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HOW TERRITORY-WIDE GIS-BASED ROAD TRAFFIC NOISE ASSESSMENT TOOLS FACILITATE DECISION MAKING IN STRATEGIC LEVEL ENVIRONMENTAL ASSESSMENT

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Abstract

Strategic environmental assessment (SEA) is a systematic process, with multi-stakeholder involvement, for analysing and evaluating environmental implications of proposed policies, plans and programmes (PPP), for assisting in strategic or planning decision-making; and for following up strategic or planning decisions. SEA has been widely adopted in many countries as a tool to facilitate the integration of environmental considerations into the PPP formulation processes and to facilitate the achievement of long term sustainability. Some SEA examples in Hong Kong are the Territorial Development Strategy Review, Comprehensive Transport Studies, Port Developments, and Hong Kong 2030: Planning Vision and Strategy. They are critical in developing long term strategies for the development of Hong Kong as an international city. Among various considerations, road traffic noise is one of the key environmental indicators to be evaluated in the SEA of PPP. In the early 90s, road traffic noise in SEA was either assessed in a qualitative approach or was carried out by making reference statistically to the assessment of some representative locations. A systematic and quantitative comprehensive noise assessment tool to evaluate the various scenarios based on the various proposed PPP was not available at that time. With the latest Geographic Information System (GIS) technology and large-scale noise computer modelling, a GIS-based noise model for SEA was developed to provide a systematic and quantitative tool to evaluate the noise impacts of various proposed PPP for decision making. This paper briefly explains the GIS-based noise model and its application in recent SEAs, which assists the policy makers or the public to comprehend traffic noise impacts of various scenarios precisely and continuously at the early stages of planning and facilitate making the decision.

1. INTRODUCTION

A Strategic environmental assessment(SEA) is a systematic and comprehensive process of evaluating the environmental effects of a policy, plan or program(PPP) and its alternatives, including the preparation of a written report on the findings of that evaluation, and using the

findings to assist in decision-making, which not only covers various environmental aspects but also in general includes a very large areas and number of projects.

Some SEA examples in Hong Kong are the Territorial Development Strategy Review, Comprehensive Transport Studies, Port Developments, and Hong Kong 2030: Planning Vision and Strategy. They are critical in developing long term strategies for the development of Hong Kong as an international city in sustainable manner. Among various environmental considerations, road traffic noise is one of the key environmental indicators to be evaluated in the planning process.

In the early 90s, when large scale noise modeling technique was still not very matured, road traffic noise in SEA was either conducted in a qualitative approach or was carried out by making reference statistically to the assessment of some representative locations. A systematic and quantitative comprehensive noise assessment tool to evaluate various scenarios based on the various proposed PPPs was not available at that time. With the latest Geographic Information System (GIS) technology and large-scale computer noise modelling, a GIS-based noise model for SEA was developed to provide a systematic and quantitative tool to comprehensively evaluate the noise impacts of various proposed PPPs for decision-making. This detailed analysis also helps to address the increasing public demand for better accountability of decisions in particular in respect of those major PPPs.

This paper briefly explains the GIS-based noise model and its application in recent SEAs, which assists the policy makers or the public to comprehend traffic noise impacts of various scenarios precisely and continuously at the early stages of planning and would greatly facilitate the process.

2. STRATEGIC ENVIRONMENTAL ASSESSMENT

SEA has been widely adopted in many countries as a tool to facilitate the integration of environmental considerations into PPP formulation processes and to facilitate the achievement of long term sustainability.

SEA is essential for an informed decision-making. The aims of SEA[1] are:

- To facilitate the search of sustainable development options or alternatives.
- To provide environmental information (including both adverse impacts and benefits) at the earliest stage of PPP formulation processes within a decision-making framework.
- To inform decision makers and the public about the environmental and sustainability implications of PPPs so as to improve decision making processes.
- To address cumulative environmental impacts that cannot be fully addressed by individual project Environmental Impact Assessment (EIA).

These aims assist in achieving the following objectives:

- Promoting full consideration and integration of environmental implications at the early planning stage of major strategic PPPs;
- Seizing opportunities to enhance environmental sustainability and quality; and
- Avoiding environmental problems and identifying environmentally-friendly options

Road traffic noise is one of the key environmental indicators to be evaluated in the SEA. It is to provide noise information at the earliest stage of PPP formulation processes within a decision-making framework. In 1996, road traffic noise impact had already been assessed in the Territorial Development Strategy Review (TDR)[2] to facilitate the search of development options or alternatives. A much simplified methodology was adopted to estimate the change of traffic noise levels at 50m from kerb side of major roads. The review concluded that the "change" of predicted noise levels in various years of assessment would be within 1dB(A) in Metro area. However, the predicted noise levels in Metro area were unacceptably high. It was

pointed out that the proposed road transport network resulted in increases of 2-3dB(A) in the North West New Territory area. The methodology provided a trend of traffic noise changes in various scenarios assessed in the study. However, there was no assessment to quantify the spatial distribution of the traffic noise problems and would not be able to identify the number of population affected by traffic noise.

In the Third Comprehensive Transport Study (CTS3) in 1999[3], road traffic noise impacts were further quantified by number of dwellings affected by major "noisy' road. The road network in Hong Kong was reviewed by a selection process including two levels of screening:- (1) identification of major 'noisy' roads having (a) a flow of 30,000veh/day or more or (b) road sections of fast changing conditions in strategic growth areas with flows between 20,000 to 30,000 veh/day; and (2) identification of the 'noise sensitivity' of these road sections which were 50% or more of the buildings fronting a particular road section were considered as noise sensitive.

