importance of annoyance	0.890
Q. 12	- Frequency of annoyance due to aircraft	0.881
Q. 14d	- Annoyance due to hearing radio or TV	0.827
Q. 13	- Noise intensity	0.812
Q. 9	- Notation of annoyance	0.729
Q. 6-7	- Perception of aircraft noise	0.655
Q. 16-17c	- Protest in the form of petitions	0.644
Q. 5	- Frequency of annoyance due to ambient noise	0.643
Q. 14e	- Annoyance with respect to opening windows	0.635
Q. 14b	- Being awakened due to noise	0.608
Q. 3d	- Tranquillity of the locality from the point of view of noise	0.595
Q. 14a	- Annoyance associated with falling asleep	0.575
Q. 8	- Rank of noise of aircraft among disturbing noises	0.530
Q. 16-17d	- Protest by participation in public meetings	0.391
Q. 4	- Possibility of moving	0.360
Q. 14f	- Fear due to aircraft noise	0.356
Q. 16-17A	- Protest expressed in writing or by telephone	0.346
Q. 16-17B	- Protest in the form of a visit to an official	0.340
Q. 2	- Estimation of living conditions in the quarter	0.288
Q. 16-17E	- Protest in other forms	0.221

(1) See pages 8 and 9 for content of these questions.

indicates, among other things, that all of the questions used a priori as possible indices of the sensed annoyance intensity are well correlated with this factor in a positive way.

From the battery of questions posed, therefore, we were able to show an important sub-variable that allows one to place each individual in a continuum of 0 annoyance to strong annoyance.

Significance of other factors

The method used determines in a hierarchical manner as many factors as there are variables introduced. We know that only the first factors, which have a large variance percentage, have a real significance. The others are simple mathematical entities, and it would be fruitless to look for a corresponding psychological meaning.

In the present case, factors II and III seem to be significant. From an examination of the saturation coefficients a_i, given on the following page (page 14), we can apparently, therefore, interpret them as follows:

Factor II seems to translate the degree of tolerance with respect to noise. At one extreme of this factor, we find individuals who do not tolerate noise at all, those who have protested against noise and those who have planned to move. On the other extreme, we have those who are quite or only slightly sensitive to aircraft noise.

Factor III seems to correspond to the type of reaction to the noise problem (protest or escape) related to the level of satisfaction with the environment. At one extreme of this factor, we have the persons who protest against aircraft noise and who are satisfied with local living conditions. At the other extreme, we have individuals who are considering moving and who are not very satisfied with their environment.

In spite of the deliberately limited number of points given on the questionnaire, and even though the factorial analysis was carried out only for the questions most directly related to noise, several significant factors could be derived. The first factor simply measures the level of sensed annoyance (later on we will discuss this interpretation). It appears that the two other factors translate more the modes of reaction to noise. Therefore, we can confirm that the exposure to aircraft noise also involves psychological (attitudinal) factors which play a non-neglible role in explaining reactions of individuals with respect to noise. /13

We can note that the propensity to protest against noise constitutes a complex phenomenon, because questions on this topic are rather highly saturated in the three factors studied. Therefore, it seems we can conclude that personal characteristics may predispose an individual to protest, and this is manifest more readily the more the individual is exposed to noise.

2. Construction of the annoyance index GO

The first factor allows classification of the interviewed persons with respect to others, as a function of the annoyance intensity which they sense. This can therefore be considered as an annoyance index.

However, it has one drawback in that it is a rough note: its distribution is characterized by values which do not have the

COEFFICIENTS a_i CORRESPONDING TO SECOND AND THIRD FACTOR

Reduced variables Q_i (1)	Factor II a_i	Factor III a_i
Q. 2 – Estimation of living conditions in the quarter	- 0.280	- 0.511
Q. 3d – Tranquillity of the locality from the noise point of view	- 0.183	- 0.475
Q. 4 – Possibility of moving	- 0.298	- 0.358
Q. 5 – Frequency of annoyance due to annoyance due to ambient noise	- 0.135	- 0.424
Q. 6-7 – Perception of aircraft noise	0.389	0.249
Q. 8 – Rank of aircraft noise among disturbing noises	0.387	0.214
Q. 9 – Noticing annoyance	0.009	0.139
Q. 11 – Importance of annoyance	0.227	0.038
Q. 12 – Frequency of annoyance due to aircraft	0.232	0.035
Q. 13 – Intensity of noise	0.363	0.136
Q. 14a – Annoyance associated with falling asleep	- 0.138	- 0.101
Q. 14b – Waking up due to noise	- 0.131	- 0.018
Q. 14c – Annoyance during conversation	- 0.138	0.038
Q. 14d – Annoyance when listening to radio or TV	- 0.181	0.035
Q. 14e – Annoyance due to opening windows	- 0.124	- 0.068
Q. 14f – Fright due to aircraft noise	- 0.143	- 0.061
Q. 16-17a – Protest expressed in writing or by telephone	- 0.515	0.376
Q. 16-17b – Protest by a visit to an official	- 0.549	0.395
Q. 16-17c – Protest in the form of petitions	- 0.240	0.142
Q. 16-17d – Protest by participation in public meetings	- 0.444	0.357
Q. 16-17e – Protest in other forms	- 0.296	0.272

(1) See pages 8 and 9 about content of these questions.

simplicity which one would wish to find in such an index. In effect, the first factor has an average of 28 and a standard variation of 7.9.

Therefore, from this factor we constructed an index which we will call GO.

In order to clarify our analysis, we made this index increase with annoyance intensity and made it vary between approximately 0 and 100. Therefore, we decided to characterize GO by an average of 50 and a standard deviation of 15. If the distribution of GO had been normal, this index would then have varied between 5 and 95 ($\pm$ 3 standard deviation).

This transformation was carried out with the following formula:

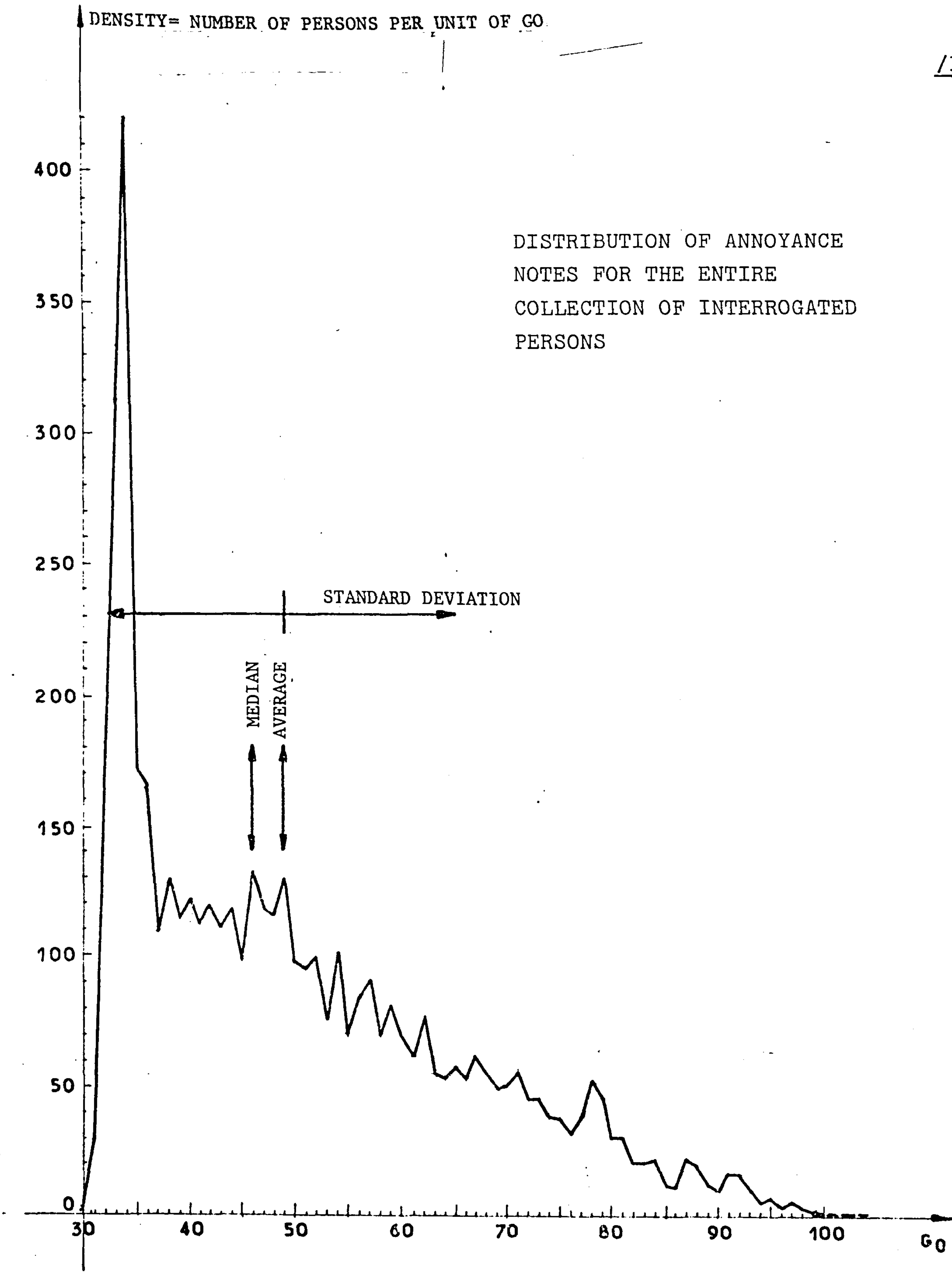
$$GO = \frac{15\ (FI - 28)}{7.9} + 50$$

On the following page (page 17) the reader will find a graph showing the distribution of GO among the various interrogated persons.

We can see that this distribution is highly non-symmetric and varies between 30 to more than 100. This phenomenon is related to the characteristics of the interview zone: the interviews were distributed for a rather large area, which includes for the most part the smaller zones, where noise exposure is very high.

It is because we interrogated a majority of persons who were not very highly exposed to noise of aircraft that we observed such a non-symmetrical property of the distribution of GO among the population interrogated.

The problem of the validity and sensitivity of GO as an


DENSITY= NUMBER OF PERSONS PER UNIT OF GO
400
350
300
250
200
150
100
50
0
STANDARD DEVIATION
MEDIAN
AVERAGE
30
40
50
60
70
80
90
100
GO
DISTRIBUTION OF ANNOYANCE NOTES FOR THE ENTIRE COLLECTION OF INTERROGATED PERSONS

instrument of measurement of annoyance will be examined in the following paragraph which discussed its interpretation.

B. INTERPRETATION OF THE INDEX GO /18

Before studying the relationship of the index GO defined as above and the isopsophic index, it is important to analyze the detail, its significance and its psychological content.

We can consider GO as a measuring instrument of annoyance, or, more strictly speaking, a measurement of distribution, because we are dealing with a scale which attempts to establish an ordering relationship between individuals. It is important to analyze calibration of GO[1], i.e. to find the significance of the various scales and the sensitivity of this measurement scale.

Examination of the coefficients a_i allowed one to confirm that GO measures the intensity of the annoyance caused by aircraft noise. The results shown in the Appendix[2], the essential features of which are summarized in the following Table, show that for all of the questions, the average note GO of the individuals who made responses is greater, the more these responses translate into a higher annoyance. The collection of these results has a very high coherence.

The significance of the absolute values of this index can also be appreciated from these Tables. We observe, for example, that the collection of persons who state that aircraft noise disturbs them greatly and those who declare that this noise annoys them very often, that they are frequently prevented from sleeping,

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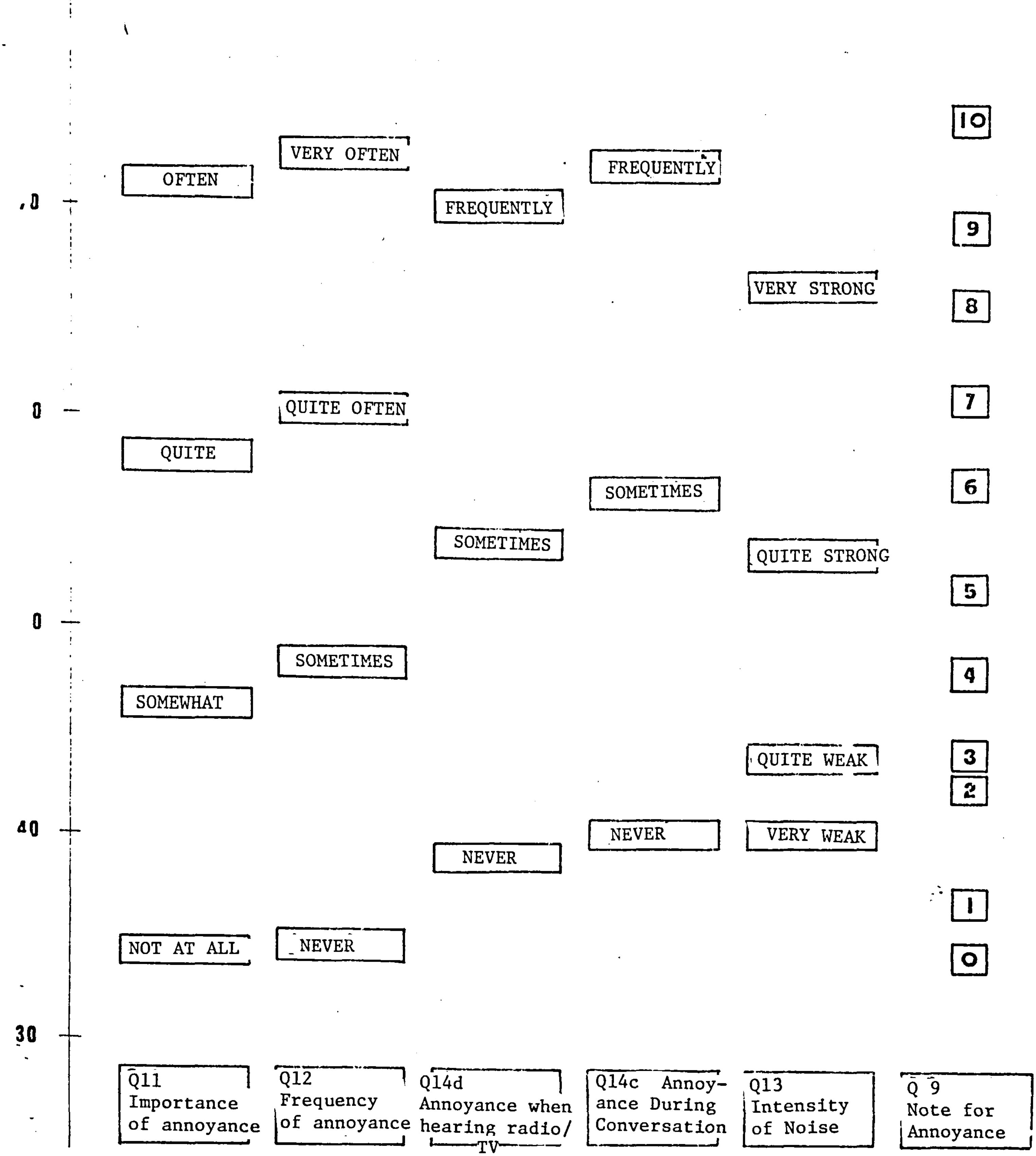
(1)The absolute values of GO are naturally only of significance in the present study: a survey realized around another airport (where various noise parameters would be different) and/or in an inquiry zone which is divided up differently, would have led to the construction of an annoyance index whose notes would have different significance.

(2)See pages 67 to 73.

AVERAGE VALUES OF GO OF INDIVIDUALS WHO GAVE DIFFERENT RESPONSES TO THE MOST SIGNIFICANT QUESTIONS



making conversation, etc., have on the average a note GO greater than 70. On the other hand, persons for whom the annoyance is 0 or negligible, on the average, have a note GO less than 40.

However, when interpreting these Tables, it must be recalled /20 that the note GO of an individual is determined by the collection of his responses to questions taken into account, and not by a single response. Therefore, the average note of persons who are very much annoyed by aircraft as well as persons who are annoyed very often will be located around 70. The average note of persons annoyed a lot and very often would have to be higher.

These Tables allow one to isolate each question with respect to GO and to find GO (in terms of annoyance) which separates the various levels of each of these verbal scales.

For the most highly saturated questions in GO, the various responses to each question taken separately are distributed in a regular manner with respect to GO. This result, certainly due in part to the construction of GO, nevertheless can constitute a presupposition of the linearity of the scale GO.

Objectively, by a priori assuming the linearity of the verbal scales, we can estimate that the difference between two levels of GO translates the same variation of annoyance to all of the levels (or, at least, between values of 40 and 80 of this index).

We are led to believe that there are not substantial anomalies in the variation of GO. This will be confirmed in a subjective manner through the following analysis.

Another method of demonstrating the psychological significance of the various values of GO consists of establishing the distribution of the individual responses which have any GO note.

In order to obtain statistically-valid data[1], we regroup the index GO into classes (5 by 5, when the collection is too reduced, or 10 by 10). Based on the collection of individuals within each class, we then calculated the percentages of the various responses to certain questions which were particularly representative for annoyance. This representation allows another interpretation of the sensed annoyance, sensed by individuals having a given note GO, which then completes the preceding analysis.

From the graphs on the following pages, we find the following:

-- Annoyance, which is essentially zero among individuals, with a GO of less than 40, appears rather suddenly after this note. But this annoyance is still almost negligible. In effect, among individuals whose notes are between 40 and 45, less than half spontaneously mentioned aircraft noise among noises heard in the quarter. None of them estimates that the noise annoyance is great. None of them is frequently annoyed by noise during a conversation, or while hearing the radio or television. Almost nobody is prevented from sleeping or prevented from opening windows due to noise.

-- After a value of 55 of GO, annoyance is rather substantial. almost all of the interviewed persons heard very strong or quite strong noises, and three-quarters of them are annoyed a lot or often. Over half are annoyed quite a lot or very frequently. Three-quarters of the interviewed persons estimate that aircraft noise prevents them from hearing radio and television or from carrying on a conversation.

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(1) Data on the order of hundreds of interviews as a minimum in each class.

-- When GO reaches 65, more than half of the interviewed persons believe that the noise annoys them greatly, which in general is very strong, and which prevents them from hearing the radio or television.

-- Above a value of 70, more than one-half estimate that the noise annoys them very often, and frequently prevents them from talking; and more than half have signed a petition against noise or would like to do so. At this level of GO, annoyance seems very intense among these persons, who spontaneously mentioned aircraft noise among noises to which they were subjected in their quarter.

-- Annoyance continues to increase with values of GO, and when GO equals 90, a tolerance threshold is reached. Among individuals whose annoyance note is equal to or greater than 90, three-quarters already have signed a petition against noise, and ammost all of them would like to do so. More than half have already protested or would like to protest in another way: attend a meeting or see a representative.

These individuals are almost all frequently annoyed while hearing the radio or television and when carrying on conversations. Three-quarters of them, approximately, are prevented from opening windows and are frequently awakened by the noise.

A more detailed examination of the distribution of responses to each of the questions shows the following: /26

-- These distributions are essentially Gaussian;

-- The standard deviations only depend on the average values of GO for the question considered and increase with GO.

This can be interpreted in the following way (assuming that if GO were linear, the standard deviations for all of the questions would be the same).

-- GO is an instrument which is not very sensitive in in the vicinity of values between 30 and 40.

-- Its sensitivity increases. Furthermore, it becomes too strong around 90. We can, therefore, consider that it is optimum in the central region (40-80) and that in this zone the linearity of GO is a good approximation.

