PROCEEDINGS

FIFTH INTERNATIONAL CONFERENCE ON ENVIROMENTAL POLLUTION

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AUGUST 28-SEPTEMBER 1, 2000
THESSALONIKI, GREECE

REPRINTS

INTRODUCTORY REMARKS

The Fifth International Conference on Environmental Pollution is taking place after two years in our city, Thessaloniki. The first of this kind of Conference was made in 1981, whereas the fifth will be rather the last of this series, except if the Chemical Engineering dpt., will continue this kind of work, which offers a lot of emotion and knowledge in old and new scientists.

Thessaloniki is a city, which is ideal for such meetings. It is a crossroads between East and West. It is the Capital of North Greece, the country of Alexander the Great. It is a commercial and industrial center and well known for its hospitality.

It is delighted to admit that the organizers succeeded to attract to the Conference famous scientists from different countries, Universities, industries organizations and research centers.

In the first International Conference on Environmental Pollution in 1981 we had pointed out that more research is needed and from the variety of there results we could develop a strategy to protect mankind, animals and plants, material and cultural values of human beings. In this area contribution is great and it will continues to bee so. This accumulated research work was classified and directives have been given for the next two decades.

Today we are in a position that we could not spend easily a decade. Of course in some aspects there is considerable improvements in Environmental Pollution. It is worthwhile to do more to improve the conditions of living in the environment.

We hope this Conference to correspond to this direction too, so that it will provoke the attention of politicians and others. We hope, also the Conference will offer scientific motives, will reveal difficulties and generally will give new expectations for further discoveries.

We would like here to express our appreciation to all of them who helped for the best possible organization of this Conference upon which we expect results, which will contribute in the progress of scientific knowledge and technological application in Environmental Pollution.

Professor A. Anagnostopoulos

EDITORIAL

I am delighted to have the opportunity to publish the Proceeding of the 5th International Conference on Environmental Pollution.

Each of the published papers has been subject to the normal review procedure by Organizing Committee. In order to achieve publication as soon as possible, it has been necessary to eliminate discussions and comments at the Conference in Thessaloniki.

We would like to express our appreciation to all referees and authors for the excellent cooperation, which we had during this short period of time. Upon this effort the publication of the Proceedings has been finished and presented to you according to the schedule.

The editor:
Professor A. Anagnostopoulos

CONCEPTUAL DESIGN FOR GIS BASED MODELLING OF ENVIRONMENTAL (TRANSPORT-RELATED) NOISE

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This paper deals with map-based modelling of environmental, transport-related, noise. Noise emission from highways and its propagation depend greatly on traffic and physical parameters. Estimating the levels of noise, at various reception points in an affected area, is important for quantifying exposures to humans. To achieve this it is first necessary to identify the general concept of the problem by constructing the conceptual data model that is an essential element during an analysis phase. Consequently, Geographic Information System (GIS) tools can be employed to provide all the necessary spatial information for enhancing the site database. The integration of the above and the management of all related data from an application developed in accordance with a noise calculation method can accomplish the aim of assessing noise pollution.

1. Introduction

Environmental noise caused by traffic, industry and recreation is identified as one of the main local environmental problems in Europe according to a Commission Green Paper.[1] It has been also stated that around 20 percent of the EU citizens are exposed to noise levels that scientists and health experts consider to be unacceptable, where most people become annoyed, where sleep is disturbed and where adverse health effects are to be feared. In addition, approximately 170 million EU citizens are living in areas where the noise levels are high enough to generate serious annoyance. Regarding the external costs of noise -especially transport noise- to society, the Green Paper states that according to a wide variety of studies, these estimates range from 0.2% to 2% of GDP across Europe. The road noise problem is considered to be one of the major priority areas for action at EU level and proposals of DGIII foresee a 25% cut in emissions from this source.[2]

When modelling environmental noise coming from linear or point noise sources and especially when predicting the noise level from such sources at the location of a receptor, a number of factors have to be taken into account. These factors include the noise source itself, the effects of distance from the noise source, the nature of the ground surface, the intervening obstructions, the purpose-built barriers and other factors affecting the propagation of sound waves such as reflection from nearby surfaces, absorption, attenuation, diffraction etc. A database containing the topography and the various characteristics of the area under study in addition to the noise level values is therefore required. This modelling/predicting task demands the employment of computer aided design tools on the one hand and spatial and descriptive analysis tools. Both of them are offered by default by GIS that have the ability to perform numerous tasks utilising both the spatial and the attribute data of different entities stored within them.

