9th INTERNATIONAL CONFERENCE ON ENVIRONMENTAL SCIENCE AND TECHNOLOGY (9th CEST)

back

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Editor: T.D. Lekkas

Editing co-ordinator: Christina Makri

CD-ROM design & software: Kotriklas George & Sotiriadis Lazaros
e-mail: gkotr@freemail.gr, lsot@aix.meng.auth.gr

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The GLOBAL NETWORK FOR ENVIRONMENTAL SCIENCE AND TECHNOLOGY (GLOBAL NEST)

The DEPARTMENT OF ENVIRONMENTAL STUDIES, of the UNIVERSITY OF THE AEGEAN

PREFACE

The International Conference on Environmental Science and Technology is organized biannually by the Global Network of Environmental Science and Technology and the Department of Environmental Studies of the University of the Aegean. Over the years an international group of environmental scientists and engineers have established this Conference as a scientific meeting where key environmental issues are discussed. In this 9th Conference, emphasis has been given to Global Environmental Change and Ecosystems Management, Water Resources Management and Water Planning, Water Quality issues and Solid Waste Management, Recycling and Sustainability.

The number of abstracts submitted has risen to 650, doubling the figure of the previous conferences. Eventually 439 full papers were accepted by the scientific committee, out of which, 267 will be presented orally and 172 as posters. Both scientific presentations are of equivalent academic status. The division of papers as “oral” or “poster” was based on the nature of the scientific work.

The expansion of our conference in size was combined with the strengthening of the international character of the event, as scientists from about fifty different countries are presenting their scientific work.

The expected number of participants is more than five hundred. The gathering of such a scientific community in the island of Rhodes with its unique environment, where presentations and discussions of scientific results on Global Environmental Change, Water Resources and Quality, and many other themes will take place, makes this meeting an important event in the struggle to protect our planet. A worth noticing matter for this Conference, is the large number of presentations in new technologies for the prevention or removal of pollution, a fact which marks the beginning of a new era where environmentally friendly technologies are employed.

The discussions which are expected to follow the presentation of each paper and during the poster sessions, will contribute to the international understanding, exchange of experience and opinions on old and new environmental problems.

In the framework of this 9th Conference, the Global Network on Environmental Science and Technology will hold its general assembly. The future activities of this international movement will be decided and a new executive committee will be elected.

With the occasion of this conference, I want to strengthen our commitment to the protection of the environment and our vision for a new civilization where humans will protect humans and any other living species on this planet. Our Science Based Environmental Movement, aims to a future where the respect of all living organisms passes through global peace, social and international justice, research and knowledge. More knowledge.

Rhodes Island, 1 September 2005

The Conference Chairman

Prof. T.D. Lekkas

GIS-BASED VISUALISATION OF TRAFFIC NOISE

A. KONSTANTINIDIS[1], K. EVANGELIDIS[2] and E. STEFANIDOU[1]

[1] Department of Geoinformatics & Surveying, Technological Education Institute of Serres
Terma Magnisias, 62124 Serres, Greece, [2] Department of Civil Engineering,
Aristotle University of Thessaloniki, A.U.Th. Campus, 54006, GREECE
e-mail: akonsta@geosense.gr