Stated differently, the fact that GO varies by five points, for example:

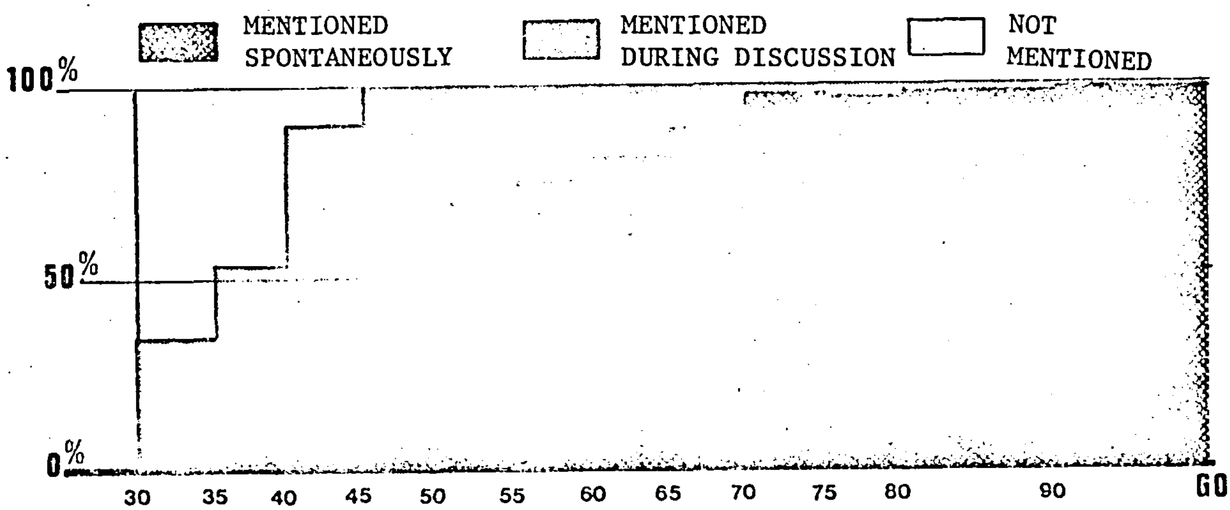
-- Is very significant between 35 and 40 (sudden appearance of slight annoyance);

-- Has a very small significance for large annoyance levels (80-100, only in annoyance excess);

-- Essentially has a constant sensitivity in the medium zones for which GO seems to be optimum.

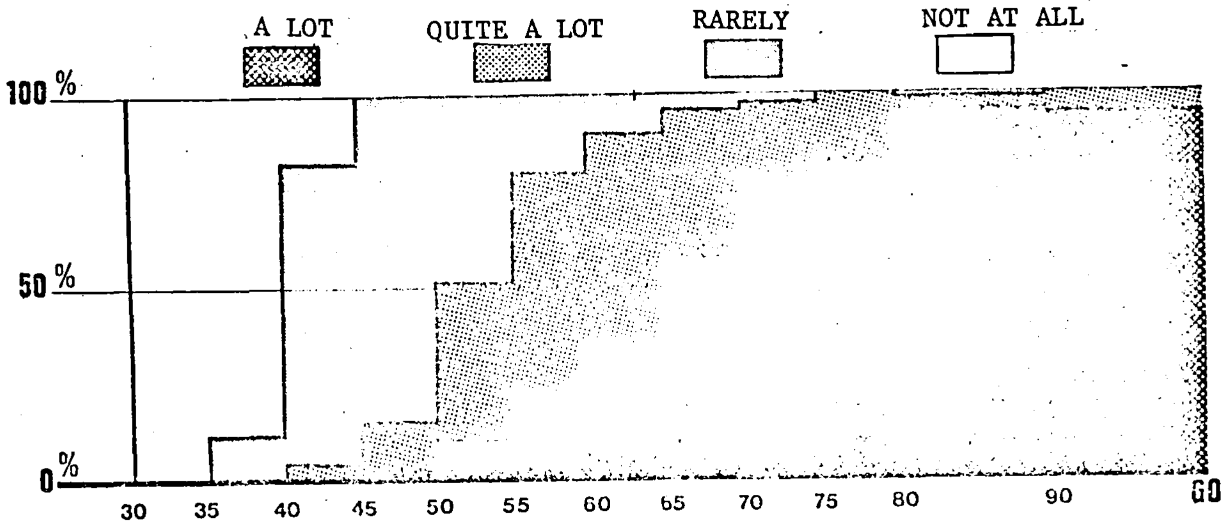
Utilization of function log (GO) for the annoyance note seems to be an acceptable idea in order to prove a subjective notion of linearity. Nevertheless, it would not be considered in this stage of the research.

NOISE HEARD IN THE QUARTER
DEPENDING ON THE VALUES OF GO

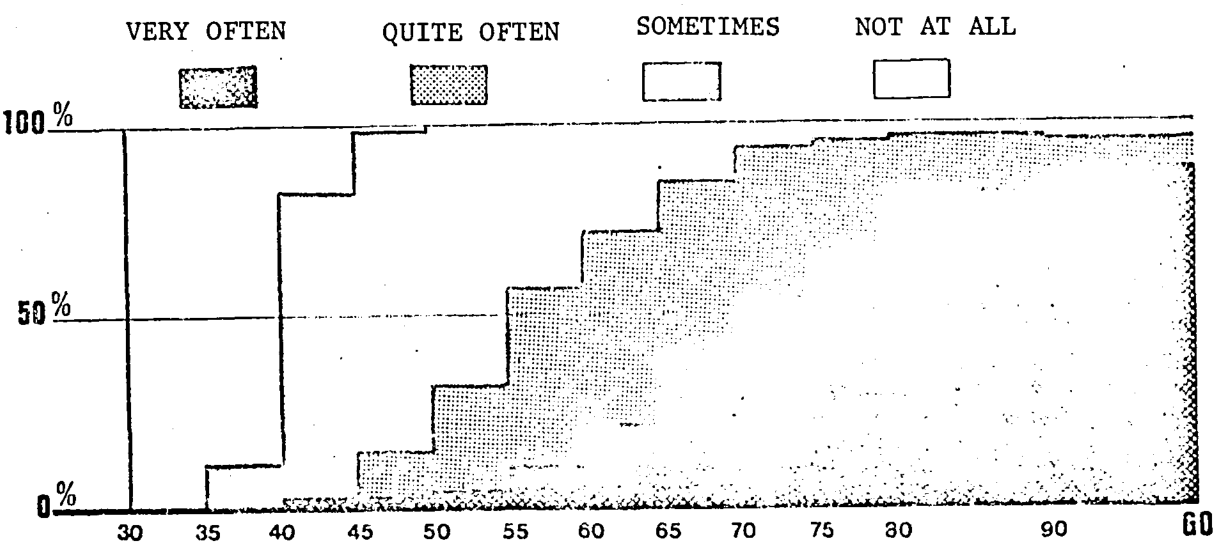


Aircraft noise

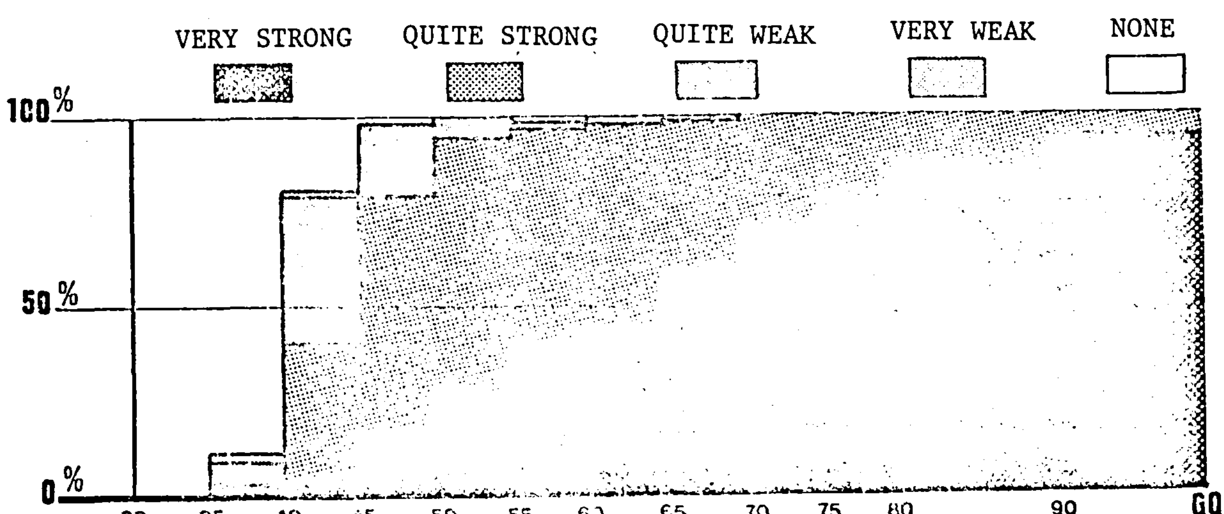
ANNOYANCE CAUSED BY NOISE OF AIRCRAFT
ACCORDING TO VALUES OF GO



Aircraft noise annoys them:



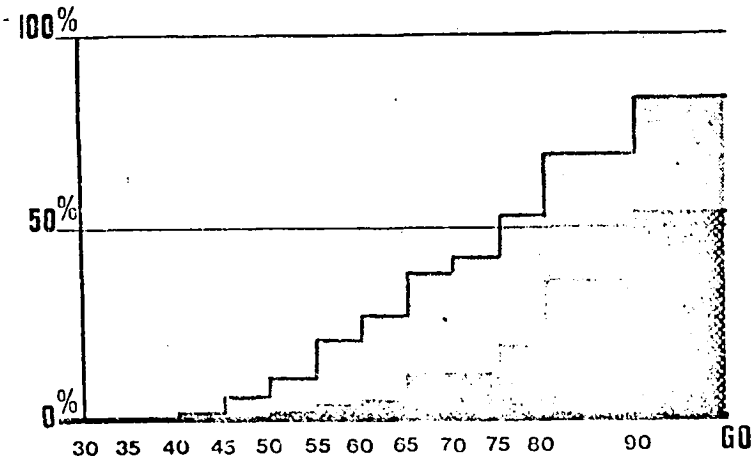
Aircraft noise annoys them:



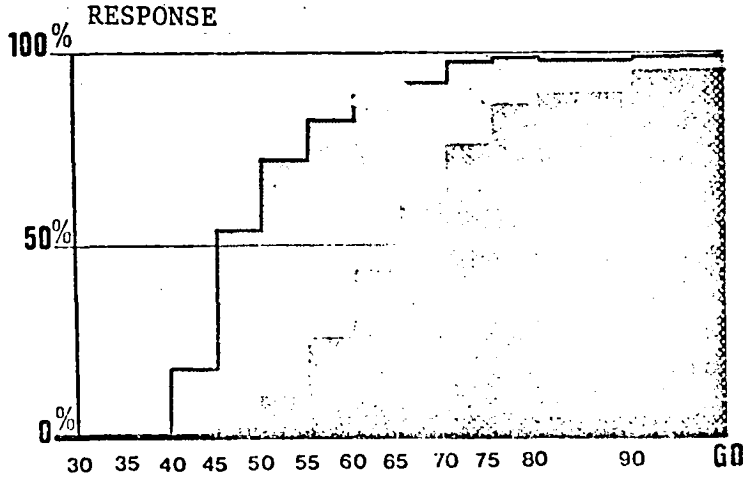
Intensity of noise of perceived aircraft

DISCOMFORT CAUSED BY AIRCRAFT NOISE
DEPENDING ON VALUES OF GO

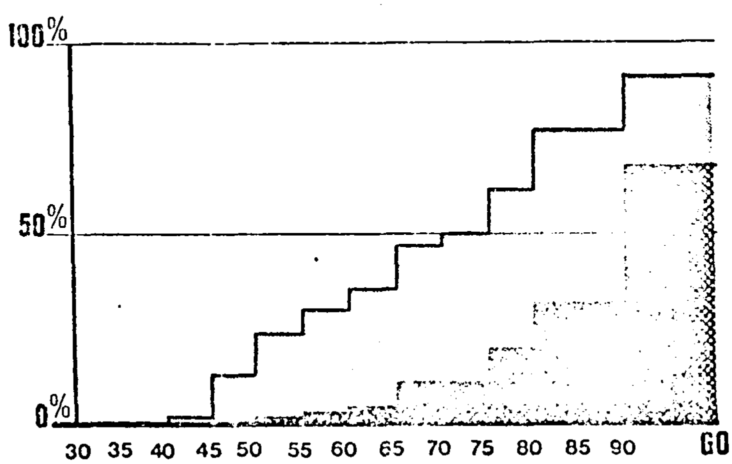
FREQUENTLY — SOMETIMES AND WITHOUT RESPONSE — NEVER



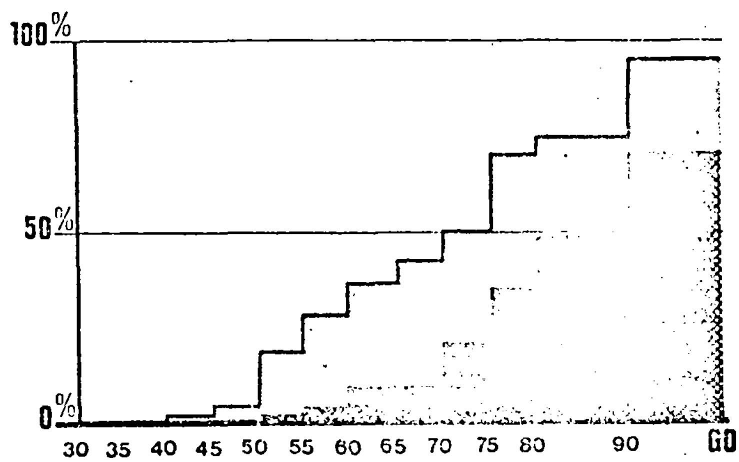
Noise prevents them from sleeping



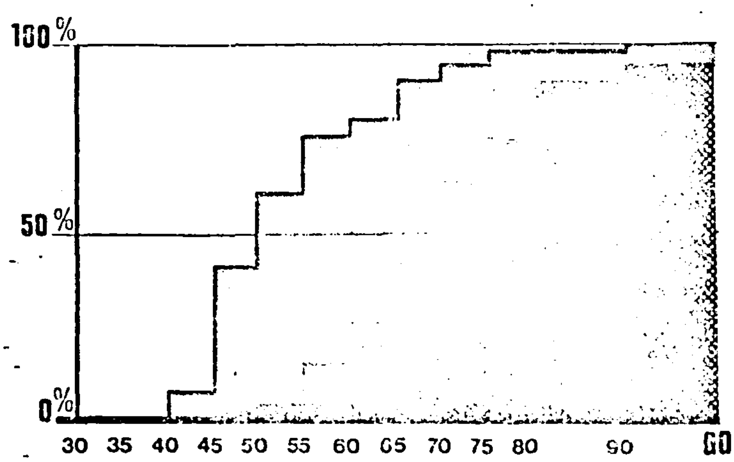
Noise prevents them from hearing radio/TV



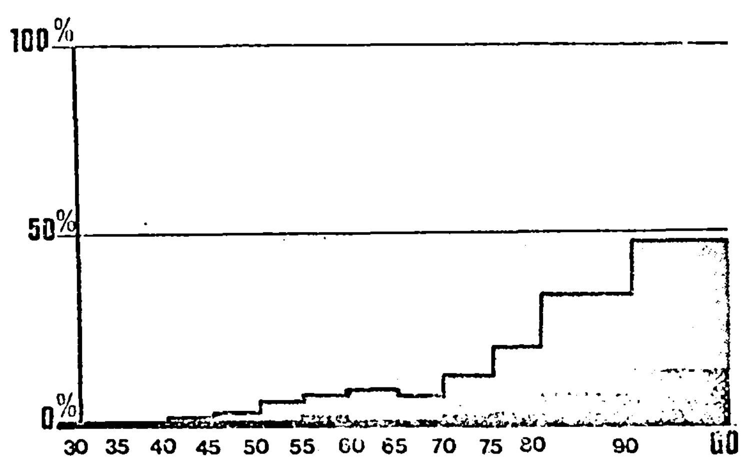
Noise wakes them up



Noise prevents them from opening windows

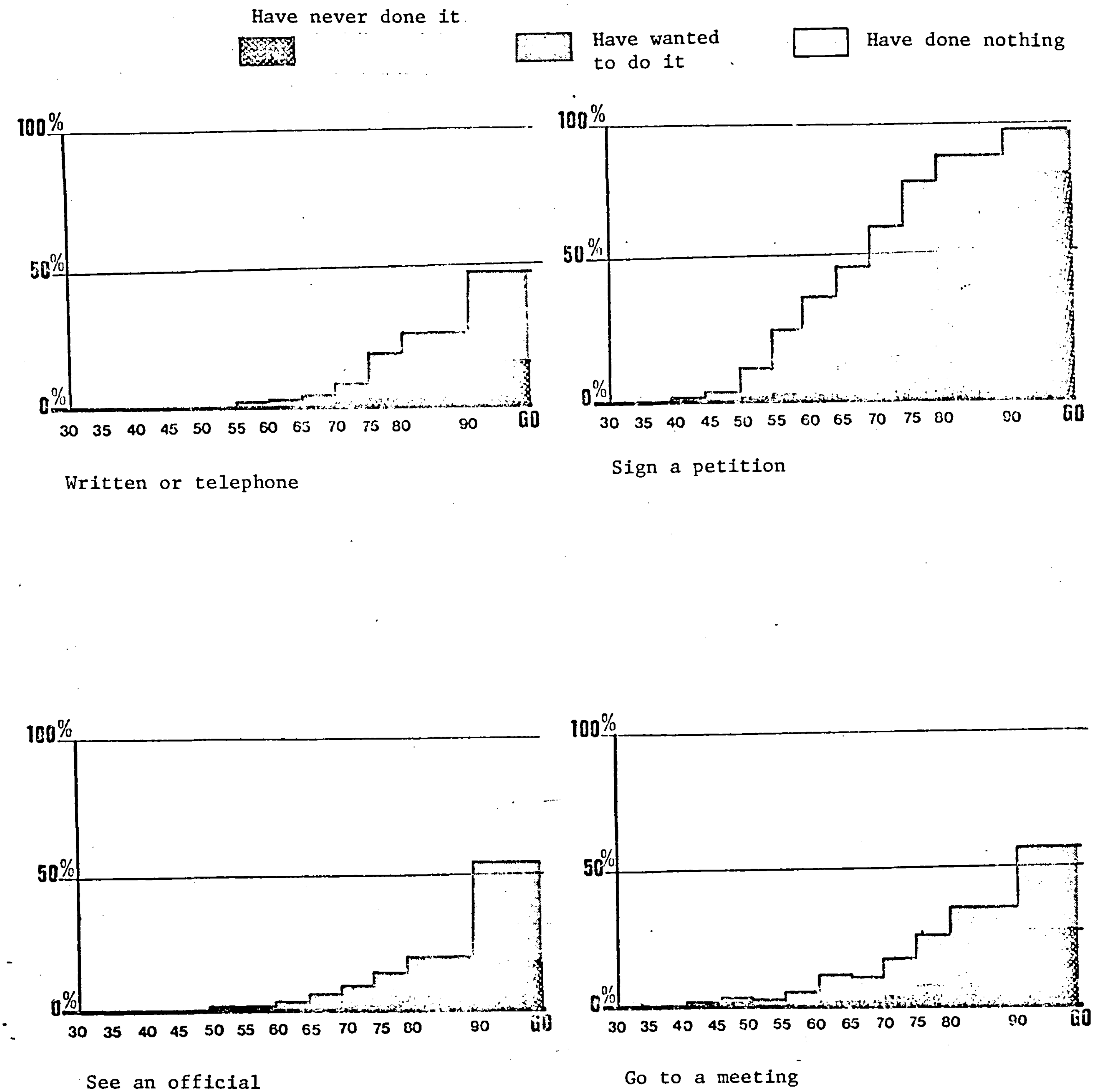


Noise disturbs conversations



Noise scares them

PROTEST ACTIONS AGAINST AIRCRAFT NOISE
ACCORDING TO VALUES OF GO



Examination of GO allows one to formulate the following conclusions about this index: /27

-- <u>Validity</u>: GO measures the intensity of annoyance well by synthesizing various aspects.