In this respect GIS/ARCVIEW 3.2 has been employed to represent all the objects that generate noise and affect its propagation at a specific area of the city of Thessaloniki. The line sources (roads), the point sources (building site activities, recreational activities, and outdoor equipment), the various obstructions, buildings or the on-purpose built barriers, the various ground covers and finally the topography of the studied area represented by the ground elevation (anaglyph) constitute the thematic zones, that in any case are included in a typical urban digitised map.

Furthermore, by using the extension Spatial Analyst 1.1 of GIS/ARCVIEW 3.2 it has been possible to perform a grid-cell analysis in the area under consideration. By applying the British CRTN[3] method and the sound propagation theory it has been also possible to combine the contributions of the various noise sources to the total noise level. Any of the above-described factors, that affects the propagation of the sound waves can be plotted in a raster layer, and in turn all the layers are combined so that every discrete unit (grid-cell) contains and represents the total noise level. The final combined raster displays the sound field either by a visual representation or by curves of equal sound level.

By modifying parameters involved in the model, such as traffic conditions, land cover, placement of on-purpose built barriers, even topography, it is possible to achieve reduced noise levels and thus provide beneficial indications for decision-makers urban-planners and consultants.

2. Conceptual Modelling and Physical Database' Building

The entities that simulate the environmental noise must include all the critical factors that actively participate in the generation and the propagation of the sound waves. All these factors, defined in the CRTN method, must have a consistent and correlated description of the environment that is appropriate for the simulation objective. Ultimately, the relations among the entities should provide an overview of the various phenomena occurring during the noise propagation. A graphical representation of the above can be provided by the Entity Relationship (E-R) diagram, constructed according to the design introduced by Chen[4] The E-R model includes data describing simulation elements and events expected to take place during simulation execution. For example, data representing roads may be stored in the database along with data describing the traffic flow, the percentage of the heavy vehicles etc. Finally, the E-R model is used to construct a *conceptual* data model, which is a representation of the *structure* and *constraints* of a database. The entities and the associative entities resulted from the appropriate set of constraints that describe and specify the simulation, are indicated in Table 1. The graphical representation of the conceptual environmental noise modelling is illustrated in Fig. 2.1

Table 1: *Entities and associative entities resulted by Constraints*

Entity	Constraint	Associative Entity
SEGMENT RECEPTOR OBSTACLE	A SEGMENT may be viewed by a RECEPTOR through many OBSTACLES that cause obstructed propagation (SCREENING) or through none (unobstructed propagation). A RECEPTOR may face many OBSTACLES on the direction of the SEGMENT or may not face any. An OBSTACLE may obstruct many RECEPTORS or may not, may cover many SEGMENTS or may not cover any. For the screening effect we record the *Zone* in which the receptor is positioned (illuminated or shadow) (*position*), the *path difference* (diffracted ray path and the direct ray path). In case the OBSTACLE is a BLOCK it is converted to the *equivalent barrier*.	SCREENING (ternary)
SEGMENT RECEPTOR OBSTACLE	A RECEPTOR may face noise correction caused by REFLECTION of the sound waves on many OBSTACLES or may not, the reflected sound waves may come from many SEGMENTS, or may not. An OBSTACLE may cause REFLECTION on the sound waves of many SEGMENTS affecting the noise level on many RECEPTORS or may not. A SEGMENT may emit sound waves that may get REFLECTIONS by many OBSTACLES affecting the noise level on many RECEPTORS or may not. For a REFLECTION effect we record the Type of reflection.	REFLECTION (ternary)
SEGMENT RECEPTOR	A RECEPTOR must have a specific DISTANCE from at least one SEGMENT and vice versa. For the purposes of the distance effect, the Intermediate surface type and the distances (slant and horizontal) and the height of the receptor are recorded.	DISTANCE (binary)
SEGMENT RECEPTOR	A RECEPTOR can VIEW by a specific angle at least one SEGMENT and vice versa. For the purposes of the angle effect, the angle of view is recorded.	ANGLE (binary)

