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GEOGRAPHICAL APPROACH OF ANNOYANCE DUE TO NOISE TRANSPORTATION

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ABSTRACT
This paper focuses on a geographical approach of annoyance due to noise transportation and intends to construct a decision making tool. The research is based on a survey. First, we describe the methodology and the results of the survey and then, the generalisation of the results and the decision making tool are presented.

1 - INTRODUCTION
Today in France, L_{Aeq} (6h-22h) and L_{Aeq} (8h-20h) are used as objective indicators of annoyance due to noise transportation. But noise annoyance is hardly represented by these indicators, as they do not take into account several explicative modulation factors, such as the number of noise events, individual neighbourhood satisfaction, and soon... We propose here a subjective indicator of annoyance, which considers these modulation factors, and we develop a decision making tool integrating a more realistic annoyance model. The construction of the subjective indicator of annoyance and the following model is based on the analysis of a survey led in Besançon, France (130 000 inhabitants). The first section of the paper describes the methodology of the survey. The results of this survey are then presented in a second section. Finally, the last section is dedicated to the description of the annoyance model and the presentation of the decision making tool.

2 - METHODOLOGY OF THE SURVEY
The annoyance due to noise transportation, as perceived by individuals, is a complex problem: previous studies have shown that, for a constant noise level, the annoyance perceived by an individual or a community depends on miscellaneous factors related to individual or collective characteristics (left of the fig. 1). For example, the level of neighbourhood satisfaction is typically an individual modulation factor whereas the dynamic of noise is a collective characteristic of a group of persons. We suppose here that spatialized variables can represent those modulation factors (see right part of figure 1). These spatialized variables were chosen for their availability in Besançon and in other French cities.
The sample used for the survey is based on a classification of residential buildings directly exposed to the traffic flow (buildings that are located near a street and that are not protected by a screen). As classification criteria, we used the spatialized variables described before as well as the noise exposition level measured *in situ*. The noise index used to represent noise exposition is the L_{Aeq}, measured by acousticians at representative locations along the streets. The length of the measurement period was 12 hours (LAeq (8h-20h)), 1 hour or 15 minutes, as french noise maps are generally made. In order to obtain the noise exposition level of each street, each punctual measure has been affected to the corresponding homogeneous street sections.
The classification of residential buildings was done automatically, using a geographic information system (GIS). Sixty classes of residential buildings (i.e. sixty residential areas) were defined. We then selected at random a sample of residents living in each area. 7454 postal questionnaires were then diffused and 2702 persons filled it in. The annoyance as perceived by individuals was expressed on a verbal scale with 4 levels. The evaluation of the community annoyance results from the aggregation of the individual responses obtained for each area. Ten of the sixty areas were removed from study, for different reasons:

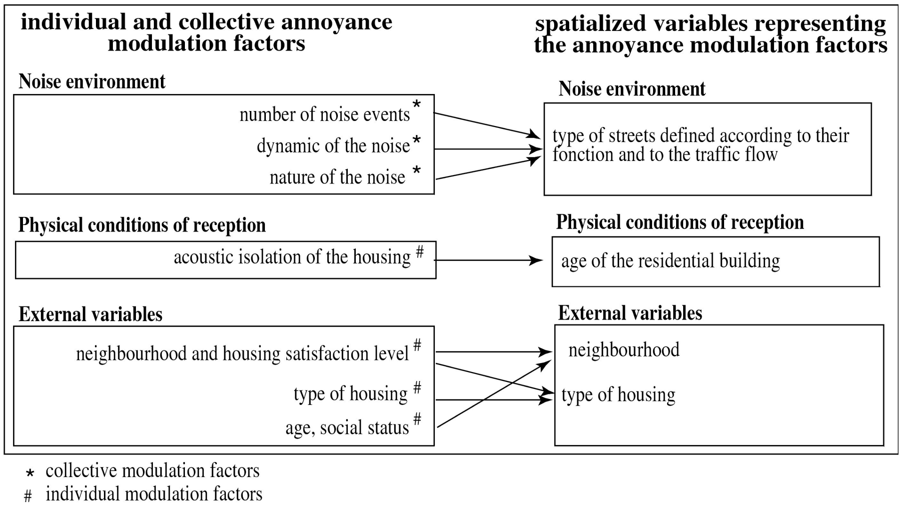

Figure 1: Annoyance modulation factors and spatialized variables representing them.

not enough respondents for an area, noise exposition too specific ... Finally, the responses of 1910 persons were taken into account. According to the nature of individual annoyance expressed, the community annoyance can be approximated using three different methods: a/ through a frequency of persons "very much annoyed", b/ a frequency profile for each modality of the verbal scale, c/ a mean value calculated after the verbal annoyance scale have been transformed into an interval scale using a scaling method. The last method was especially used here: annoyance means were sorted and classified into 8 groups corresponding to 8 community annoyance ratings.