-- <u>Sensitivity</u>: The sensitivity of GO varies according to the level of the index. In factors, we can attach a significance to a variation of one point in these whole value zones and medium zones. The significance is two points in the zone with a high degree of annoyance.

-- <u>Calibration</u>: Interpretation of values of GO shows that we can schematically distinguish six large scales in annoyance:

Zero annoyance	:	GO less than 40
Small annoyance	:	GO between 40 and 55;
Rather strong	:	GO between 55 and 65;
Strong annoyance	:	GO between 65 and 70;
Very strong annoyance	:	GO between 70 and 90;
Intolerable annoyance	:	GO above 90.

II. RELATIONSHIP BETWEEN ANNOYANCE INDEX AND ISOPSOPHIC INDEX /28

A. STUDY OF THE RELATIONSHIP BETWEEN THE TWO VARIABLES GO AND N

The determination of the value of the index N in each point of the territory under study (at the center of each square with a side length of 333 m) was made by a computer calculation. We assumed that the results were correlated with real measurements in a sufficiently precise manner for the present work.

A summary explanation of the calculation method, which is entirely classical, is given in the Appendix on page 62.

Therefore, the method should be tested and a more complete study made.

We decided to do an analysis in a zone where the noise of variable intensity is homogeneous. This is the noise from overflights, in the extension of the axis of a predetermined runway. The results given below were established from data for interviewed persons who reside in the northeast sector of the zone under consideration[1]. We decided to proceed in this way in order to disassociate ourselves as much as possible from the hypotheses about annoyance and the isopsophic index.

In order to study the relationship between GO and N, we measured the closeness of this relationship by means of a correlation calculation. Also, we examined the variation of GO as a function of N.

1. Calculation of correlation.

This calculation consists of studying the dispersion of the cloud of points, which can be represented in a GO - N diagram. The correlation was calculated by the formula of Bravais - Pearson[2]:

---

[1] See map on page 51.

[2] Even though the variables GO and N are not normally distributed, we can assume that recourse to this coefficient allows a satisfactory approximation of the relationship between GO and N. Later on we will see that the curve, which can be adjusted to the cloud of points, is very close to a straight line.

where $r_{GO,N} = \frac{COV_{GO,N}}{\sigma_{GO} \times \sigma_N}$ où : σ = standard deviation
COV = covariance

This calculation was carried out based on 2,148 individuals/29 interrogated, who live in the sub-zone studied.

The correlation between the note GO of each individual and the index N corresponding to his residence is weak; the correlation coefficient obtained is:

$$r = .21$$

In other terms, if we know the value of the index N which characterizes a given point, it is not possible to predict with accuracy the intensity of the annoyance which an individual could experience living at this point. Reciprocally, the knowledge of the note GO of an individual does not allow one to know the value of the isopsophic index at his residence location.

It should be noted that even if the correlation between GO and N is weak, it is in any case better than the result which one would obtain from responses to a given isolated question on the questionnaire. As a verification, we calculated the correlation between N and Question 11 (Does aircraft noise annoy you a lot, quite a lot, slightly or not at all?) The coefficient obtained is r =.15. GO, therefore, seems to be better correlated with the noise than with the responses to a single question and constitutes a better representation of the noise.

This slight relationship, at the individual level, between the noise and the annoyance is found again in all of the inquiries on the subject. In the present case, it can be explained by the simple interaction of various factors which affect the two indices, GO and N, without involving their validity:

-- Given its calculation mode, the isopsophic index does not take into account local noise exposure, e.g. ground accidents, orientation of the lodgings, etc. This could modify the propagation of the noise and its intensity at a given point.

-- Also, the annoyance perceived and measured by GO can vary from one individual to another for various reasons, psychological, physiological and sociological.

A second correlation calculation seems to demonstrate that factors of this type take into account the weakness of the GO-N connection primarily at the individual level, and, therefore, these two indices do not have to be questioned in a fundamental manner. In effect, we have examined this relationship at the level of "average individuals", by taking as a basis of the examination not the 2,148 individuals, but the groups of persons (generally five in number) residing in each square with a side length of 333 m. For each square, we took into account the average note GO of the individuals who live there and the value N. Therefore, we have made up a population of 432 fictitious individuals.

Such a procedure seems quite justified, to the extent to which one attempts to estimate an average annoyance level in any zone, and not the annoyance level of a specific individual, using indices. /30

The correlation cooefficient obtained is :

$$\boxed{r = .68}$$

Taking as the statistical unit the average notes of GO relative to each group of interviewed persons localized in the same square, we therefore obtained a result which is much more satisfactory than if we use the individuals as a base of the calculation. This is because the dispersion of the measurements is reduced by considering these average values. With this method, the influence of various psychological and sociological factors on the annoyance perceived is reduced. This is the same for certain noise exposure factors which could vary within a given square.

The attenuation of the individual fluctuations, therefore, allows a better demonstration of the degree of dependence between GO and N. At least in the northeast sector of the zone of the inquiry, globally there is a very good agreement between isopsophic index and the average perceived annoyance.

This correlation coefficient, in any case, would be improved if we had increased the integration area (larger squares) or the interrogated population density (by averaging over a larger number of individuals). Other inquiries have demonstrated that one can obtain coefficients of .95 by averaging data relative to 100 persons. In the present study, we preferred a rather fine grid over the inquiry zone, because it was then necessary to analyze in detail the relationship between GO and N (including at the local level.)

2. Variation of GO as a function of N.

In order to study the relationship between noise exposure and perceived annoyance, it is appropriate to examine not only the closeness of the relationship between GO and N, but also the nature of this relationship.

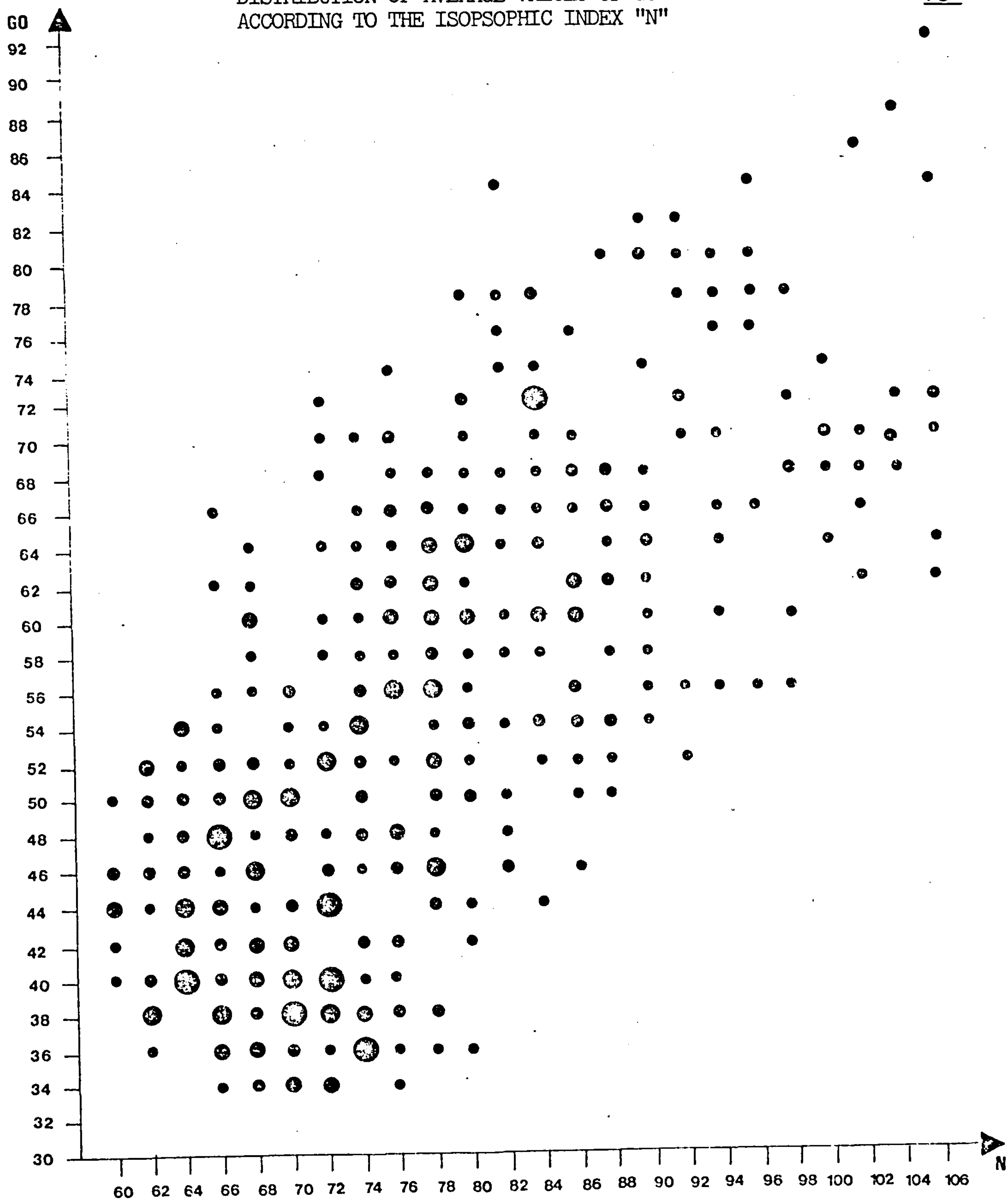
The relatively high correlation coefficient r = .68 obtained on the basis of "average individual" means that if we know the value of the index N at a point of the territory next to the runway under consideration, we can then predict with a very good approximation average annoyance of the individuals who reside at this point. But the dispersion in GO with respect to N becomes rather strong, even after "smoothing" introduced by the calculation method, which can be appreciated according to the cloud of points presented on the following page (page 31).

In order to summarize this cloud of points and to draw the curve which best represents GO as a function of the isopsophic index, we proceeded as follows: after having regrouped the values of N into classes in order to have sufficient information for each of them, we calculated the average value and the standard deviation of GO of the individuals who all reside inside the collection of squares with a side length of 333 m corresponding to each of these classes. In this way we obtained an average value and standard deviation of GO per class of N. This series of points was then subjected to a manual smoothing.

The graph obtained is given on the following page (page 32) and shows that the relationship between GO and N can be represented by a very flattened S curve. This form of curve seems to better summarize the cloud of points than straight lines. The relationship between GO and N is therefore slightly greater than one would estimate if we used the hypothesis of a regression line.

We observed that the standard deviation of GO tends to increase for higher values of N, which seems to be due to the increase in the sensitivity of GO for large values. We also see in the cloud of points that there is a strong concentration in the vicinity of the value of 40, which could explain the weak sensitivity of GO in this zone. This graph shows one the most likely annoyance level for each value of the index N.

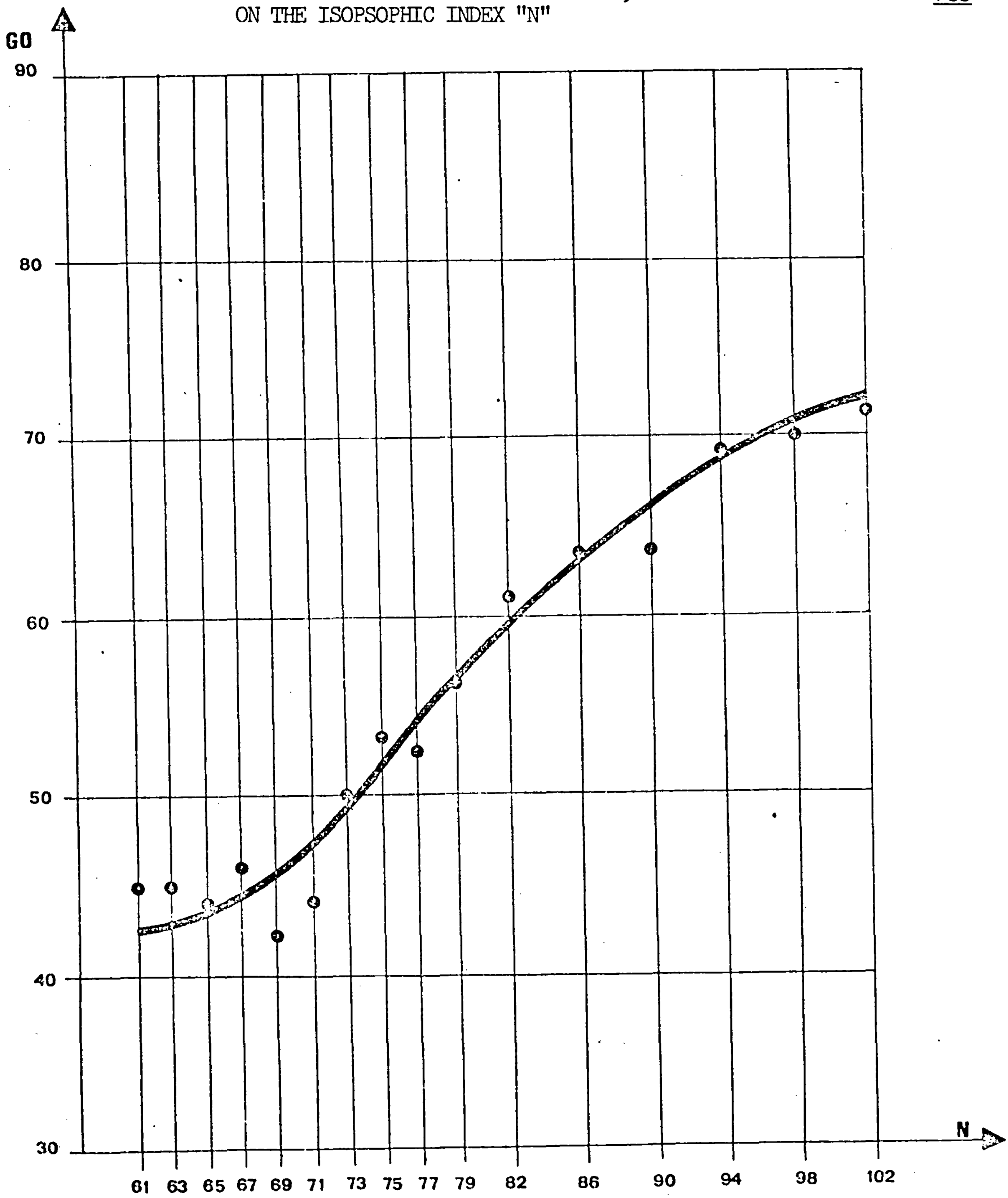
DISTRIBUTION OF AVERAGE VALUES OF GO
ACCORDING TO THE ISOPSOPHIC INDEX "N"



NOTE: This graph shows distribution of the 432 squares, each 333 m on a side, characterized by the average value of GO of the five persons interviewed who resided in each square, and the value of N at the center of the square.

1 square
2 squares
3 squares
4 squares
5 squares and more

AVERAGE OF THE ANNOYANCE INDEX GO, DEPENDING ON THE ISOPSOPHIC INDEX "N"



Therefore we have the possibility of establishing a correspondence table, which is approximate, between the average annoyance observed and the isopsophic index. By referring to the meanings of the notes of GO which we obtained at the end of the first chapter, we can then distribute the values obtained as follows:

CORRESPONDENCE BETWEEN THE ANNOYANCE LEVEL AND THE ISOPSOPHIC INDEX

Average Annoyance Level	Values of GO	Value of the Isopsophic Index
Weak annoyance	$GO < 55$	$60 < N < 80$
Rather strong annoyance	$55 < GO < 65$	$80 < N < 90$
Strong annoyance	$65 < GO < 70$	$90 < N < 100$
Very strong annoyance	$GO > 70$	$N > 100$

3. Distribution of GO as a function of N. /34

Below we find another graphic representation established as follows: we have divided the variable GO into classes, and we calculated, for each class of N, the percentage of individuals who appear in the various classes of GO. This calculation was based on individual data and not on "average individuals" in order to have a sufficient number of statistical data points.

We see that this graph makes three "thresholds" appear in the variation of GO as a function of N:

-- A threshold in the vicinity N = 90 which corresponds to the passage from a sensitive annoyance to a strong annoyance.

- A threshold for N = 78-80 when the annoyance, weak up to then, becomes rather strong.

- A third threshold appears for N - 72.

Among the individuals who are not much annoyed, we can assume that the annoyance is essentially zero for $N < 72$ and that it appears rather abruptly after N = 72.

Between the thresholds, the annoyance appears relatively constant. We can interpret this phenomenon with successive bars by qualitative modifications of the annoyance as a function of noise level. The thresholds observed correspond to a distinct variation in the sensing of the annoyance caused by aircraft noise.

The graph on the following page (page 35), which seems to be satisfactory above N = 72, shows anomalies for values less than N. This phenomenon probably is due to calculation hypotheses for the index N, which do not take into account the trajectory dispersions with respect to the theoretical trajectories.

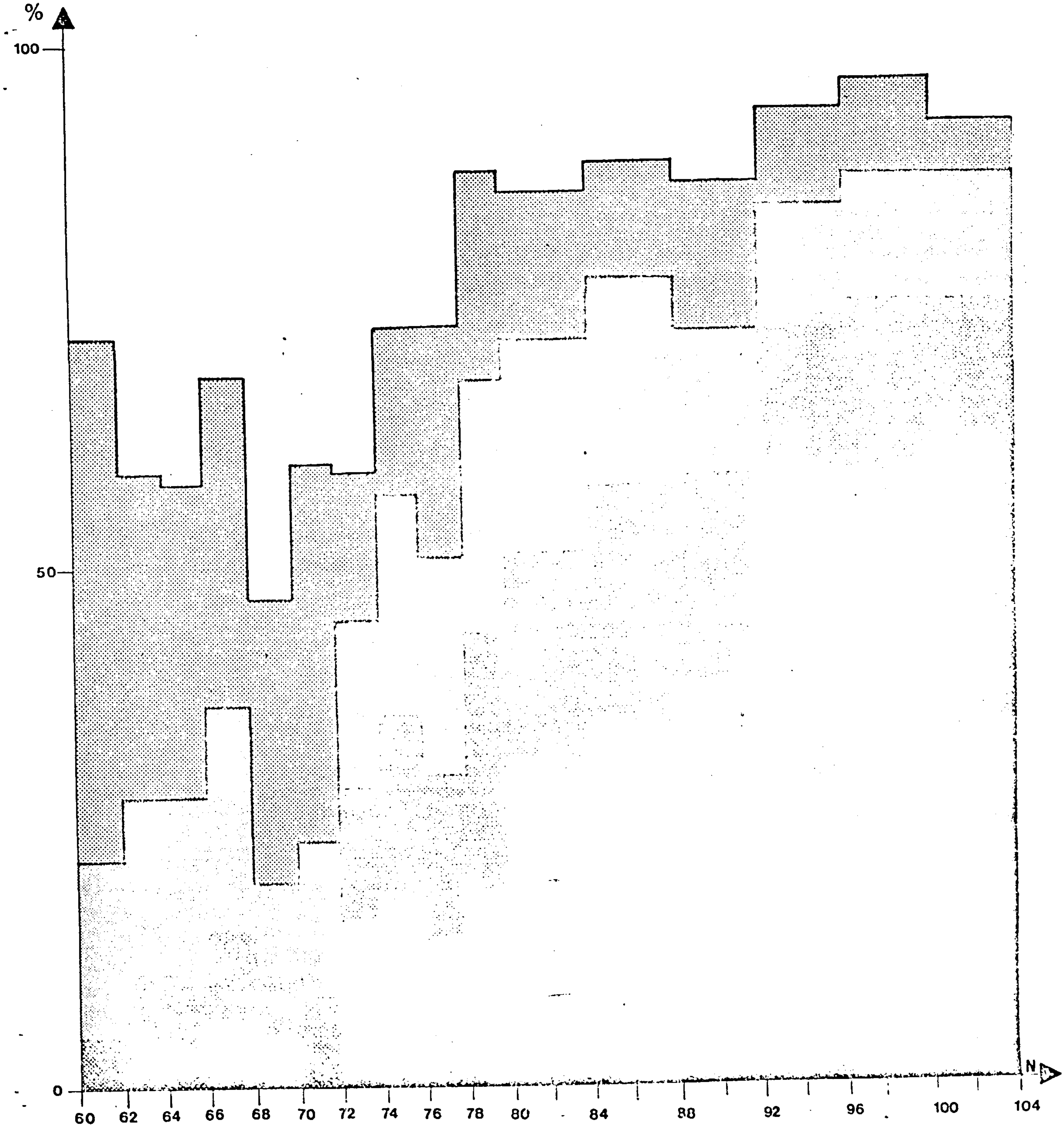
Therefore, this result shows the necessity of refining the calculation method for the isopsophic index and to base the analysis on more concrete data. This work is presently in progress from observations using radar of the aircraft trajectories.