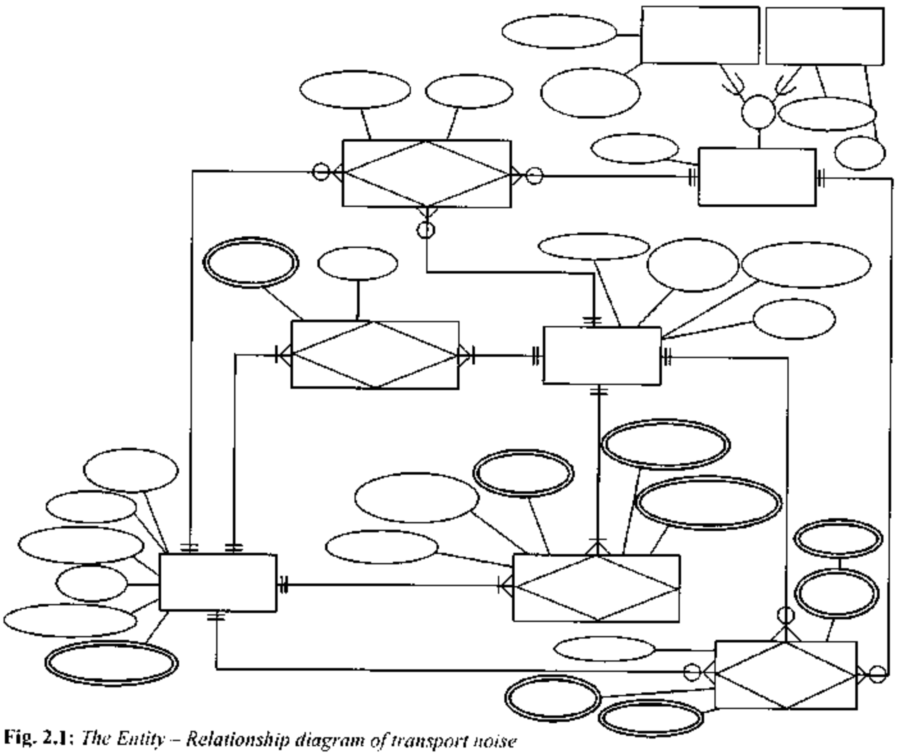
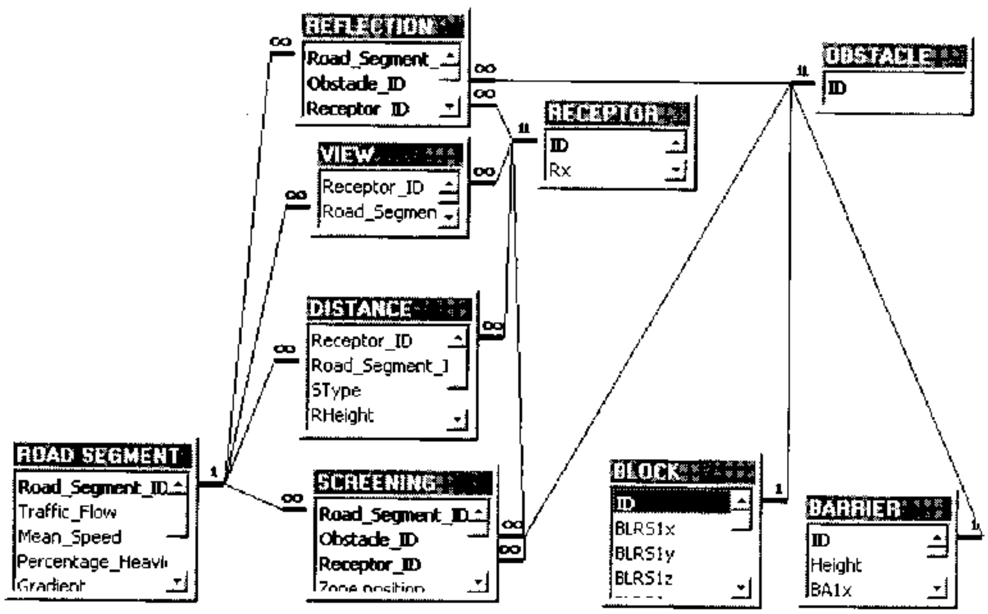


Fig. 2.1: *The Entity – Relationship diagram of transport noise*

During the physical database design the E-R diagram that was developed during conceptual design is transformed into a relational database schema (Fig. 2.2).

Fig. 2.2: *The Noise Database implemented in Access*



3. Integrating The Relational Database, The GIS Tools And the CRTN method

The principles that govern the generation and the propagation of noise are complex ones and the various associative entities such as screening, reflection, distance, etc. that arise through binary and ternary relationships had to be represented in a relational data schema.