3 - DETERMINANTS OF COMMUNITY ANNOYANCE

For a given level of noise (L_{Aeq} classes of a 3 dB(A) interval), community annoyance as estimated can have different corresponding levels. To explain the observed differences, empirical and statistical analyses were led (exploratory analyses and classical statistic tests). The main results are exposed below:

- Bus traffic (more than 500 vehicles/day) generates higher annoyance than "composite traffic".
- For "composite traffic", the community annoyance is positively related to the rate of traffic flow. More, for a given rate, noise assessment is higher when the traffic is mainly composed by heavy vehicles.
- Buildings constructed after 1978 or recently renovated generate lower annoyance than buildings constructed before 1978.
- Up to 62dB(A), groups of residents living in individual houses express a lower annoyance than those living in collective buildings. This phenomenon can be related to the level of neighbourhood satisfaction.
- People living in downtown and in social housing neighbourhood are more sensitive to noise than persons living in other types of neighbourhood. The high annoyance level observed in social housing neighbourhoods is due to the weakness of the satisfaction level of neighbourhood. On the contrary, in spite of a high satisfaction neighbourhood level in the downtown, the sensitivity to noise is important because of the low rate of elderly people living in. Actually, elderly people are less annoyed than the other.

These results show that community annoyance is a complex problem:

- some thresholds or inversions of trends can be observed (especially for the variable "type of building"),
- if we consider only variables related the noise environment, for high noise levels the annoyance is essentially explained by the noise level, whereas for low noise levels other types of noise environment variables can be identified.

- some correlation appear only if the modalities of the variables and not the variables themselves are taken into account for the statistical tests.

Finally, the analysis of the survey show some links exist between the variables representing annoyance modulation factors and the community annoyance. In fact, we can establish linear causalities between on one hand spatialized variables and L_{Aeq}, and on the other hand the 8 "community annoyance" ratings.

4 - GENERALISATION OF THE RESULTS AND CONSTRUCTION OF A DECISION MAKING TOOL

The linear causalities presented before and observed in Besançon were transformed into inference rules that are valid in others french towns. However, some inference rules are absent because they correspond to situations that do not exist in Besançon. The missing rules shall be written only after complementary surveys are led. The inference rules were integrated in a rule based model, called GÊNEVA. For example, the inference rule of street section is: if "L_{Aeq} exposition level" is "72 dB(A)" and "rate of traffic flow" is "15 000 vehicles/day" and "neighbourhood" is "downtown" ... then "community annoyance rating" is "7".
GÊNEVA model was integrated to a decision making tool that must be used as following:

- First, community annoyance ratings must be evaluated for each street section using the pair GÊNEVA model/GIS. The GIS contains the information feeding GÊNEVA model and after applying the model, community annoyance ratings can be spatialized with the GIS: each rating is represented on a map by a colour (figure 2, upper and left map).

- Second, for each street section, the user of the tool must calculate the total number of persons to whom the community annoyance rating corresponds. These persons are those living in buildings directly exposed to the traffic flow. This procedure is performed with the GIS. The product between the "mean number of persons per housing" calculated for each clusters of buildings (statistical French division) and the total number of housings in buildings leads to the number investigated. The total number of residents exposed to the noise is represented on a map with varying line thickness (figure 2, upper and right map).

- Third, using the GIS, cartographic crossings between "community annoyance rating" and "total number of residents exposed" are available (figure 2, lower map). With this kind of map, evaluation of the extent of noise pollution can be led.

Using this tool, decision makers can make simulation to evaluate the extent of noise pollution for different planning scenarii. For example, different urban planning options were tested in Besançon.