This anomaly in the distribution of GO as a function of N seems to be localized on the map, in the northease sector of the zone which is exposed to noise relatively little. In this direction, the geographic study of the distribution of GO and N seems promising.

B. GEOGRAPHIC DISTRIBUTION OF THE VALUES GO AND N /36

Calculations presented in the preceding pages treat GO and N as two variables, and it is not possible to know whether the agreement is better or poorer in any geographic zone than elsewhere.

FREQUENCY OF THE ANNOYANCE INDEX GO
DEPENDING ON THE ISOPSOPHIC INDEX "N"



VALUE OF "GO"

- Less than 40
- 40 - 49
- 50 - 59
- 60 - 69
- 70 - 79
- 80 and above

Another analysis method consists of examining the dispersion of the values of the variables GO and N in the geographic space of the inquiry zone. Since measurements obtained are distributed along geographic coordinates, we can plot the average value of GO for the collection of individuals who live in each square of the territory.

On the following page (page 37) the reader will find the map of distribution of GO. This was regrouped into four classes:

-- 30 to 44
-- 45 to 59
-- 60 to 74
-- 75 and above.

The map of the annoyance found surrounding the airport is an original document which contains much information. In effect, we can very accurately determine the zones in which the inhabitants, on an average, sense annoyance at a given intensity.

From an examination of this map of annoyance, we can derive the following:

-- Overall, the distribution of the annoyance agrees well with expectations. The sensitivity of GO is sufficient to demonstrate clearly the east/west and north/south runway axes.

-- The strongest annoyance is found in the zones which are overflown by aircraft; it decreases progressively as one moves away from them.

-- From one square to another, at a distance of 300 meters, we observe very large deviations in annoyance, even though the annoyance notes are averages and therefore constitute a smoothing of individual values. The dispersion of the annoyance notes at various locations very close to one another geographically does not seem to come from noise exposure differences, but instead from psychological, sociological and other factors. As a corrollary to this, an isopsophic index, no matter how valid it is, could never exceed a certain threshold in the prediction of annoyance. Naturally, one has to take this phenomenon into account when one wishes to improve the existing isopsophic indices.

Within the scope of the present research, the annoyance map must be analyzed in reference to the distribution of the values of the isopsophic index. A following page (page 39) gives the map showing the isopsophic curves established for the values N = 84, 89 and 96, i.e. the curves which delimit the zones, which have been given the names A, B and C. In order to facilitate the comparisons, we also show the superposition of the two maps, GO and N. /38

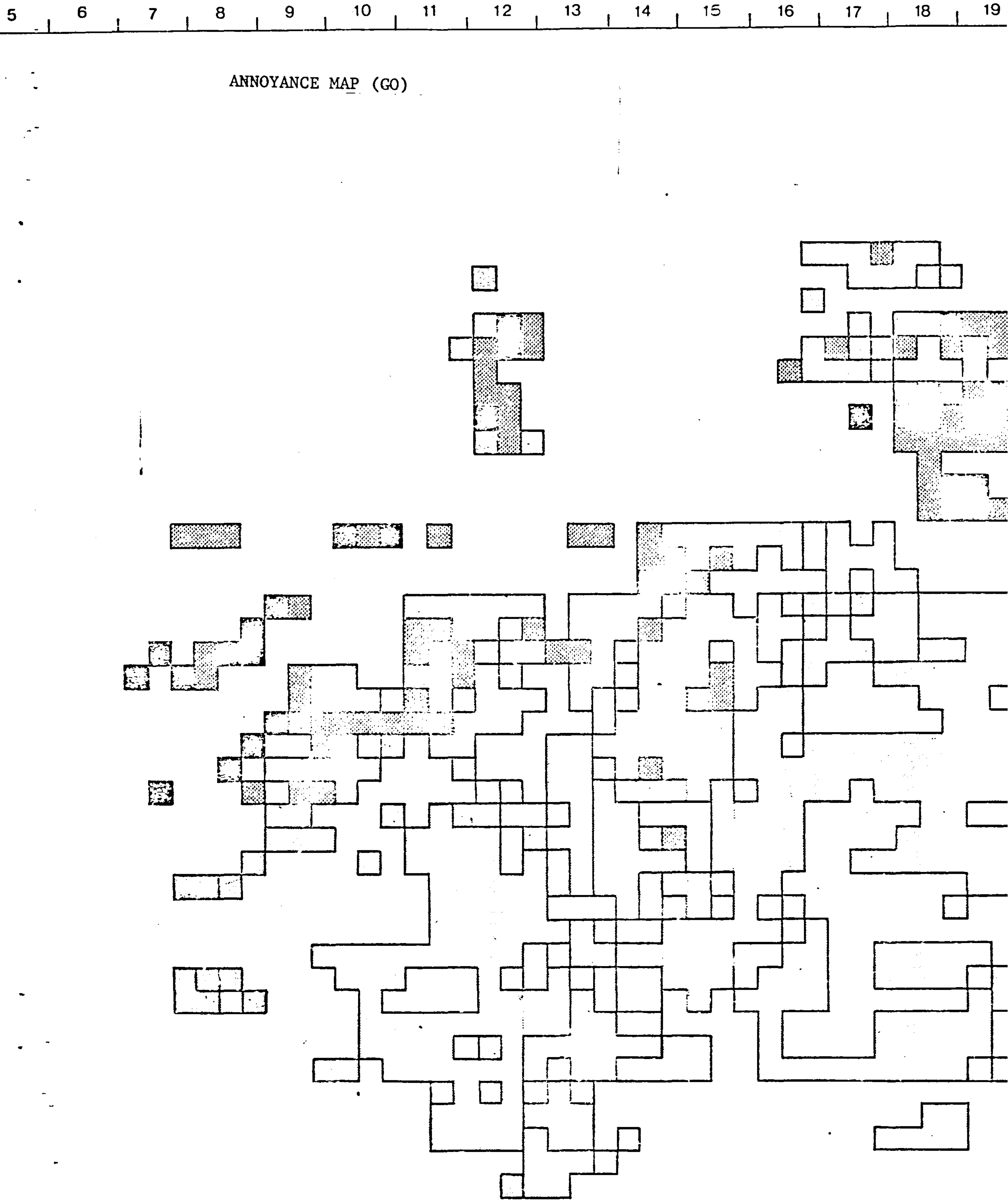
In the territory study, we observed good agreement between the two indices. The very strong annoyance practically never appears outside of the curve C (N = 84). Two phenomena appear distinctly, which leads us to formulate a certain number of conclusions and hypotheses.

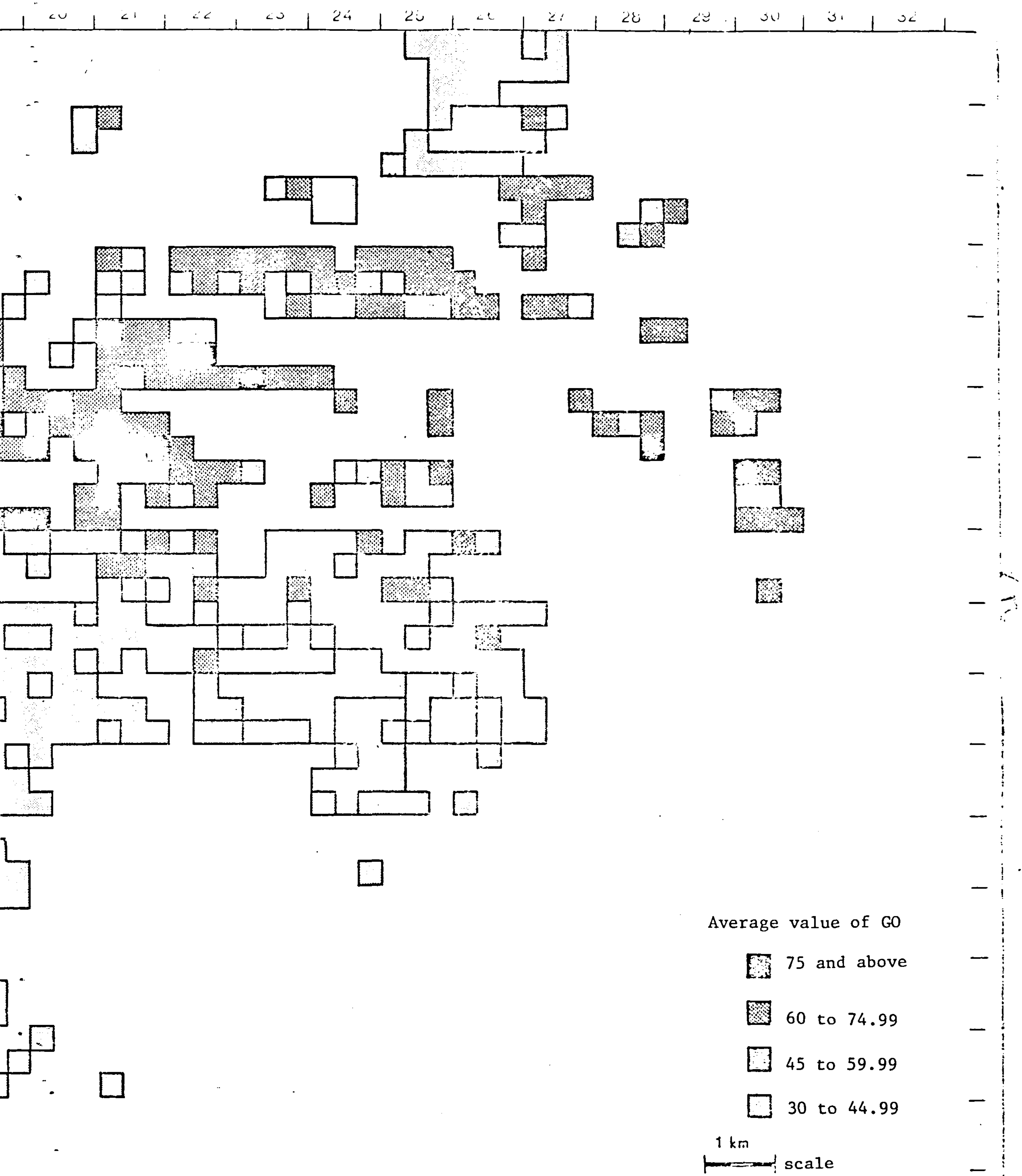
1. Significance of zones A, B and C.

The distinction between zones A and B does not seem to correspond to real differences of perceived annoyance. A very strong annoyance, in fact, is frequently manifest in one zone or another. The zone C, on the other hand, is distinctly different from these two zones: it is characterized by a rather strong or strong annoyance.

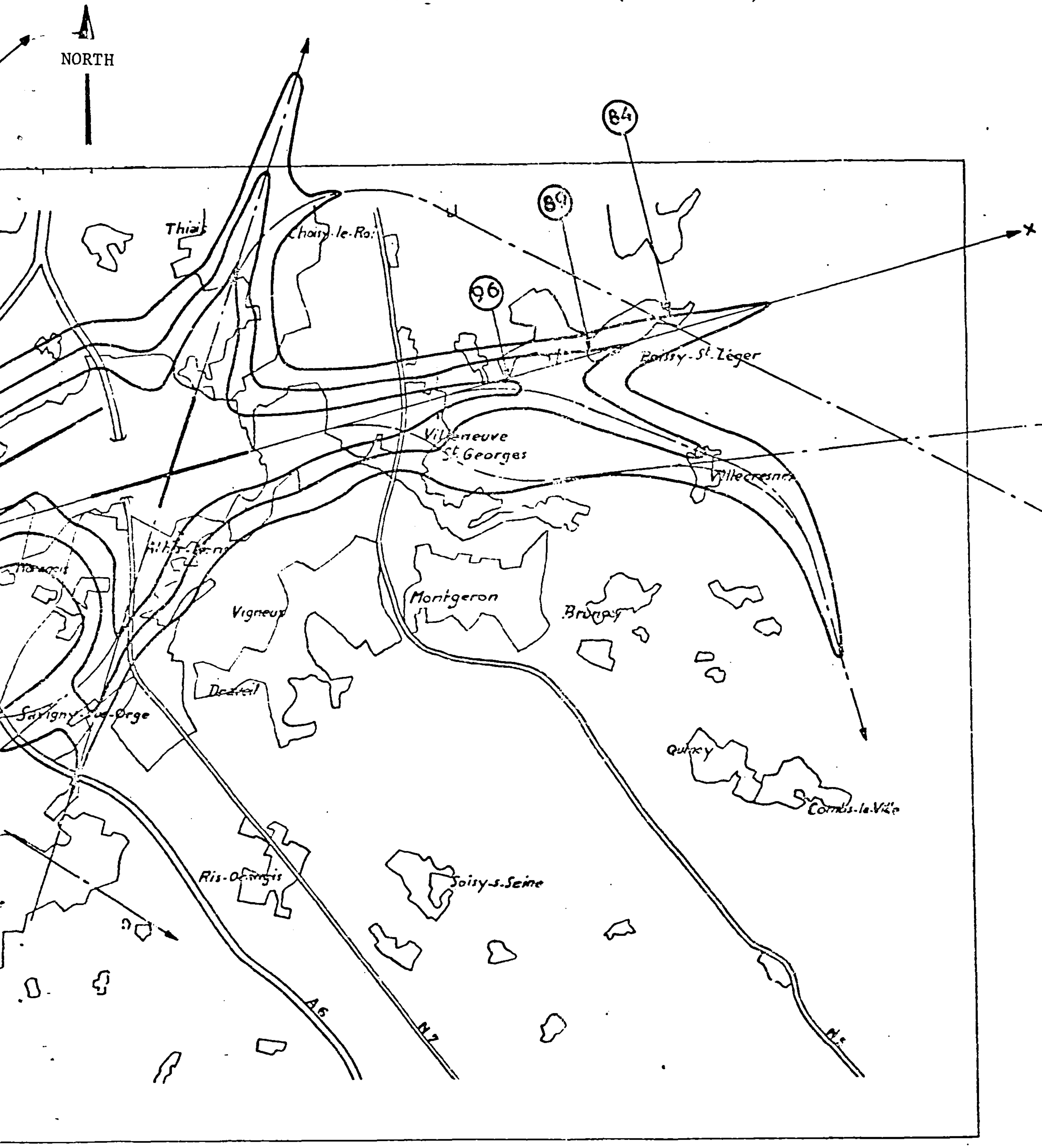
These results cover the persons who were involved in the

ANNOYANCE MAP (GO)