The procedure of data input for filling the database is hard and time consuming. The area under study has to be analysed and every spatial element as well as the relative distances from the various entities has to be encoded. More specifically, it is required to encode the locations of every road segment that generates noise as well as every possible barrier or building that obstruct the noise propagation. Furthermore, encoding is needed for every reception point where the assessment of the noise level is attained, including: its exact geographical location, its relative distances with the above mentioned critical spatial elements and finally the proportion of the various types of the intervening ground between itself and the road segment (values that change from a reception point to another). Since there are no available data files providing such kind of spatial information - and even if they did exist, they could not have a standard format - additional work is required for any researcher who wishes to change the density of the receptors and to study different scenarios of traffic and topological conditions. The dynamic interference is an essential factor in every procedure for assessing environmental impacts and the GIS tools can satisfy this need since every layer representing an entity is dynamically connected with a table of attribute and spatial information. This information is stored in the relational database and is available for further processing by the noise calculation method. The British CRTN method provides explicitly the algorithm for the calculation of road traffic noise. This algorithm can be implemented in a visual application interacting with the database.

Conclusively, the three key elements that have to be properly integrated in order to accomplish the aim of the noise assessment are:

- a relational database maintaining information and describing the various relations,
- a GIS tool managing the digital map of the area under study and keeping dynamic spatial information, and
- a method for the calculation of road traffic noise

The integration of the above three elements enables the construction of raster maps representing separately the various stages in which the calculation of the final noise level on a receptor point is divided. Since GIS makes use of certain interpolation algorithms an infinite number of receptors is created. This happens because every grid cell element on every raster map has a value for every stage that contributes to the final noise level.

The site selected for the demonstration contains all the typical parameters that affect the propagation of the noise waves generated by a fivefold source line (Fig. 3.1) such as Blocks, Barriers, Soft Ground. A barrier 6m height was purposely placed in front of an inhabited building. The receptors were placed in 3m height forming a grid with relative distance between each other 25m.

Figure 3.2 illustrates the influence of distance on the basic noise level. The distance correction is calculated along the shortest slant distance from the source line to the reception point. As expected the value of every grid cell on the first raster output is a function of distance from the noise source. A large part of the surface of the area under study is covered from soft ground (grassland). The correction is progressive with distance and particularly affects reception points close to ground (Fig. 3.3). The influences of Screening, Angle of view and Reflections are illustrated in Figures 3.4-3.6.

The final noise field of the area is provided by combining all the raster maps and adding the contribution of every parameter, on the basic noise level (Fig. 3.7). The same procedure is being used for the calculation of the noise levels on a different height (Fig. 3.8). The values are in dB (A) and represent the L_{10}(18h) noise level.

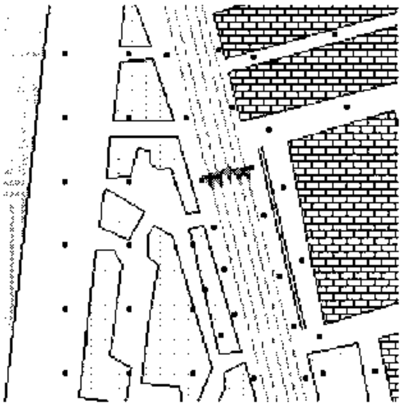
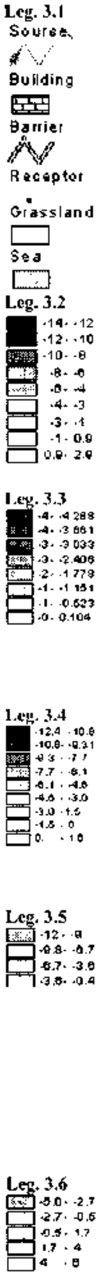