REFERENCES

1. **H. Houot**, *Approche géographique des nuisances sonores urbaines*, Thèse de doctorat en géographie, pp. 326, 1999

2. **J.M. Fields**, Progress toward the use of shared noise reaction questions, In *Internoise 96*, pp. 2389-2394, 1996

3. **M. Bjorkman and R. Rylander**, The relation between different noise descriptors for road traffic noise and the extend of annoyance, In *6th International Congress NPHP*, pp. 351-354, 1993

4. **R.F.S. Job**, Community response to noise: a review of factors influencing between noise exposure and reaction, *Journal of the Acoustical Society of America*, Vol. 83(3), pp. 991-1001, 1988

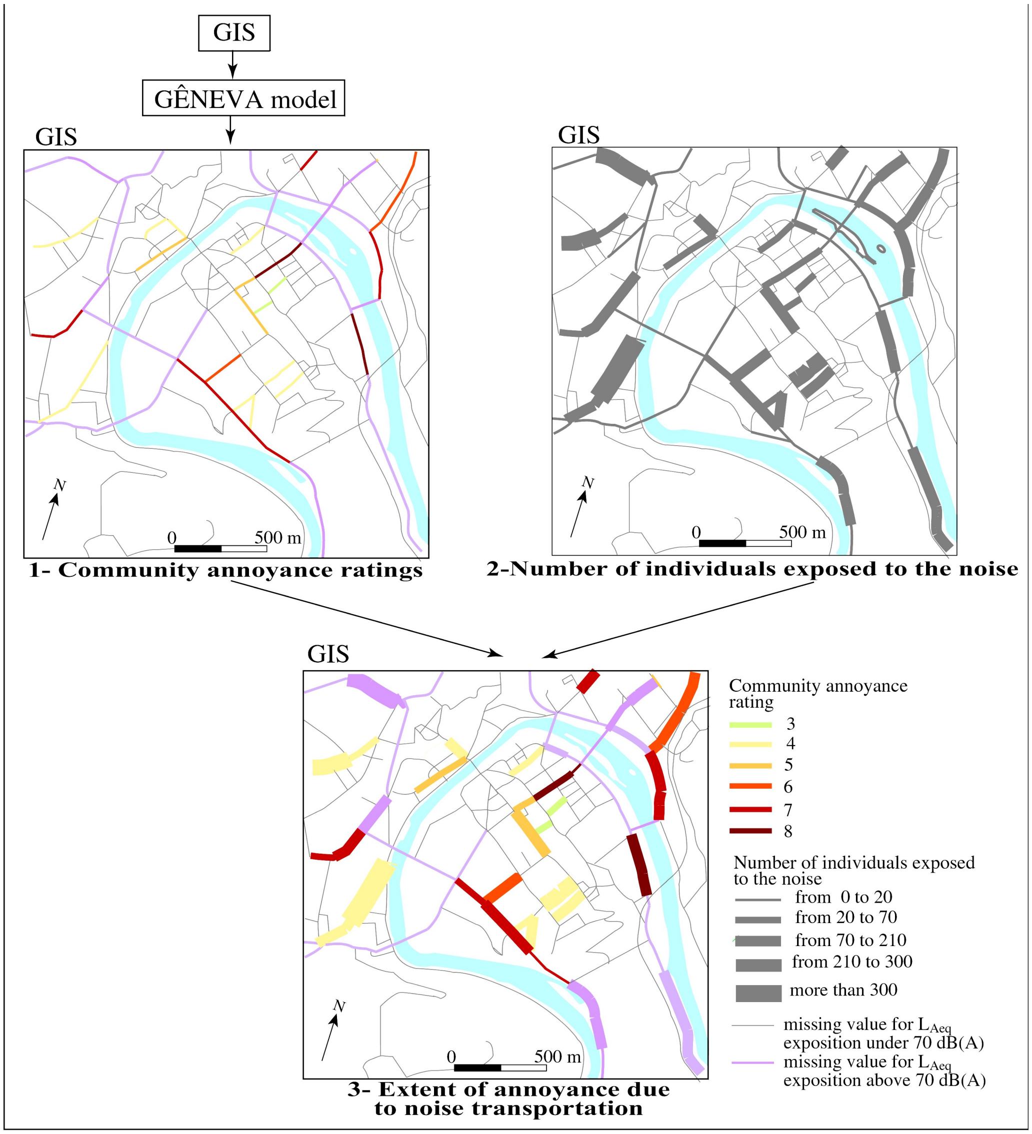

Figure 2: Architecture of the decision making tool.