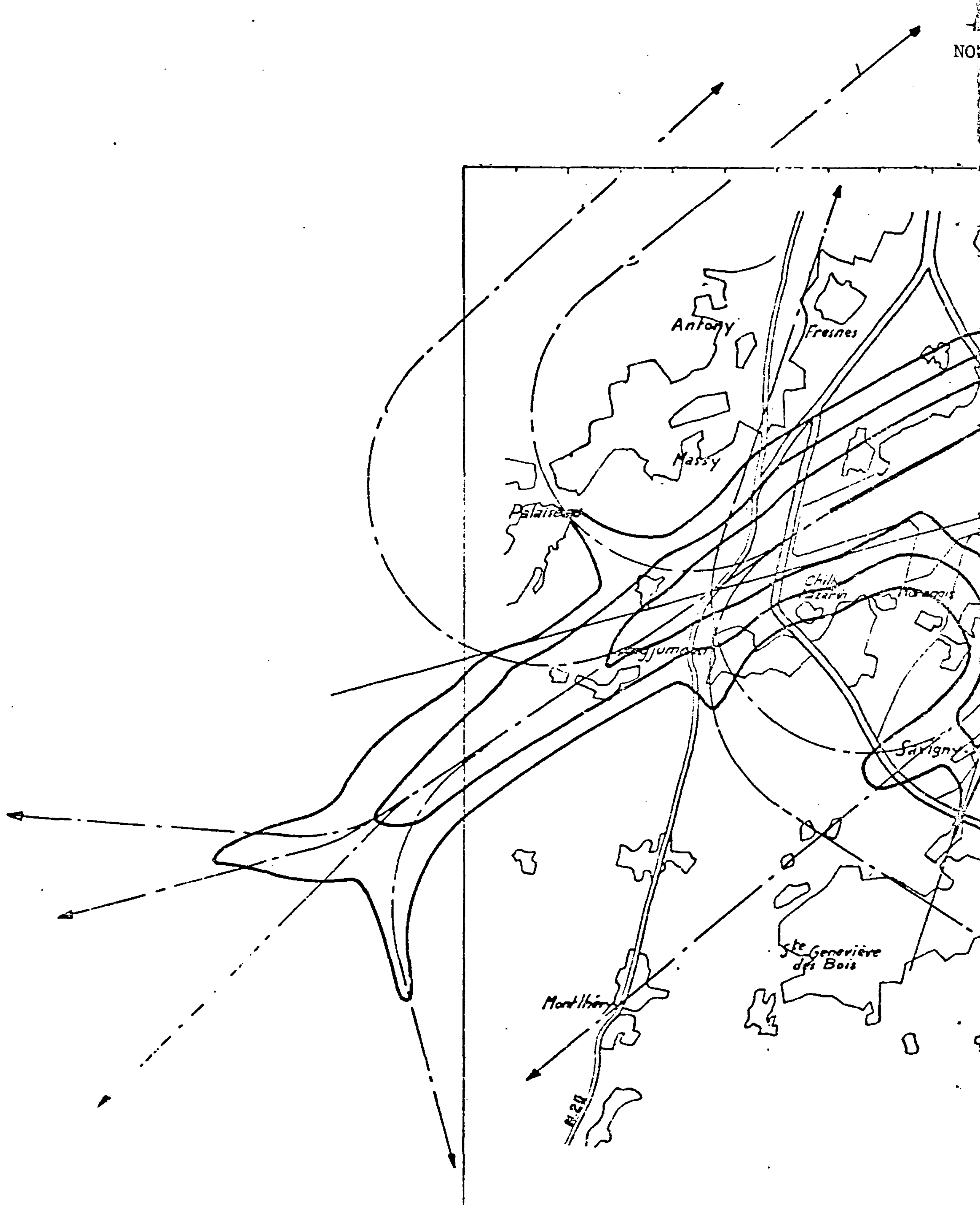


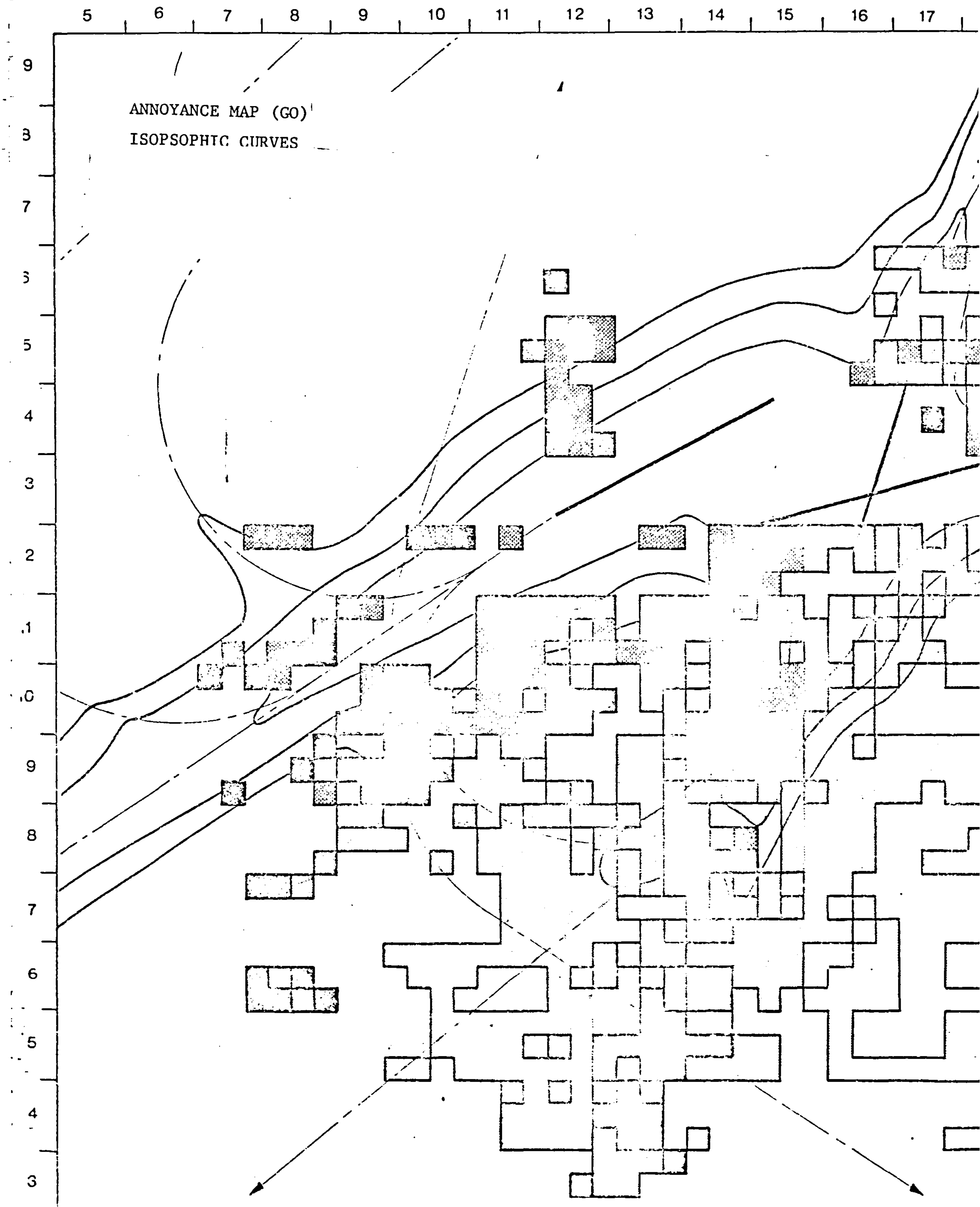

24
28
Average value of GO
75 and above
60 to 74.99
45 to 59.99
30 to 44.99
1 km
scale

ISOPSOPHIC CURVES (1971 traffic)



SCALE : 1cm p.1km


Antony
Fresnes
Massy
Palaiseau
Savigny
Ste Geneviève des Bois
N.20


ANNOYANCE MAP (GO)
ISOPSOPHIC CURVES
5
6
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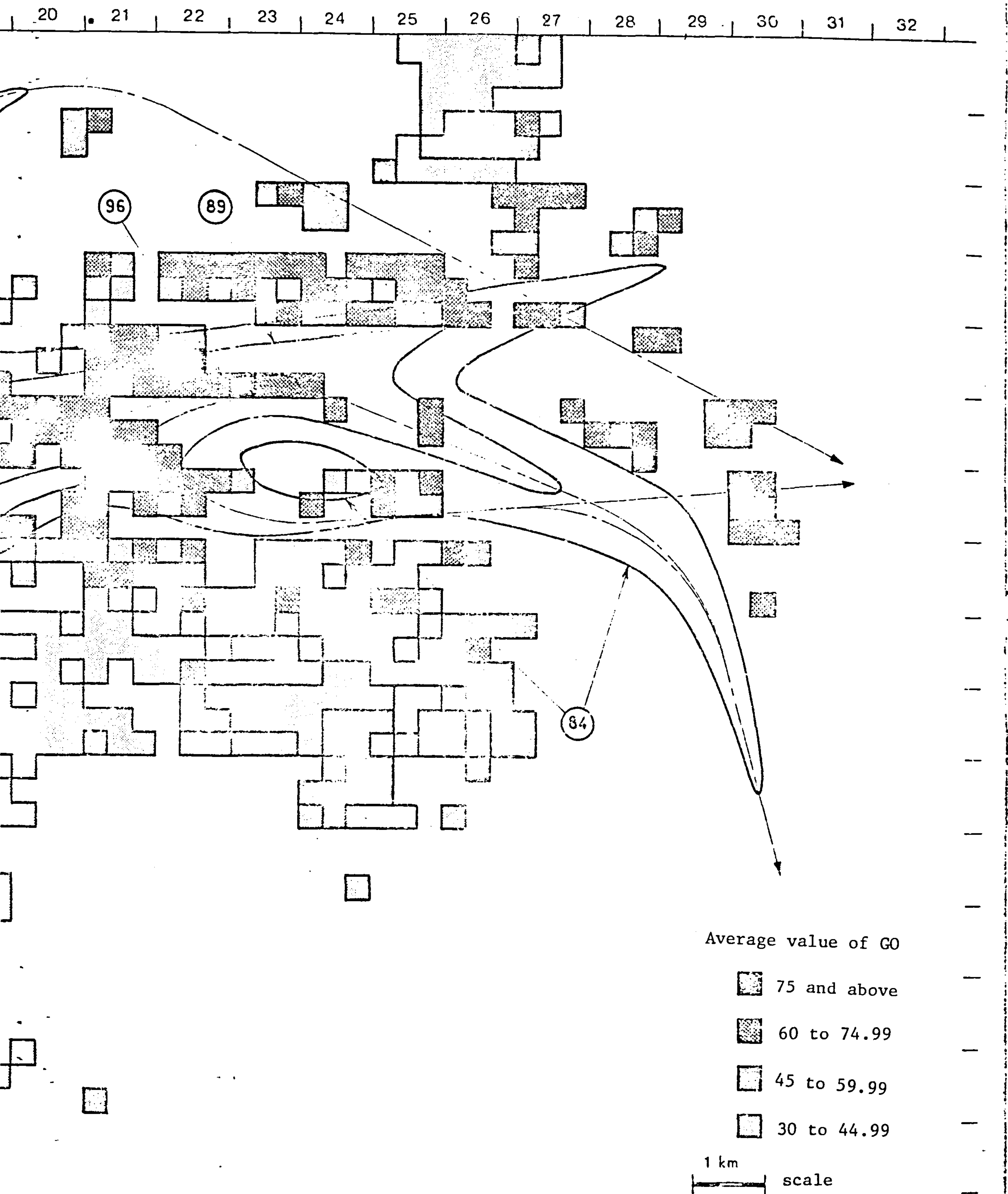

20
21
22
23
24
25
26
27
28
29
30
31
32
96
89
84
Average value of GO
75 and above
60 to 74.99
45 to 59.99
30 to 44.99
1 km
scale

northeast sector of the territory under study. We saw that after $N = 90$, the annoyance was strong, on the average. Around $N = 90$, we observed a threshold beyond which the annoyance increases sensibly. On the other hand, for values of N before 80 and 90, the annoyance is relatively constant while rather strong on the average. In practice, instead of distinguishing three zones limited by isopsophic curves with values of 84, 89 and 96, it seems preferable to do the following:

-- Merge zones A and B in order to delimit a single zone (corresponding to $N > 90$) characterized by a strong annoyance.

-- And, maybe, reduce from 84 to 80 the curve C above which the annoyance is on the average rather strong.

2. Local anomalies. /41

If we compare the perceived annoyance (measured by GO) and the annoyance estimated by the index N, we observe large differences in the two sectors of the territory studied:

-- In the axis of the north/south runway.

-- At the eastern extremity of the east/west runway.

These anomalies could be explained in part by different phenomena.

a) Axis of the north/south runway.

In the extension of the north/south runway, the perceived annoyance is sensibly weaker than the index N leads one to predict. In this sector, the correlation between GO and N seems to be good, but the correspondence between the values of GO and N is not the same as in the other sectors of the territory studied. This phenomenon could possibly be explained by the fact that this runway only covers 70% of aircraft movement over the entire airport. In the calculation of index N, we had to make a hypothesis about the influence of the relative use of the runways. Therefore, we must re-study the validity of this hypothesis, because it leads to an overestimation of the perceived annoyance, perceived by individuals subjected to noise coming from this runway.

On the other hand, the persistence of the annoyance which is observed to the south, in the extension of the runway, could come from traffic from the Bretigny airport nearby.

b) Eastern extremity of the axis of the east/west runway.

Around the eastern extremity of the east/west runway axis, the index N seems to underestimate the annoyance: the values of GO are stronger than what one would expect by using the index N, in the sectors which are not theoretically overflown by aircraft.

In order to understand this anomaly, the S.T.N.A. has obtained radar recordings corresponding to the period during which the interviews of the inquiry were performed.

These recordings are presently be analyzed, but a summary analysis has already shown that certain aircraft deviate from the theoretical trajectories to the south of the eastern extremity of the axis of this runway. After take-off, the aircraft move away with an amplitude of 20° around the theoretical trajectory. The zone overflown is, therefore, more extensive in practice than the isopsophic curves would lead one to believe. This zone draws a pointed tongue toward the southeast, which corresponds poorly with reality: it should be shortened and enlarged.

These overflights of the zone located to the south of the eastern extremity of the axis of the runway could explain the relatively strong annoyance observed in this location. When the study of the radar recordings is finished, we will calculate the values of the isopsophic index on this new basis. Probably we will obtain isopsophic curves which will agree better with the annoyance level measured by GO.

Therefore, in order to construct a valid noise index, it is very important to know precisely the effective trajectories of the aircraft. For this purpose, recourse to radar recordings is probably indispensable.

The underestimation of the annoyance perceived to the north of the eastern extremity of the east/west axis using the index N is more difficult to explain. A first examination of the radar recordings shows that the sector is very rarely overflown. The inhabitants are primarily subjected to landing noise (74% compared with 26% for take-off) and it is not impossible that the N index underestimates the relative importance of landings in the collection of aircraft noise. Could it be that a landing is more annoying that one believes, and should one give a higher weight to this kind of noise in the calculation of N? An analysis of the optimum weighting to give to landing noises and to take-off noises will be undertaken to determine to what extent it will be possible to determine the correlation between GO and N in this sector. But the

(1) Established, let us recall, from theoretical trajectories.

underestimation of the annoyance, using the index N seems to be too great an extension over too large a surface for such a calculation to improve the results very substantially.

Therefore, we must consider other hypotheses in order to explain this phenomenon. In particular, we will determine whether characteristics of the population in this sector (social-demographic characteristics, residence characteristics, etc.) could take into account a certain hypersensitivity to aircraft noise.

Protests /43

Within the zone studies, we localized persons who had declared during interviews that they had already protested in some manner against aircraft noise (by signing a petition, going to meetings, telephoning officials, etc.)

On the following pages, the reader will find a map showing the geographical distribution of these protestors, as well as a map which shows the isopsophic curves. Another map also shows the locality of all of the real and potential protestors. By potential protestors, we mean persons who have not yet protested but would like to do so in some way.

Generally speaking, the persons who had already protested against aircraft noise live in sectors which are characterized by an index N which is at least equal to 84. We find practically no protestors in the central zone of the map, which is not overflown by aircraft.

Examination of the localities of the protestors leads to similar conclusions to those formulated above for GO [1]:

-- Distinction between zones A and B does not seem to correspond to sensible differences in the rate of protesting.

-- Complaints are relatively infrequent along the north/south runway axis.

-- Protests are abnormally numerous, considering the isopsophic curves, along the eastern extremity of the east/west runway.

As for the map showing the localities of the real or potential protestors, they show a rather large dispersion of discontent of the inhabitants of the territory studied. We find that these protests are deeply concentrated along the main aircraft trajectories.

/47

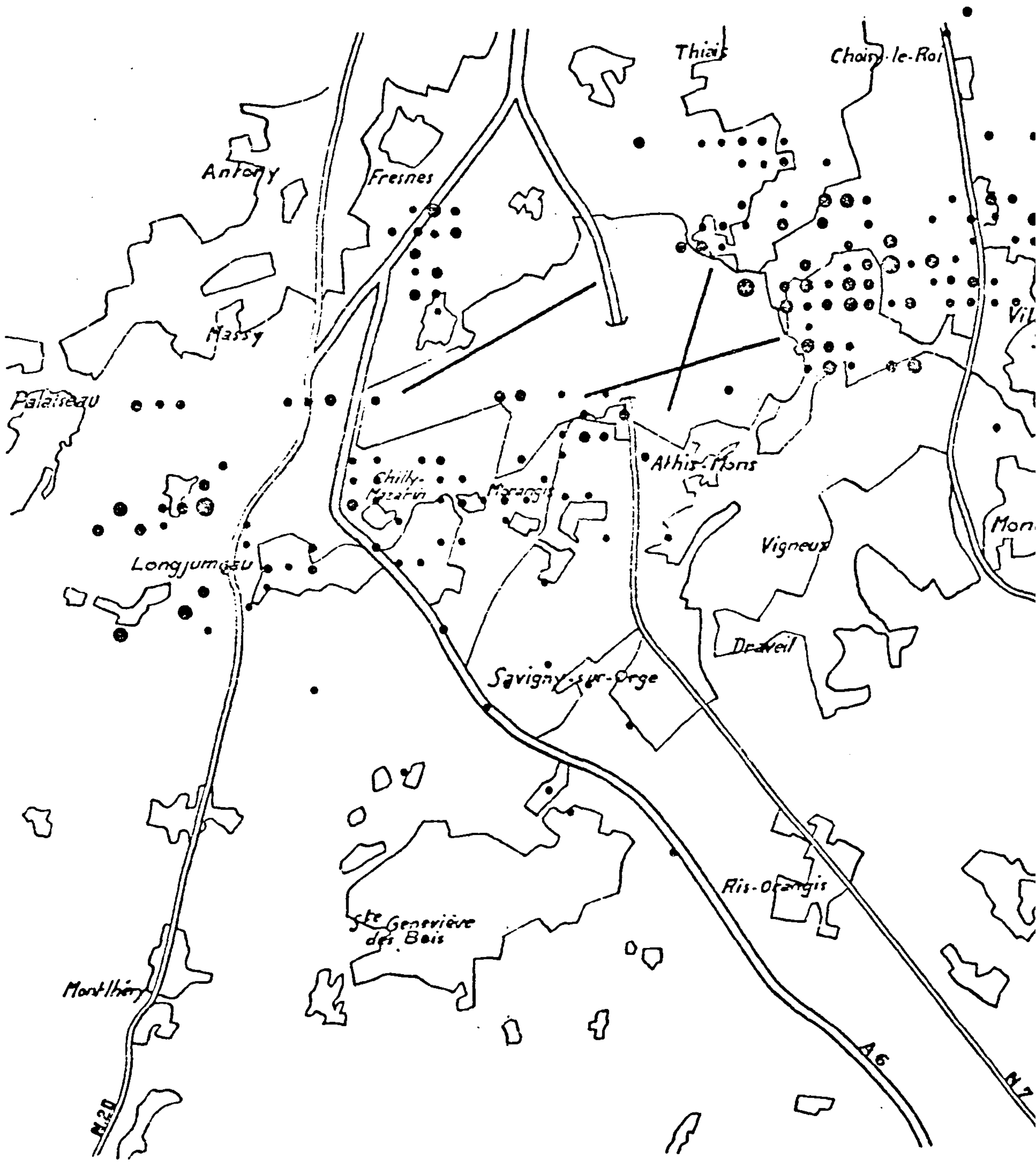
CONCLUSION

This document essentially had the purpose of presenting an original methodology and the first results which were derived from it. These results are very encouraging and can be summarized as follows:

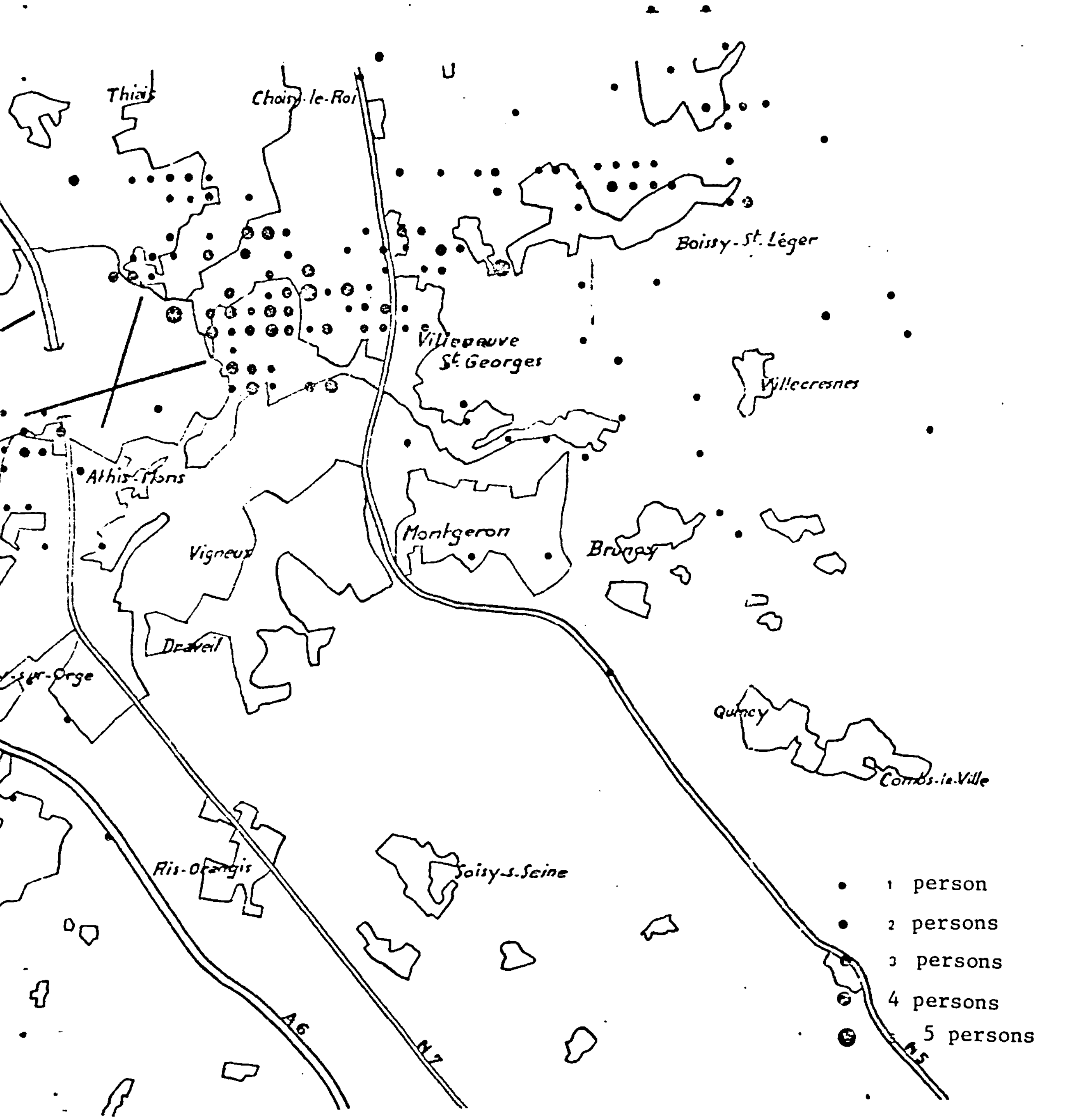
We were able to characterize each of the 5,000 inhabitants around Orly Airport interrogated by means of an annoyance index (GO) constructed from a battery of questions. The validity of this

(1) This is not surprising, because the questions relative to protesting were strongly saturated in the first factor of the factorial analysis.