EXTENDED ABSTRACT

Among the environmental problems emerged in the majority of modern cities, noise pollution along with air pollution is considered to be the most important ones. Traffic noise is a priority issue in the EU. According to a Commission Green Paper, Environmental noise caused by traffic, industry and recreation is identified as one of the main local environmental problems in Europe.
Various methods simulating traffic noise have been developed (NMBP, NAC, CRTN etc.). These methods focus on the impacts of numerous factors on the final noise levels, such as the distance from the noise source, the nature of the ground surface, the intervening obstructions, the purpose-built barriers, as well as other factors affecting the propagation of sound waves, such as reflection from nearby surfaces, absorption, attenuation, diffraction etc. Computer models implementing noise methods also support a map-based representation of the final noise levels on the area under study. However, there is enough space for improvements, not only with respect to the integration between the map elements representing the above factors and the software implementing the noise method, but also to the final visualisation of traffic noise levels.
Hardware evolution, reflected to processing capacity, provide the capability of storing, processing and manipulating large datasets of spatial information as well as managing and visualising large image files. In addition, contemporary GIS tools support analysis and design of complex systems, as well as simulation of any critical parameter governing such systems. In this respect ArcGIS tools have been employed to represent all the objects that generate noise and affect its propagation at a specific area of the city of Thessaloniki. The site comprises a two branch (3-lane each) segment of the ring road of the city, a residential area located right next to the highway and a series of noise barriers placed across the edge of the road in order to reduce the final noise levels reaching the buildings.
Traffic noise entities, digitised according to GIS principles along with the topography of the studied area, constitute various vector and raster thematic areas. Furthermore, by using extensions supporting spatial analysis it has been possible to perform a grid-cell analysis in the area under consideration. By this, any of the above described factors that affect the propagation of the sound waves was plotted in a raster layer, and in turn all the layers were combined so that every discrete unit contains and represents the total noise level.

Key words: Noise, GIS, CRTN, Traffic Noise, Noise Visualisation, Noise Mapping.

1. INTRODUCTION

One of the main environmental, technologically induced problems is noise. In the context of the human environment, noise is normally sound which causes annoyance or disturbs activities. Generally, sound becomes unwanted, when it hinders speech communication, when it impedes thinking processes, when it interferes with concentration, when it obstructs activities or when it presents a health risk due to hearing damage. Moreover, noise may be detrimental to health, as it may have a number of direct adverse effects, other than hearing damage, such as cardiovascular and psycho-physiological effects, as well as problems concerning social behaviour. Its origins are in human activities and it is especially associated with the process of urbanization and with the transportation and industrial development.

Transport-related noise refers to noise caused by any kind of transport mode while traffic noise is induced by road traffic. The construction of transport-related infrastructures combined with the ever-increasing traffic volumes, leads to a subsequent increment of noise levels rendering noise a significant source of annoyance. Among the noise sources affecting the population at levels over the critical value of 65 dB(A) [1], traffic noise turns out to be the dominant source possessing nine tenths on the noise sources pie. Considering also that citizens when asked about their main environmental concerns, usually put noise as the main cause of distress, one can conclude that the problem of noise has become very complex. So, action to reduce noise needs to be set within a long-term context and a higher priority must be given to noise abatement in environmental policy making, by implementing regulations, restrictions and measures. Noise mapping provides a valuable assistance to such a strategic planning.

According to European Commission's, "Good practice guide for noise mapping" [2], "Strategic noise map' shall mean a map designed for the global assessment of noise exposure in a given area due to different noise sources or for overall predictions for such an area".

Our study, extends the above by assessing effects on the basic noise level $L_{10(18\text{-}h)}$, due to critical factors affecting noise propagation, including:

- influence of distance from the noise source,
- screening effects due to noise barriers and
- reflections from buildings facade.

Moreover, noise assessment is achieved for every grid cell (reception point) of the analysis area. A set of raster map layers, each one representing effects of the above-mentioned factors to the basic noise level, is generated. Putting up these maps together, results to the global noise assessment providing advanced visualisation challenges through GIS functionalities.

2. EU POLICY AND NOISE VISUALISATION ISSUES

2.1. EU policy issues

Further to its 1996 Green Paper (COM(96)540) [1], the European Commission developed a new framework for noise policy, based on shared responsibility between the EU, national and local level, and including measures to improve the accuracy and standardisation of data to help improve the coherency of different actions.

EU's 1996 Green Paper initiated a comprehensive set of measures, including among others:

1. The Directive 2002/49/EC [3], on Environmental Noise produced by (COM(2000)468), regarding noise maps on the basis of harmonised indicators, public information about noise exposure and its effects, and action plans to address noise issues. More specifically the Directive's main objectives were as follows:

- monitoring the environmental problem,
- informing and consulting the public,

- addressing local noise issues and
- developing a long-term EU strategy.