Fig. 3.1: *Initial Site digitised Map*



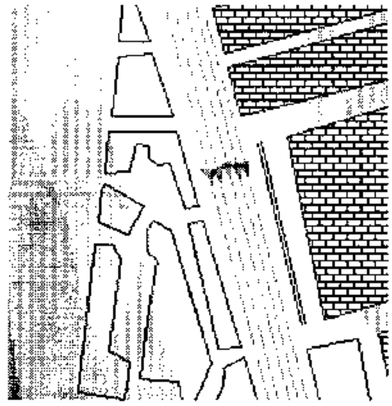


Fig. 3.2: *Influence of Distance on $L_{10(18h)}$*

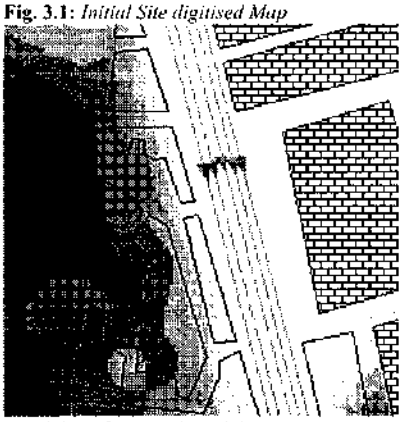


Fig. 3.3: *Influence of Land Cover on $L_{10(18h)}$*

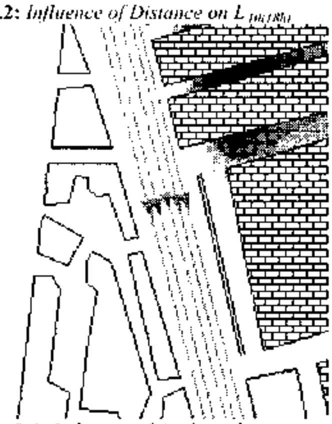


Fig. 3.4: *Influence of Angle on $L_{10(18h)}$*

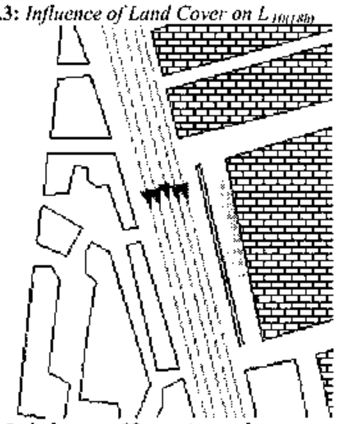


Fig. 3.5: *Influence of Screening on $L_{10(18h)}$*

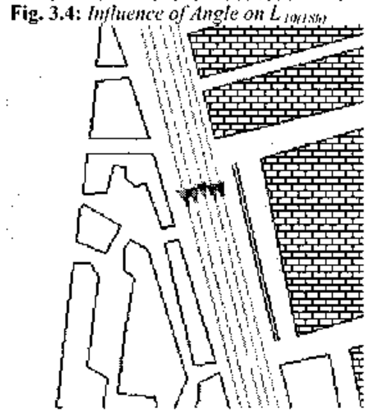


Fig. 3.6: *Influence of Reflections on $L_{10(18h)}$*

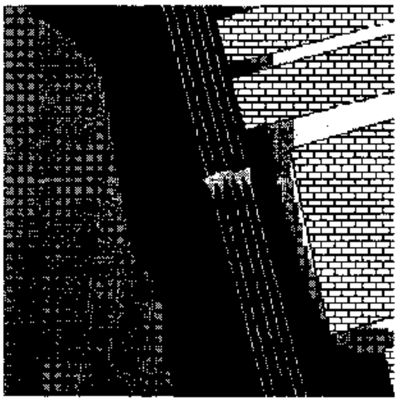


Fig. 3.7: *Noise levels at 3m height*

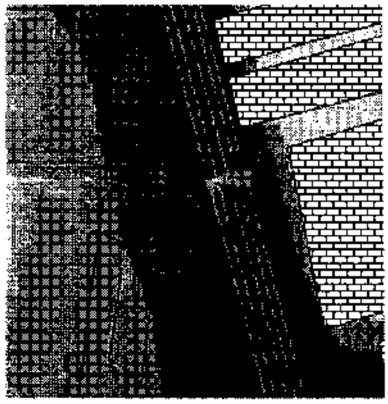


Fig. 3.8: *Noise levels at 9m height*

4. Conclusions

The entities that simulate traffic noise emitted by a linear source can be represented in a conceptual data model regardless of software and application used. Detailed and exact definitions of all involved parameters are required to avoid redundancy in the various stages of noise calculation.

GIS is proved to be an effective tool for providing spatial and attribute information and displaying visually the various stages of noise calculation. The combined use of raster and vector elements is decisive for the development of such an application

This paper referred to the noise calculation issue, by proposing a conceptual design approach, which was subsequently demonstrated at a model level, by employing GIS tools. Developing a full application at a certain computer environment, with real world data, which is a challenge in this area of concern, will definitely demonstrate the applicability of the method and the comparative advantages of GIS against other conventional techniques.

5. References

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4. Chen P.P. "The Entity – Relationship Model – Toward a Unified View of Data." ACM Transactions on Database Systems 1 (March): 9-36