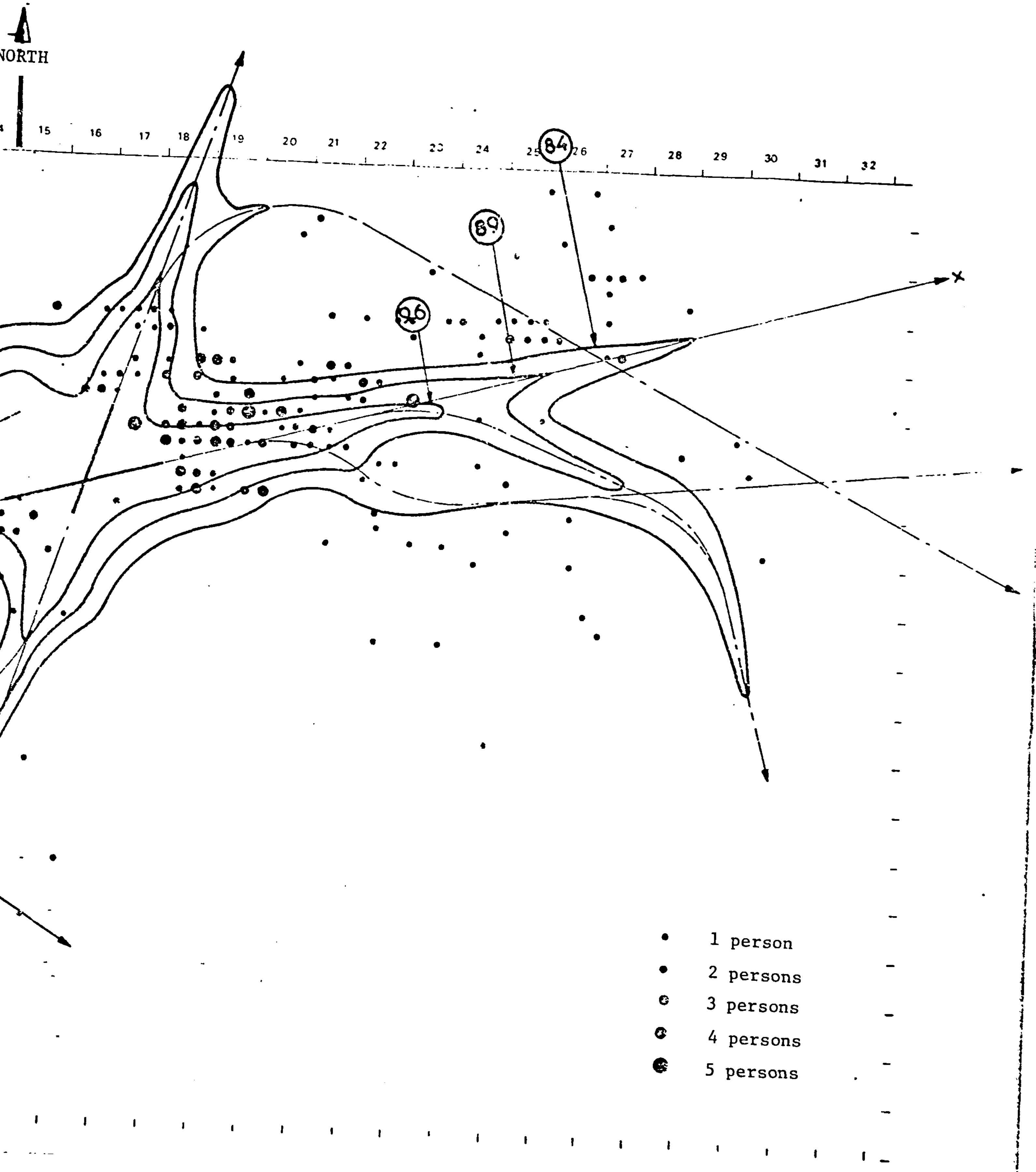
THOSE WHO DID SOMETHING TO PROTEST AGAINST NOISE (Question 16)

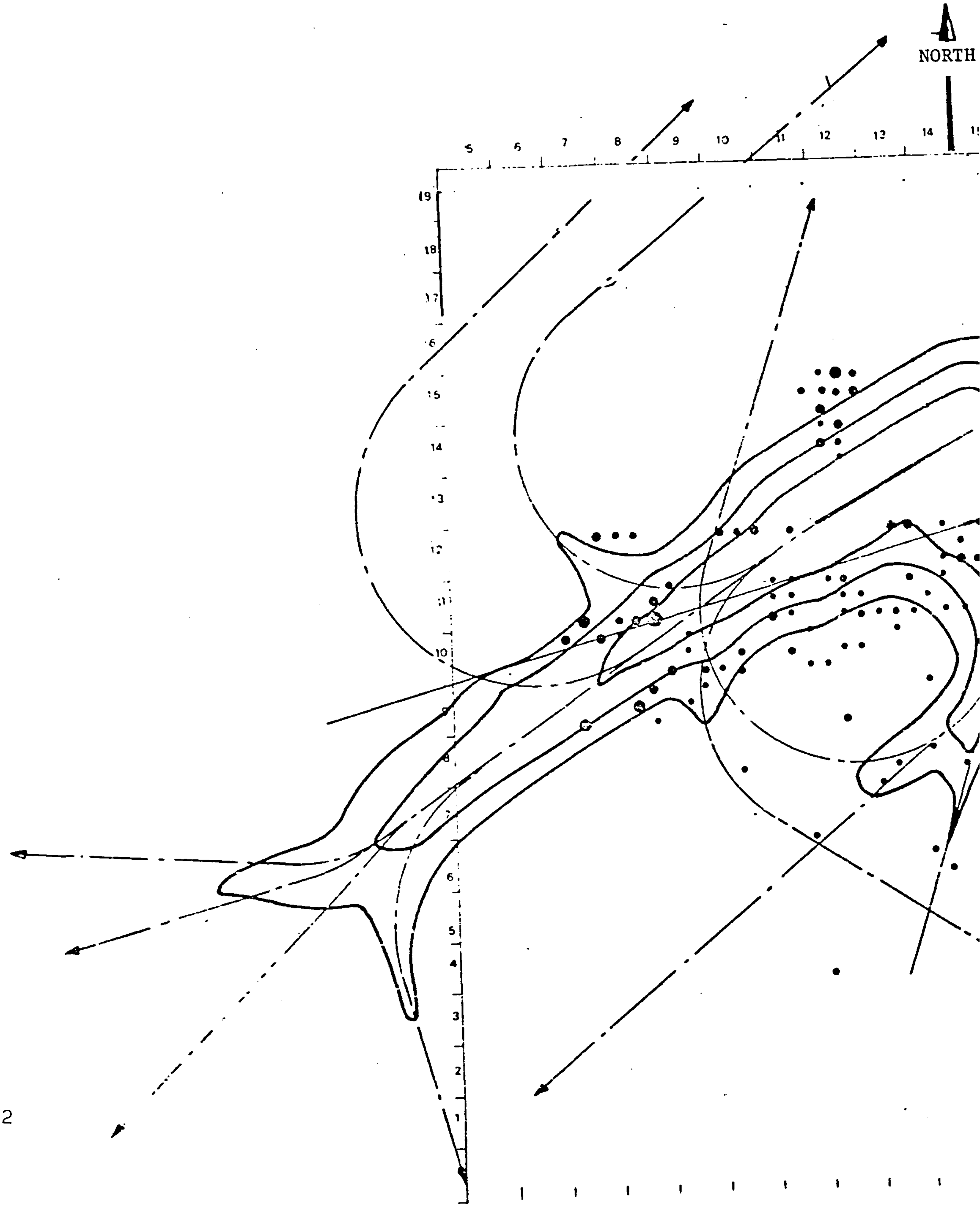


AINST NOISE (Question 16)



THOSE WHO DID SOMETHING TO PROTEST AGAINST NOISE (Question 16)





NORTH
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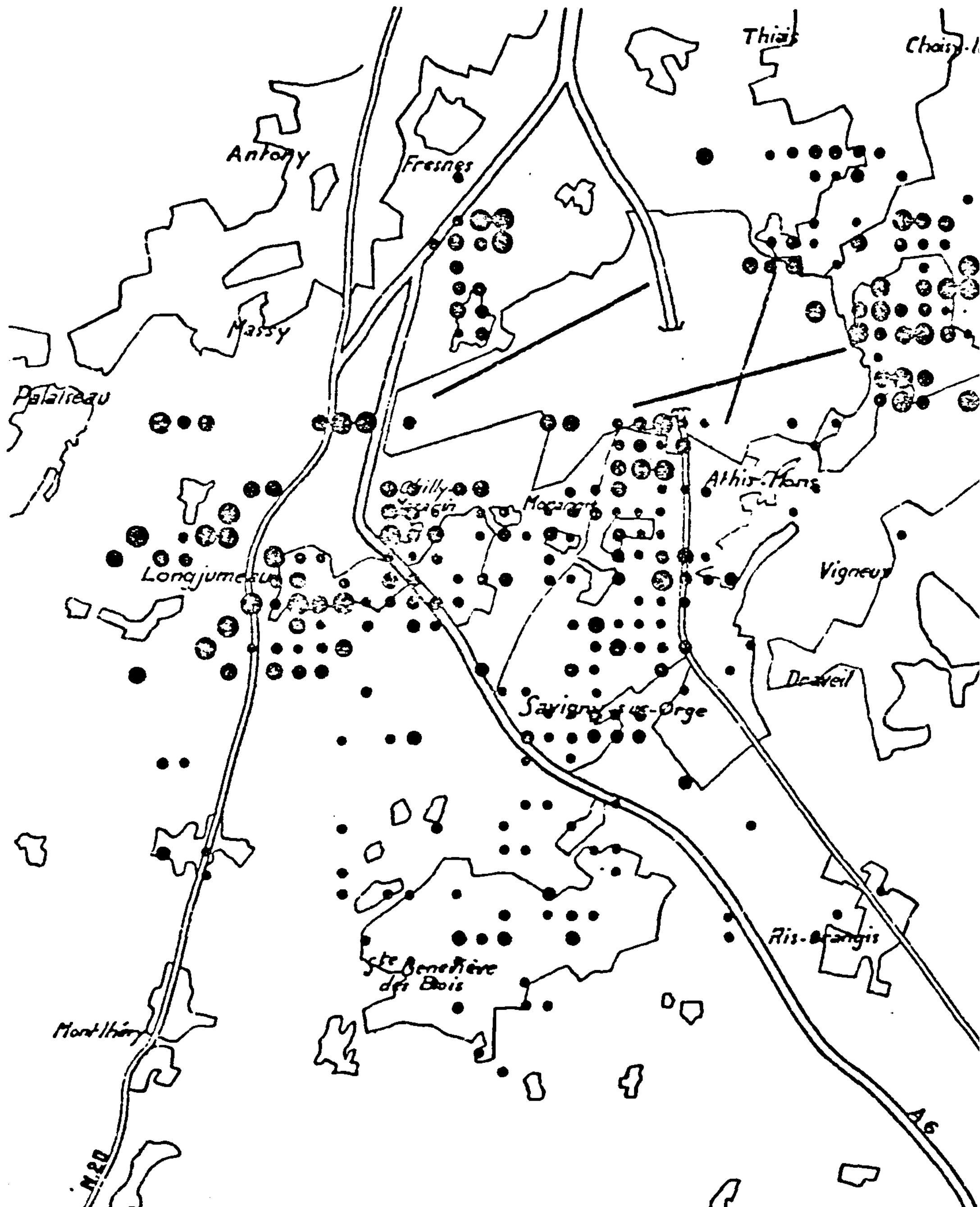
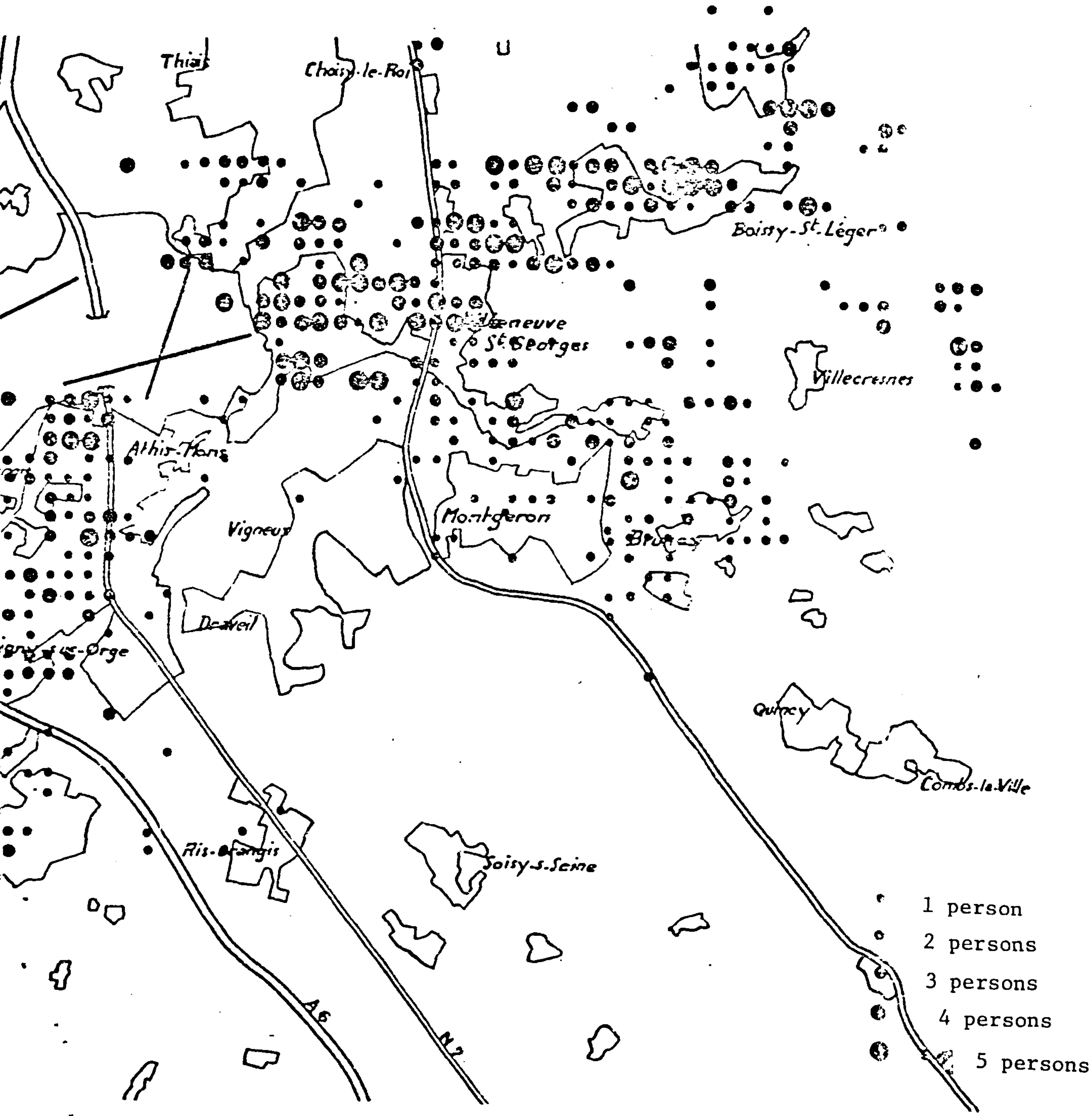
THOSE WHO DID SOMETHING TO PROTEST AGAINST



SOMETHING TO PROTEST AGAINST NOISE (Question 16)



scale : 1cm p.1km

index seems to be established, and its sensitivity is sufficient for the purposes of the study. Due to the geographical distribution of interrogated persons, we established a cartographic representation of the annoyance around the airport, which constitutes a document whose utility is obvious. It can be used particularly for determining the zones to be subjected to regulatory actions around the airport.

We then studied the relationship between the annoyance perceived by the inhabitants (measured by GO) and the annoyance estimated by the isopsophic index N. This analysis was made at two levels: we studied the correlation and the distribution function of these two variables in a sector of the inquiry zone; also, we compared the distribution of these two indices over the entire territory studied.

As for the first phase of this research, we can distinguish a certain number of partial conclusions about the quality of the isopsophic index as applied to the estimation of annoyance:

-- The correlation between GO and N in the northeast sector is relatively satisfactory if one calculates this correlation at the level of "average individuals": $r = .68$ [1].

The map of the annoyance corresponds quite well /48 overall to the map of the isopsophic curves. The isopsophic index, established from data for aircraft noise, therefore constitutes a good estimation of the average annoyance. But the correlation between the annoyance and the isopsophic index at the individual level is very weak $r = .21$, i.e. if we know the value of the index N characterizing a given point, it

(1) By "average individual" we mean a group of five interviewed persons who reside in a square having a side length of 1/3 kilometer.

is not possible to accurately predict the intensity of annoyance perceived by an individual living at this location. The correlation improves considerably if one speaks of an average individual and an average annoyance. Therefore, it is only at this level that the index N constitutes a satisfactory predictor for annoyance.

Certain reservations have to be mentioned:

-- Even if we consider average annoyance levels, we find relatively large variations in the annoyance, which the isopsophic index does not explain and probably will never be able to explain. No matter what the improvements that are implemented, a noise index can only predict an average annoyance level.

-- Locally, the correlation between the isopsophic index and the annoyance index appears to be satisfactory, but the correspondence between these two indices is not at the same levels, depending on the runway considered. From this we can conclude that in the constitution of the isopsophic index, taking into account the utilization coefficients of runways is not satisfactory.

-- The isopsophic index is not very discriminating: it requires a rather large variation of this index in order to observe a sensible variation of the average annoyance. Instead of using the three zones A, B and C, as we are now, it would seem preferable to distinguish two zones: a zone combining A and B (limited by the index value) and a zone C, which extends up to the index 80.