2. EU legislation relating to sources of traffic noise such as Motor Vehicles [4], Motor Cycles [5], and Tyres for motor vehicles and their trailers and their fitting [6].

3. Financial support noise related studies and research projects.

As regards the European legislation concerning strategic noise mapping, it is defined that all noise maps should meet the criteria that the European community has set. As far as the time planning is concerned, the current trends are:

- At least until 18-7-2005 all member states should notify the information concerning the authorities and organizations that will be responsible for the elaboration and possibly, for the approval of the strategic noise maps.
- At least until 31-12-2005 all member states should take action, so as to elaborate noise maps, which will present the prevalent situation of the former year. These noise maps must have been approved by the competent authorities, for all residential areas exceeding 250.000 residents and for all roads with an increased traffic. If the member state uses the indices L_{den} and L_{night} and does not adjust its own indices, the noise maps mentioned above should be elaborated, at least until 31-12-2006.
- At least until 31-12-2008 all member states should inform the commission about all the built-up areas with over 100.000 residents, as well as about all the big roads situated in their territory.
- At least until 30-6-2012 and ever since, every five years, noise maps concerning the prevalent situation of the former year should be elaborated and possibly approved for all the built-up areas and the big roads mentioned above.
- It is suggested that all noise maps should be re-examined and possibly re-elaborated every five years.

2.2. Noise Visualisation

One of the most significant problems that the authorities have to confront, in order to be able to successfully contribute in noise abatement, is that the data available on noise exposure is generally poor, in comparison to that collected to measure other environmental problems. Moreover, even if the data exists, due to different measurement and assessment methods, it is often difficult to make comparisons. For example, the indices used by the countries to measure the levels of noise usually differ. After the harmonization of the methods and indices is finished, there should be an elaboration of guidelines on how noise monitoring and assessment should be realized to ensure valid and comparable data, so as to enable accurate mapping techniques. Although the noise information collecting process may vary between different countries, in terms of accuracy, since each country has its own needs, targets and potential efficiency, it is certain that noise mapping can be a powerful instrument, providing an effective and relatively inexpensive way, to proceed with the visualization and assessment of the acoustical environment. One of the best ways to start noise data collection and presentation is to compile noise maps.

Noise mapping (visualisation) aims not only to provide a visual representation of the noise profile at a given geographical area, but can also show the dimension of the noise impact, for example as a percentage of population affected by a certain high level of noise, as well as identify noise black spots, where action is required, or quiet areas. By adding and combining other information, for example population density and building occupancy, a map can be developed which displays operational information, identifying numerically the actual number of people exposed to a specific undesirable noise level, to support action taking against various types of noise.

In that way, the compilation of noise maps becomes a fundamental tool to find out about the noise problem, as well as for planning actions, since the data will be collected and presented in appropriate ways to all those concerned, from simple charts and maps for the general public, up to more scientific reports. As a consequence, noise mitigation plans will be possible and then, by updating those maps, at given intervals, it will be easy to monitor the effect of these plans and re-evaluate actions.
Generally, noise mapping will undoubtedly raise public awareness of noise issues regionally and nationally. In the same time, improvements made in computer and information technology may develop new ways and systems for preparing and presenting noise information, which will of course contribute in adopting the appropriate abatement policy.

3. GIS-BASED VISUALISATION OF TRAFFIC NOISE

3.1. Noise method employed

It is well known from the existing bibliography [7] that the following factors have to be considered for the calculation of the noise derived from traffic:

- Traffic flow
- Condition of roads and adjacent areas
- Weather
- Time of measurement
- Place of measurement

According to the British method "Calculation of Road Traffic Noise" (CRTN) [8], the basic noise level is obtained, right on the linear noise source (road segment), as a function of the flow rate, the mean traffic speed, the traffic composition, the gradient of the road and, where appropriate, the road surface.
Factors affecting noise propagation and influencing the basic noise level, are considered 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. [9].