-- When one draws the isopsophic curves, it is not justifiable to neglect the dispersion of flights around the official trajectories.

Therefore, the methodology which has been tested seems to be both rich and promising. In a detailed way, we were able to visualize the annoyance around Orly Airport and to determine locally the quality of the isopsophic index presently used in France. /49

It, therefore, seemed quite desirable to continue in this direction and, in a second phase, to carry out research which would consist of a critical analysis of the index N in order to find its predictive capacity for annoyance.

First of all, we will calculate the values of the isopsophic index from real trajectories, such as can be established by analyzing radar recordings. Then we will examine to what extent the correlation between the annoyance and the index N will be improved.

Also, we will attempt to optimize the weightings assigned to the various parameters which enter into the composition of N, and we will then, finally, obtain an index which will have a better validity at the level of the ensemble of the inquiry zone.

In order to evaluate the obtained improvement, we will extend the methodology used to the entire territory studied. In this way, we will obtain an index constructed according to the same principles as the index N, but which has a greater validity and which can be used over a wider range.

This research will lead to a better mastering of indices which attempt to estimate the annoyance caused by aircraft noise.

Their operational value will be established, and, without doubt, it will be possible to use it better as a reference in order to formulate regulatory measures or other measures designed to protect inhabitants living near airports against noise.

/50

APPENDIX 1 -- METHODOLOGY OF THE INQUIRY

A. THE INQUIRY ZONE

a) Definition of the zone

The vicinity of Orly Airport was used as the experimental area, and it is therefore defined as the inquiry zone.

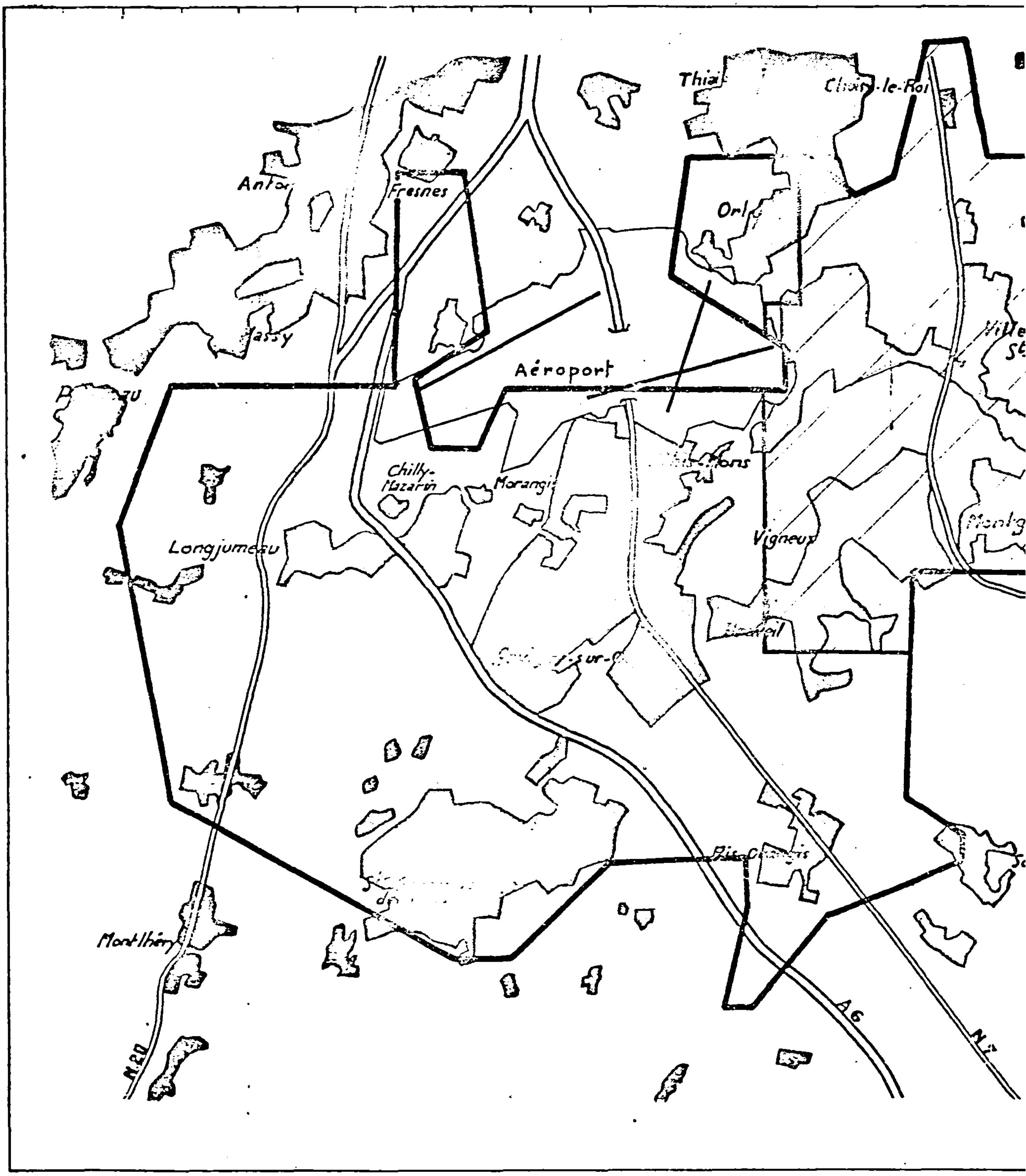
This zone is contained in an extended rectangle, extended in the east-west direction, with a length of about 25 km and a height of about 15 km. The zone itself includes about 33 localities[1]; the airport is located in the northern part (see the map on page 51.)

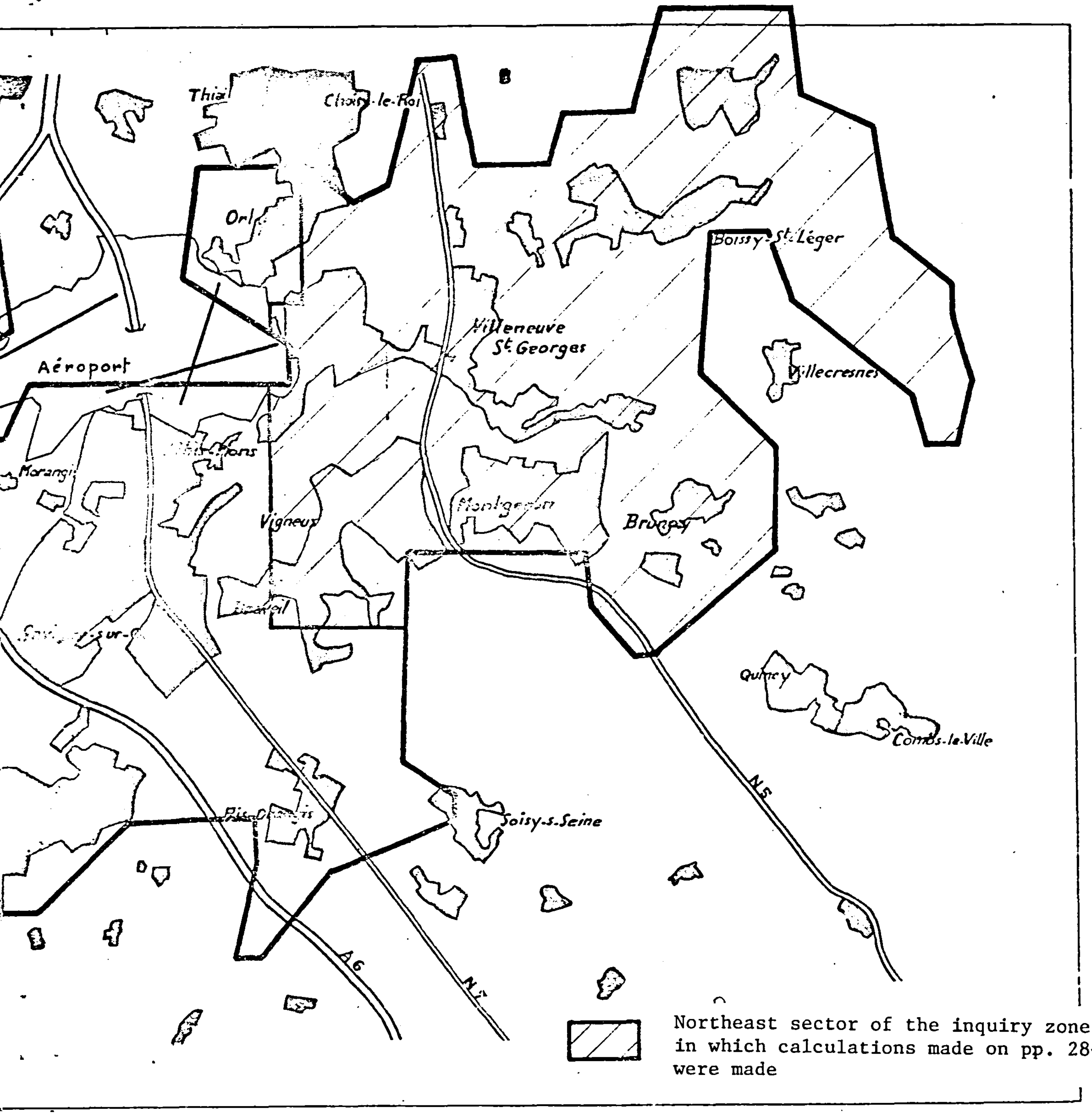
b) Measurement of a point in the zone

The zone was divided up, using parallels and meridians, separated by 1 km. Each square defined in this way, with a side length of 1 km, was then divided up into nine smaller squares, each having one-third of a km (333.3 m) side length.

[1] See the list of localities of the inquiry on page 54.

☐ INQUIRY ZONE





Northeast sector of the inquiry zone in which calculations made on pp. 28-35 were made

scale : 1cm p. 1km

This double division of the zone of inquiry allowed us to define two systems of coordinates used for measuring points in the zone[1].

B. THE SAMPLING METHOD

/52

The persons interrogated in the inquiry constitute a representative sampling of the population who are 20 years of age and older and who live in the zone defined above.

The sampling method used was the quota method. It consists of finding persons to be interrogated by observing pre-established social-demographic quotas based on statistical information available for the reference population[2]. A consignment was used in order to maintain a "random" selection of interviewed persons.

a) Geographic distribution of those interviewed

It was decided to carry out five interviews per square with a side length of one third of a kilometer, for any population density[2].

The persons performing the interviews had maps of the localities within the zone at a scale of 1/5,000, and on it they drew the squares having a side length of 1/3 km; they were

(1) The kilometer mesh corresponds to that of the NORTH ZONE LAMBERT projection. The origin of latitude which was taken is the graduation 100 in this system, and the longitude origin is the graduation 587. The ordinates are computed from south to north, and the abscissae are computed from west to east.

(2) We used statistics from the census performed in 1968 by INSEE; these statistics give the distribution of the population of the large agglomerations in France, according to the main social-demographic characteristics at the communal level and, for some reason, even for small groups of blocks.

(3) The main objective of this research was to measure the annoyance caused by aircraft noise as a function of the geographical location. Therefore, it was not necessary to assign an importance to any of the points of the inquiry zone based on population density. Naturally, uninhabited areas did not result in any interviews.

told to make a maximum of five interviews within each square. For control purposes, by using a cross on the map the marked the location of each person interviewed. /53

b) <u>Determination of the persons to be interrogated</u>

The five interviews of a square had to be performed with persons who resided in the same type of lodgings, i.e. row houses or apartments in buildings; this rule was maintained in order to facilitate the work of the persons making interviews. The location of any building was used for establishing whether interviews should be performed. By area, it was possible to find the distribution of the population according to lodging type. We were, thus, able to verify that in each locality the row house-apartment ratio was respected.

The persons performing interviews had to respect sex quotas, age quotas and professional quotas for the heads of household whom they interrogated. These quotas were calculated for each of the localities within the zone, based on the last INSEE census.

C. REALIZATION OF INTERVIEWS

Overall, 4,998 interviews were performed between April 8 and May 17, 1971, using 19 interviewers[1].

In spite of the skepticism of certain persons interviewed about the utility of such an inquiry, the general climate was very good, and there was no incident to be reported. The questionnaire, which was short and simple, passed very well. From the reports from

[1] See the distribution of interviews by locality on the following page (page 54).

persons performing interviews, we find the following:

-- Certain squares, in which interviews were requested, were completely uninhabited. These squares were then replaced by others located at the edge of the zone.

-- Persons interviewed residing in the southwest region of the zone (particularly the Ris Orangis zone) dicated that the aircraft which they heard and which annoyed them were not those from Orly Airport but, instead, were aircraft from Bretigny Airport.

D. SAMPLE OF THE STRUCTURE INTERROGATED /55

The Table on the following page (page 56) shows the main social-demographic characteristics of the interrogated sample, compared to the entire population as a reference.

This comparison shows small unimportant deviations between the two structures in the distributions according to sex, age and profession of the heads of household, as well as a more substantial deviation between distributions according to the type of lodging. This distortion is due to the fact that the interviews were uniformly distributed in the inquiry zone (45 persons per km^2) and the population density in single houses was relatively small. Therefore, the persons living in this type of lodging are under-represented in the sample.

In order to conform with the experimental plan of the inquiry and to give an identical weight to each square, the sample interrogated was not subjected to weighting which would have corrected this distortion.

LOCALITIES OF THE INQUIRY

Localities	Number of Interviews	Localities	Number of Interviews
Ablon/Seine	60	Orly	110
Athis-Mons	230	Paray-Vieille-Poste	75
Ballainvilliers	45	Ris-Orangis	170
Boissy-St-Léger	90	Ste-Geneviève-des-Bois	276
Brunoy	255	Santeny	63
Champlan	50	Saulx-les-Chartreux	20
Chilly-Mazarin	125	Savigny/Orge	280
Crosne	70	Sucy-en-Brie	215
Draveil	310	Valenton	70
Epinay/Orge	110	Vigneux/Seine	190
Epinay-sous-Sénart	65	La Ville-du-Bois	40
Grigny	74	Villemoisson/Orge	75
Juvisy	110	Villeneuve-St-Georges	165
Limeil Brévannes	135	Villeneuve-le-Roi	195
Longjumeau	151	Villiers/Orge	55
Marolles-en-Brie	35	Viry-Chatillon	217
Montgeron	215	Wissous	75
Morangis	150	Yerres	255
Morsang/Orge	190	TOTAL	5 016 (1)

(1) Certain interviews were eliminated at the end of controls; analysis was carried for 4,998 cases.

STRUCTURE OF THE INTERROGATED SAMPLE

	Structure Obtained	Theoretical Structure (1)
100		
COLLECTION	%	%
SEX		
- Men	45	48,2
- Women	55	51,8
	100	100,0
AGE		
- 20 - 34 years	31	34,7
- 35 - 49 years	34	35,2
- 50 - 54 years	19	16,5
- 65 years and above	16	13,6
	100	100,0
PROFESSION OF BREADWINNER		
- Businessmen in industry and commerce	8	6,9
- Liberal professions, higher levels	10	9,8
- Medium levels, employees	29	28,6
- Workers, service personnel	34	37,8
- Inactive, retired	19	16,9
	100	100,0
TYPE OF LODGINGS		
- Houses	65	53,5
- Apartments in buildings	35	46,5
	100	100,0

(1) Source: Census carried out in March 1968 by l'INSEE.

E. THE QUESTIONNAIRE /57

The questionnaire of the inquiry, which is given on the following page (page 58) shows the main questions usually posed in studies performed on annoyance caused by ambient noise.

After a series of questions about the various living conditions in the quarter, where the noise problem is placed within a more general context (Questions 1 through 8), the modalities of annoyance due to aircraft noise (Questions 9 through 14) and the counteractions for this noise (Questions 15, 16 and 17) are discussed. The last questions (A to J) record the main social-demographic characteristics of the persons interrogated. The localization of the interview is finally measured by the number of the square having a side length of 1/3 km.

APPENDIX II - ISOPSOPHIC INDEX /62

I. DAYTIME TRAFFIC

The value of the isopsophic index at a point under consideration around an airport depends on the following:

-- The noise level relative to each pass of an aircraft of a given type (level expressed in PNdb, Perceived Noise Decibel).

-- The direction of the noise for each pass.

-- The number of repetitions of aircraft noises over a day (or over a night).

FRENCH PUBLIC OPINION INSTITUTE 20, Rue d'Aumale, Paris 9 - TRI 97.75 +

The French Public Opinion Institute is carrying out a study on living conditions of inhabitants in the Paris region. On this occasion, we would like to obtain your opinion about certain problems. /58

1. For how long have you been living in this quarter?

Since (1) years

2. In a general way, what do you think of living conditions in this quarter? Would you say that the life is any of the following?

Very agreeable?	1
Quite agreeable?	2
Not very agreeable?	3
Not at all agreeable?	4
?	0

3. For each of the living conditions mentioned, please tell me whether you, personally, are very satisfied, quite satisfied, not very satisfied or not at all satisfied with the present situation at (mention your residence)?

	Very satisfied	Quite satisfied	Not very satisfied	Not at all satisfied	?
a) Public transportation	1	2	3	4	0
b) Green areas: squares, public gardens, parks	1	2	3	4	0
c) Possibility of finding work not too far away	1	2	3	4	0
d) Tranquillity from the point of view of ambient noise	1	2	3	4	0
e) Cost of lodging: rent and construction costs (2)	1	2	3	4	0
f) Possibilities of distraction	1	2	3	4	0
g) School and sport possibilities: schools, private schools, sport areas, swimming pools, etc.	1	2	3	4	0
h) Maintenance of the city: cleanliness of roads, monuments, building facades	1	2	3	4	0
i) Possibilities of driving and parking	1	2	3	4	0
j) Air purity in the area (Are there odors or smoke?)	1	2	3	4	0

4. a) Since you've been living here, have you already considered moving, are you presently considering this or have you ever considered this?

Yes, I have already thought about it.	1
Yes, I am presently looking.	2
No, I have never considered it.	3

4. b) For what reasons? (DON'T SUGGEST ANYTHING.)
Are there other reasons?

5. Would you say that the noise here in your quarter annoys you a lot, very often, quite often, sometimes, never?

Very often.	1
Quite often.	2
Sometimes.	3
Never.	4
?	0

6. What kind of noise do you hear in your quarter? (DO NOT SUGGEST ANY ANSWERS; IF THEY ARE MADE SPONTANEOUSLY, INDICATE THEM IN THE FOLLOWING TABLE IN THE FIRST COLUMN.) /59

7. Questions to asked only if noises were not mentioned spontaneously.

Do you hear aircraft noises?
Do you hear street noises?
Do you hear other noises?

(WRITE DOWN RESPONSES IN THE SECOND AND THIRD COLUMNS OF THE TABLE.)

8. IF TWO OR MORE NOISES WERE MENTIONED FOR Q. 6 or Q. 7

Among the noises which you have heard here in your quarter, which ones annoy you the most? And after that? (TRY TO CLASSIFY NOISE HEARD ACCORDING TO THE ANNOYANCE ORDER AND NOTE THE RESPONSES IN THE LAST COLUMN OF THE TABLE.)

	Q. 6 Mentioned Spontaneously	Q.7		Q. 8 Order of annoyance		
		Yes	No	1st	2nd	3rd
Aircraft noise	1	1	E	1	1	1
Road noise (cars, trucks, motor-cycles)	2	2	E	2	2	2
Other noises (mentioned below)	3	3	E	3	3	3

(continued, next page)

8. (continued)

THOSE WHO DID NOT HEAR AIRCRAFT NOISES (Q. 6 OR Q. 7), GO TO THE CHARACTERISTICS.

---

9. I would like to ask you to define at what point aircraft noise which you hear at this time annoys you, personally. Please look over this drawing and tell me at which point you are located (from 0 to 10); 0 means you are not at all annoyed by aircraft noise, and 10 means the opposite, i.e. you are very much annoyed. (SHOW THE SCALE FROM 0 TO 10)

Annoyance note:

---

10. THOSE WHO HEAR ANOTHER NOISE (IF MORE THAN ONE, DISCUSS THE MOST ANNOYING NOISE, SEE Q. 8)

I would like to ask you to tell me in the same manner, using a note from 0 to 10, the point you would give to the noise (mention the noise) which annoys you at this time?

Annoyance note:

---

11. ALL THOSE WHO HEAR AIRCRAFT NOISE

I would like to ask you a few questions about aircraft noise which you hear in your quarter.

Does aircraft noise annoy you:	Much?	1	
	Quite a lot?	2	12
	Slightly?	3	
	Not at all?	4	15

---

12. Does aircraft noise annoy you:	Very often?	1
	Quite often?	2
	Sometimes?	3

---

13. Most often, when you hear aircraft noise, is this noise:

Very strong?	1
Quite strong?	2
Quite weak?	3
Very weak?	4

14. Does aircraft noise cause the following annoyances in your residence? (If "yes": ASK FOR AN EXPLANATION AS TO WHETHER THIS HAPPENS OFTEN OR OR FREQUENTLY, ONE RESPONSE PER LINE.) /60

Does it happen that:	No	Yes, sometimes	Yes, frequently	?
a) It stops you from falling asleep?	1	1	1	E
b) That you wake up?	2	2	2	E
c) It stops you from having a conversation with your family or friends?	3	3	3	E
d) You are disturbed when listening to the radio or TV?	4	4	4	E
e) It prevents you from going out on your balcony, if you have one, in good weather?	5	5	5	E
f) It frightens you?	6	6	6	E

FOR ALL THOSE WHO HEAR AIRCRAFT NOISE

15. a) Have you already done something or are you presently considering doing something about sound-insulating your lodging, or part of your lodging, against external noise: (SEVERAL RESPONSES ARE POSSIBLE)

Yes, have already done something.	1	
Yes, am now considering it.	2	15b
No, have done nothing and am considering nothing.	3	16

15. b) What?

16. Have you personally done one of several things indicated on this card to protest aircraft noise? If yes, what have you done? (SHOW THE CARD, AND IN THE FOLLOWING TABLE ENTER THE RESPONSES IN THE FIRST COLUMN.)

17. On this card, are there things which you have not yet done, personally, for combating aircraft noise, but which you would now like to do? (ENTER RESPONSES IN SECOND COLUMN.)

 (continued, next page)

17. (continued)

	Q. 16 Already done	Q. 17 Not yet done but would like to
Write or telephone an official or a newspaper.	1	1
Visit an official.	2	2
Sign a petition.	3	3
Go to a public meeting.	4	4
Do other things (what?).	5	5
Nothing.	6	6

CHARACTERISTICS

/61

A. Type of lodging:

Apartment in building	1
Row apartment	2
Other (indicate)	3

____

____

____

Number of stories in the building:

B. Approximate construction date of your lodgings (apartment or row house). Was it:

Before 1945?	1
Between 1945 and 1954?	2
Between 1955 and 1964?	3
After 1965?	4

C. Are you the owner or renter of your lodgings?

Owner or co-owner?	1
Renter?	2
Other?	3

D. Profession of person interrogated:

____

Salaried person	1
Owner	2
Official	3

E. Profession of head of household:

____

Salaried person	1
Owner	2
Official	3

(IF OWNER)

How many persons are employed in your enterprise? Number of persons: ______

F. Does your profession or that of another person in your circle relate to aviation in general, Orly Airport, airport construction, etc.?

Yes, person interrogated	1
Yes, another person in his circle	2
No, none	0

G. Sex: Male 1 Female 2

H. Age:

20 to 24 years	X	50 to 54 years	5
25 to 29 years	0	55 to 59 years	6
30 to 34 years	1	60 to 64 years	7
35 to 39 years	2	65 to 69 years	8
40 to 44 years	3	75 and above	9
45 to 49 years	4		

I. Do you usually work outside your quarters; and, if yes, can you give me the precise location? (SHOW A MAP TO GET PRECISE INFORMATION).

No office outside of my domicile	1
Yes, outside of the inquiry zone	2
Yes, inside the inquiry zone (mention locality below)	3

____

J. EXACT LOCATION OF DOMICILE

PRECISELY INDICATE THE NUMBER OF THE ZONE (five digits required)

____

Address: Street ______________________

Number ______________________

Floor ______________________

Locality ______________________

K. Name of the person taking interview: ______________________

Date of interview: ______________________

L. Duration of interview, between first question and end of questionnaire:

Less than 10 minutes	1
10 to 15 minutes	2
16 to 20 minutes	3
21 to 25 minutes	4
26 to 30 minutes	5
31 to 35 minutes	6
36 to 40 minutes	7
41 to 45 minutes	8
45 and above	9

An observer located at a given point around an airport will be exposed to variable noise levels, first of all because noise characteristics vary depending on type of aircraft, and also because the trajectories followed by aircraft are also variable because they are essentially a function of the destination of the aircraft. An estimation of the total exposure to the noise sensed by an observer during one day, therefore, has to take into account the sum of these various exposures to aircraft noise, i.e. the number of repetitions of these various noises during one day.

The calculation of the isopsophic index, therefore, must consider both the noise for each pass of any kind of given aircraft and the number of passes of aircraft of a given type.

It is obvious that estimation of total noise exposure must take into consideration the duration of this noise. For this purpose, we assumed that in a general manner each movement of an aircraft produces a disturbing noise for 30 seconds, and that the motions follow one another at a maximum frequency of one per minute. Considering that the traffic period during the day extends between 06.00 hours and 22.00 hours, that is, over 16 hours, we can realize that the maximum exposure amounts to 16 x 60 = 960 aircraft movements per day. Therefore, the total exposure for a number of aircraft A less than the number 960 will have to be reduced, with respect to the maximum exposure, by the ratio of sonic energies relative to 960 passes, and also relative to the number A considered. /63

The isopsophic index $\mathcal{N}$, which takes into account the noise exposure during one day is calculated from the following general formula

$$\mathcal{N} = N - \lambda \log \frac{T}{t} \qquad (1)$$

with: $\mathcal{N}$ = isopsophic index

N = noise level expressed in PNdb, for one aircraft pass of a given type, according to a given trajectory

λ = 10

T = maximum exposure duration to aircraft noise during one day (16 hours)

t = real duration of noise exposure

This can be written simply as:

$$\mathcal{N} = N - 10 \log \frac{960}{A} \tag{2}$$

with: A = real movements of a given type of aircraft along a given trajectory, and over one day (between 6.00 and 22.00 hours) /64

The term 10 log 960 essentially equal to 30, and the formula (2) above is finally written as:

$$\boxed{\mathcal{N} = N_{(PNdb)} - 30 + 10 \log A}$$

2. NOCTURNAL TRAFFIC

The calculation of the isopsophic indices for nocturnal traffic is defined using the same principles as those used for diurnal traffic, i.e. by the relationship:

$$\mathcal{N} = N_{(PNdb)} - \lambda \log \frac{T}{t}$$

with: T = duration corresponding to maximum night traffic

t = duration (or number of operations) carried out during the night

λ = numerical coefficient whose value will be given later on

These studies made on the detrimental effects of noise on sleep show that this effect is more pronounced during the first half of the night. In order to take into account this fact, we consider a higher weight for aircraft motions carried out during this first half of the night. We, therefore, will replace T and 5 by $eT_1 + T_2$ and $3t_1 + t_2$, respectively, where the indices 1 correspond to the operations which take place over the first half of the night, and indices 2 correspond to operations which occur during the second half.

For take-offs which follow one another at a frequency of one per minute at a maxium, $3T_1 + T_2$ is equal to: 3 x 2 + 2 = 8 hours (22.00 to 06.00 hours) and the number of movements corresponding is: 3 x 240 + 240 = 960 so that:

$$\mathcal{N} = N - \lambda \log \frac{960}{3n_1 + n_2} = N - 3\lambda + \lambda \log (3 n_1 + n_2)$$

n_1 and n_2 are the number of movements over the second half of the night.

Considering the special character of annoyance during the night, it did not seem possible to take a constant value for the coefficient λ, as was done during the daytime annoyance. The coefficient 10 can be accepted because the number of operations does not during the night exceed the number which produces an acceptable annoyance for nocturnal sleep. Studies made by the Applied Physiological Study Center of the Medical Faculty of Strasbourg, shows that thirty-two repetitions of aircraft take-offs of the Caravelle type, also uniformly distributed over the night and which produced a global noise level of 75 db inside only produced an acceptable annoyance level.

Beyond thirty-two, it is appropriate to assign an increasing value to λ using a logarithmic law, according to the number of repetitions, until the value of 17 is reached for the maximum number of repetitions.

Considering the weighting of the number of take-offs between the two halves of the night, this law leads to the following:

$$\lambda = 6 \log (3 n_1 + n_2) - 1$$

and the expression for $\mathcal{N}$ must be replaced by:

$$\mathcal{N} = N - 17 \log 960 + \lambda \log (3 n_1 + n_2)$$

where: /66

$$\mathcal{N} = N - 51 + \lambda \log (3 n_1 + n_2)$$

when $3 n_1 + n_2$ is greater than 64(x).

When $3 n_1 + n_2$ is less than 64, the value $\lambda = 10$ is used so that

$$\mathcal{N} = N - 51 + 10 \log (3 n_1 + n_2)$$

(x) $n_1 + n_2 = 32$ for $n_1 = n_2 = 16$ we have $3 n_1 + n_2 = 64$.

For landings, a formula of the same type is proposed. We considered the fact that the spectrum of the noise was different from the noise for take-off, and therefore the attenuation (expressed in PNdb) sensed by the houses is higher than in the case of take-off. Therefore, we took into account an additional attenuation of 5 PNdb so that the formula for landings at night is:

$$\mathcal{N} = N - 56 + \lambda \log (3 n_1 + n_2)$$

when $3 n_1 + n_2 > 64$

with $\lambda = 6 \log (3 n_1 + n_2) - 1$

and

$$\mathcal{N} = N - 56 + 10 \log (3 n_1 + n_2)$$

when $3 n_1 + n_2 < 64$

APPENDIX 3 : NUMBER TABLES /67

A. AVERAGE ANNOYANCE NOTES AND FREQUENCIES OF VARIOUS RESPONSES TO QUESTIONS RELATIVE TO ANNOYANCE.

The results allow one to appreciate the internal coherence between GO and to see at which level of this index the various items within each question are located.

The annoyance notes obtained by the persons who gave all of the responses are distributed to either side of the average of this index (50) in a symmetric manner, if one takes into account the weighting related to the number of individuals who gave each response.

B. INFLUENCE OF INDIVIDUAL CHARACTERISTICS ON THE PERCEIVED ANNOYANCE

We observe an important inter-individual variability of the annoyance due to aircraft noise. This phenomenon appears both for the geographical location (two individuals residing in the same square having a side length of 333 m can have a very different annoyance note) and in comparison with the isopsophic index (the dispersions of the values of GO for a given value of N are large.)

During the present inquiry, we measured the social-demographic characteristics of the persons interviewed as well as information about their lodgings, in order to study the extent to which these variables can explain the fluctuations of the annoyance found.

When one calculates the average annoyance note of the collection of the individuals for each characteristic, one only finds very slight differences among groups (see Tables on pages 47 and 48).

The annoyance, therefore, seems to be slightly less than among the following:

-- Women.

-- Younger and older people.

-- Inactive and retired persons.

-- Persons living in a home or persons having a professional relationship to aviation.

-- Persons living in a house of recent construction.

We believe that the small influence of these variables on the perceived annoyance demonstrates, on the other hand, the importance of these variables as more properly psychological.

AVERAGE ANNOYANCE NOTES AND FREQUENCIES OF VARIOUS RESPONSES TO QUESTIONS RELATING TO ANNOYANCE

NOTE: As for the averages of the calculated GO for the entire collection of persons who responded to each item, we show the proportion represented by these individuals among the popula- studied.

The questions are classified according to decreasing values of coefficients a_i.

	Average Values of GO	Distribution of the Responses Within the Studied Population
		%
Q. 11 - Aircraft noise annoys them:		
A lot	70.5	21
Quite a lot	58.0	17
Somewhat	46.4	28
Not at all	34.8	14
No answer	34.6	20
		100
Q. 12 - Aircraft noise annoys them:		
Very often	72.4	15
Quite often	60.4	17
Sometimes	48.4	34
Never or no answer . . .	34.7	34
		100
Q. 14d- Aircraft noise annoys them when listening to the radio or TV:		
Frequently	70.0	22
Sometimes	54.0	25
There is no annoyance when listening to radio or TV or they do not hear it	29.1	53
		100

AVERAGE ANNOYANCE NOTES AND FREQUENCIES OF VARIOUS RESPONSES TO QUESTIONS RELATING TO ANNOYANCE (continued)

	Average Values of GO	Distribution of the Responses Within the Studied Population
		%
Q. 14c - Aircraft noise prevents them from carrying on conversation:		
Frequently	72.1	17
Sometimes	56.5	25
No prevention of carrying on conversation or they do not notice it	40.1	58
		100
Q. 13 - Very often the aircraft noise is:		
Very strong	66.2	26
Quite strong	53.5	31
Quite weak	43.7	9
Very weak	40.1	
No answer or they do not hear it	34.7	34
		100
Q. 9 - The annoyance note assigned to the aircraft noise is:		
0	34.4	8
1	38.2	4
2	42.4	7
3	44.1	8
4	47.8	7
5	52.1	14
6	57.1	6
7	61.0	6
8	65.5	8
9	69.4	2
10	74.4	10
No answers	34.8	20
		100

(continuation of Table)

	Average Values of GO	Distribution of the Responses Within the Studied Population
		%
Q. 6-7 - Perception of aircraft noise:		
Hear aircraft noise and it is mentioned spontaneously	58.7	51
Hear it and it is discussed after being mentioned	43.7	29
Do not hear aircraft noise	34.6	20
		100
Q. 16-17c-Signing a petition for protesting:		
Have already done this	74.8	7
Would like to do it . .	64.8	13
Have not done it and do not wish to	44.8	80
		100
Q. 5 - Frequency of annoyance due to ambient noise:		
Very frequent	65.2	20
Quite frequent	56.9	15
Sometimes	46.8	33
Never	40.0	31
No anwer	49.2	1
		100
Q. 14e - Aircraft noise prevents them from opening windows:		
Frequently	76.3	7
Sometimes	64.1	12
No prevention from opening windows or they do not notice . .	45.1	81
		100

(continuation of Table)

	Average Values of GO	Distribution of the Responses Within the Studied Population
		%
Q. 14b - Aircraft noise wakes them up:		
Frequently	76.7	5
Sometimes	63.6	16
Does not wake them or they do not hear it . .	45.1	79
		100
Q. 3d - Evaluation of present situation in their locality about tranquillity from the point of view of ambient noise:		
Very satisfactory	38.9	18
Quite satisfactory . . .	44.7	42
Barely satisfactory . .	54.1	17
Not at all satisfactory	64.2	22
No answer	47.7	1
		100
Q. 14a - Aircraft noise prevents them from sleeping:		
Frequently	77.4	5
Sometimes	65.9	11
Not at all or they do not notice	46.0	84
		100
Q. 8 - The rank of aircraft noise among annoying noises:		
1st	59.6	37
2nd	48.1	19
3rd or not classified .	41.8	44
		100

(continuation of Table)

	Average Values of GO	Distribution of the Responses Within the Studied Population
		%
Q. 16-17d-Attend a public meeting for protesting:		
Have already done this. .	77.6	2
Would like to do it . . .	70.1	5
Have not done it and do not wish to	48.0	93
		100
Q. 4a - Possibility of moving:		
Presently considering it .	54.5	17
Have considered it . . .	52.1	10
Never considered it . . .	48.1	73
		100
Q. 4b - Reasons for which they wish to live elsewhere:		
Because of aircraft noise	80.2	2
Because of street noise .	63.3	2
Because of other noises or unidentified noise . .	67.4	2
Q. 14f - Aircraft noise scares them:		
Frequently	81.9	1
Sometimes	68.8	5
Does not scare them or they do not hear it . . .	48.3	94
		100

(end of Table)

	Average Values of GO	Distribution of the Responses Within the Studied Population
		%
Q. 16-17a-Write or telephone official or a newspaper for protesting:		
Have done it.	83.2	1
Would like to do it . .	75.3	3
Have never done it and do not wish to . .	48.6	96
		100
Q. 16-17b-Wish to visit an official for protesting:		
Have done it	84.7	1
Would like to do it . . .	74.5	3
Have not done it and do not wish to	48.6	96
		100
Q. 2 - Evaluation of living conditions in the quarter. Believe that life is:		
Very agreeable	43.8	23
Quite agreeable	49.3	54
Not very agreeable . .	54.8	13
Not at all agreeable .	59.8	8
No answer	51.0	2
		100
Q. 16-17e-Do other things for protesting against aircraft noise:		
Have done it	77.1	1
Would like to do it . .	71.2	1
Have not done it and do not wish to	49.1	98
		100

AVERAGE VALUES OF GO DEPENDING ON CHARACTERISTICS OF INTERROGATED PERSONS

		Average GO	Distribution of the Responses Within the Studied Population
			%
SEX:			
	Males	50.9	45
	Females	48.5	55
			100
AGE:			
	20 to 24 years	47.1	10
	25 to 29 years	48.8	9
	30 to 34 years	49.5	12
	35 to 39 years	49.2	12
	40 to 44 years	50.1	12
	45 to 49 years	50.7	10
	50 to 54 years	50.8	7
	55 to 59 years	50.0	5
	60 to 64 years	52.3	7
	65 to 64 years	50.2	9
	75 and above	47.7	7
			100
PROFESSION OF INTERROGATED PERSON:			
	Agricultural	57.0	1
	Owner of industry or business	49.9	1
	Upper cadre, liberal profession	50.8	4
	Medium level	50.9	8
	Employee	50.9	15
	Worker	50.0	5
	Service personnel	49.0	5
	Other active	50.1	1
	Inactive, retired	48.8	50
			100

(end of Table on following page)

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(end of Table)

	Average GO	Distribution of the Responses Within the Studied Population
PROFESSION OF THE HEAD OF HOUSEHOLD:		
Agricultural	58.3	1
Owner of industry or business	49.2	8
Upper cadre, liberal profession	49.7	10
Medium level	50.1	14
Employee	50.0	12
Worker	48.8	30
Service personnel	48.8	3
Other active	48.7	3
Inactive, retired	50.1	19
		100
RELATIONSHIP OF PROFESSION TO AVIATION:		
Interviewed person	49.3	5
Another person in circle of person interviewed	48.5	6
TYPE OF LODGING:		
Apartment in building	49.3	34
Row house	49.7	65
Other	56.0	1
		100
CONSTRUCTION DATE OF HOUSE:		
Before 1945	50.7	40
Between 1945 and 1954	49.9	7
Between 1955 and 1964	49.1	26
1965 or after	48.3	25
Not identified	49.3	2
		100
OCCUPATION STATUS OF THE LODGING:		
Owner or co-owner	49.7	61
Renter	49.4	35
Others	49.5	3
Not identified	54.6	1
		100