3.2. Case Study

The site selected illustrates a segment of the city's ring road where a series of noise barriers has been placed in order to protect the residential area. This area instance provides a representative aspect of traffic noise propagation theory: the attenuation of noise waves due to their distance from noise sources, the screening effects due to the noise barriers as well as the reflections due to buildings facade.
The mapping representations consists of a set of raster maps providing noise estimations for every discrete unit (grid-cell), including:

- the area under study (fig. 1a),
- the influence of distance on the basic noise level $L_{10(18\text{-}h)}$ (fig. 1b),
- the influence of screening effects on the basic noise level $L_{10(18\text{-}h)}$ due to the noise barriers (fig. 1c),

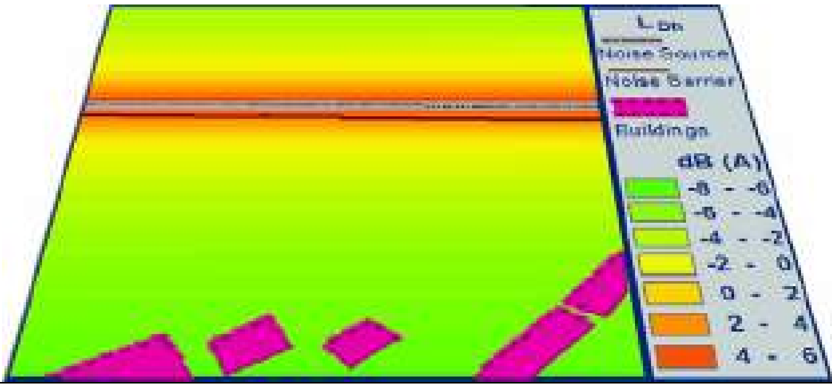
<u>Location:</u> Thessaloniki, Ring Road, Konstantinoupolitika residential area

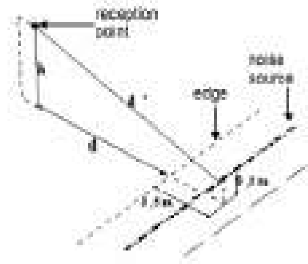
<u>Traffic Features:</u>

Traffic flow: Q = 4000 veh./h
Mean speed: v = 85 km/h
% Heavy vehicles p = 3
% Gradient G = 10

<u>Other:</u> Noise barrier placed along the edge of the highway

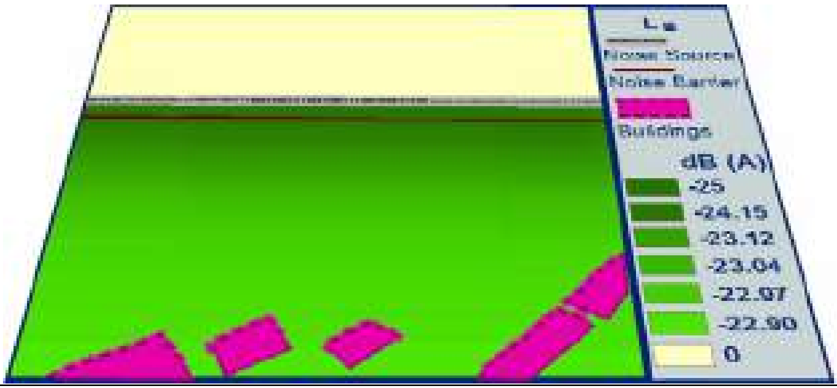
fig. 1a: Study Area

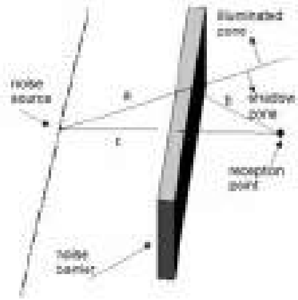




L_{Dh}= -10 log (d′/ 13.5)
$d' = \{(d + 3.5)^2 + (h - 0.5)^2\}^{1/2}$

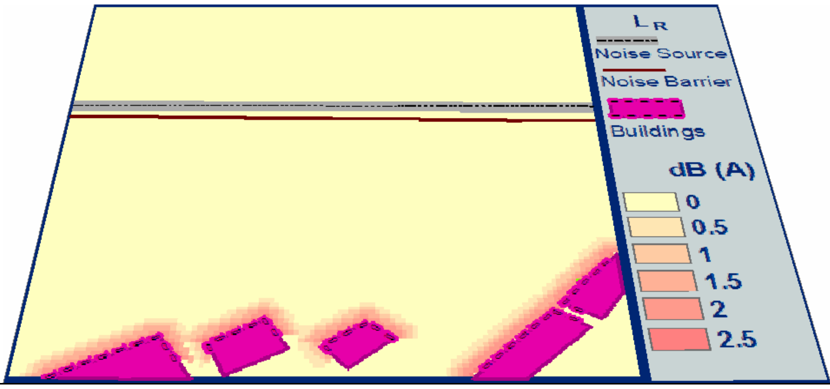
fig. 1b: Influence of Distance

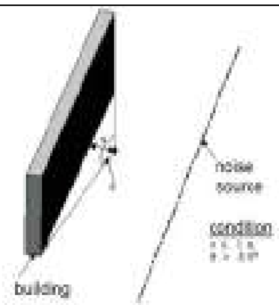




$L_B = A_o + A_1X + A_2X^2 + ...A_nX^n$ dB (A)
X=log(a+b-c)

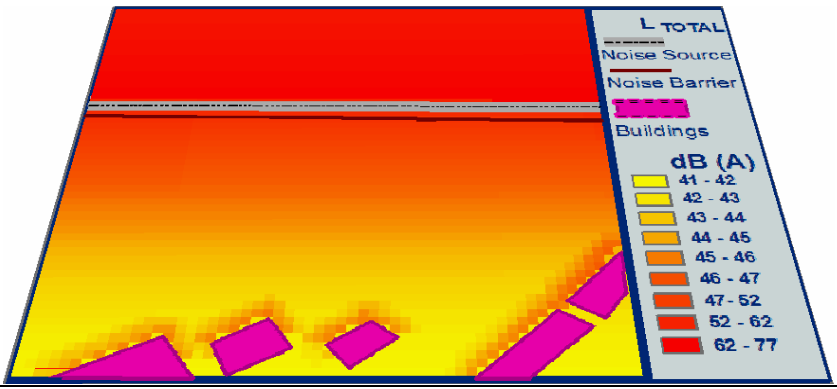
fig. 1c: Influence of Screening





L_R = +2.5 dB(A)

fig. 1d: Influence of Reflection



Basic Noise Level

$L_{10(18h)}$
{Q, v, p, G}

Q: traffic flow
v: mean speed
p: % heavy vehicles
G: gradient

$L_{10(18h)}$ = 71,89 dB (A)

$L_{Total} = L_{10(18h)} + L_{Dh} + L_B + L_R$

fig. 1e: Total Noise Levels

- the influence on the basic noise level $L_{10(18\text{-}h)}$ of noise waves reflections on the buildings facade (fig. 1d) and
- the global noise estimation as a combination of the basic noise level and the influences of the factors affecting noise propagation (fig. 1e).

5. CONCLUSIONS

Our work, extends the conventional traffic noise mapping representations by providing the impacts of the factors affecting the propagation of noise waves, on the basic noise level $L_{10(18\text{-}h)}$. More specifically we separately visualised such critical factors as:

- influence of distance from the noise source,
- screening effects due to noise barriers and
- reflections from buildings facade.

Moreover, traffic noise values were achieved for every individual grid cell of the analysis area. A set of raster map layers, each one representing effects of the above-mentioned factors to the basic noise level, was generated, and in turn the combination of all raster layers resulted to the global noise estimation. The combined use of raster elements is decisive for a deep understanding of the noise calculation method and even for revising and enhancing its methodological approach.

GIS is proved to be an effective tool for visualising the various stages of noise calculation. The advanced spatial functionalities of GIS raise its comparative advantages against other conventional techniques.

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