According to above screening criteria, about 200 roads in the territory were considered in the CTS3. A single representative assessment point for each road section was identified to calculate the road traffic noise levels at noise sensitive receivers in the vicinity. It was estimated in the report that about 440,000 population affected by road traffic noise. However, the study stated that the figures reported were by no means exhaustive or comprehensive as different screening factors were adopted and the assessment considered only those busier and more "sensitive" road sections. Also, the traffic noise levels were only represented by assessment points and were not a complete assessment to traffic noise impacts at the sensitive uses.

3. GIS AND LARGE-SCALE NOISE MODEL

Similar to other major metropolitan cities, noise is an issue in Hong Kong. More than one million people are exposed to excess traffic noise, making it one of the biggest environmental noise problem in the Hong Kong. To facilitate setting objectives and formulating policies, plans and programmes to tackle road traffic noise, the Environmental Protection Department of Hong Kong SAR developed a territory-wide noise model using the latest GIS technology and large-scale noise computer mode for collating and compiling noise information on Hong Kong identifying and quantifying the scale of noise problems and evaluating the effectiveness of various mitigation measures for road traffic noise.

Having considered the road traffic flow information, buildings, other infrastructures, and other relevant factors, the road traffic noise in terms of dB(A)(1 hour)L10 at four discrete layers, i.e. 4m, 18m, 40m and 80m above ground level and 3D façade noise levels of buildings, could be computed. Figure 1 shows one of the noise contour maps of dB(A)(1 hour)L10 at 4m from ground level. Different colours represent different noise levels. People can easily "see" that it is noisier in the urban areas and in the vicinity of major roads as compared with that in the remote areas.

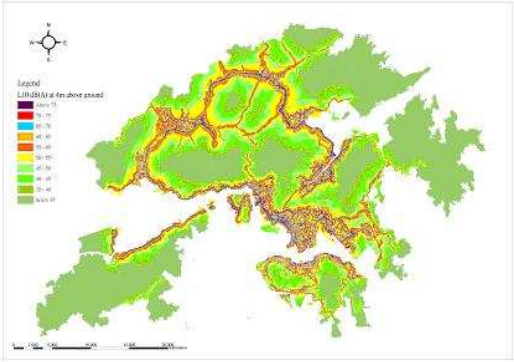


Figure 1 Territory-wide noise contour map L10 at 4m above ground

The development of this kind of noise contour map enables the readers to feel the noise levels for a large area. Figures 2(a) and 2(b) give a closer look of the noise contour map and 3D[1] spatial noise distribution on building facades respectively. By utilizing the population distribution data obtained from census surveys conducted by various authorities, the number of residents exposed to different noise levels can also be predicted. Figures 3(a) and 3(b) show the population exposed to various traffic noise levels in whole of Hong Kong and a breakdown of population affected by traffic noise level exceeding 70dB(A)L10(1 hour) in various districts respectively.

Figure 2(a) Noise contour map

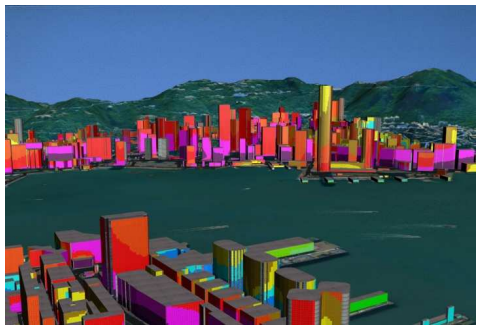


Figure 2(b) 3D spatial noise distribution of building facades

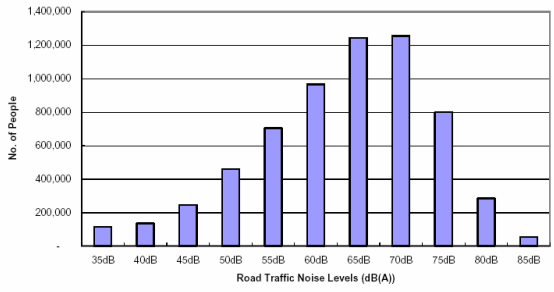


Figure 3(a) The population exposed to various traffic noise levels

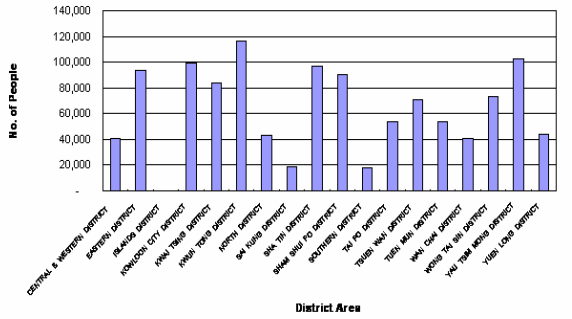


Figure 3(b) The population affected by traffic noise in various districts

The indicators for evaluation of noise impacts in SEA, which were discussed in [4], should be able to (1) express the complex issues under different scenario in simple term, (2) provide quantitative and measurable parameters wherever possible; and (3) communicate effectively with stakeholders, decision makers, public etc.

Using the latest GIS techniques, complex traffic noise issues under different scenario can be expressed graphically in noise contour maps and 3D spatial noise distribution on building facades to simplify the presentation. Other quantitative statistical data, such as the number of residential flats affected, the population affected by more than 1 dB(A), noise impact due to any plans or programmes, ……etc., can also be obtained, some of which are difficult to be deducted in the traditional noise impact assessment approach adopted in previous SEA. This will improve not only the quality but also make available more environmental noise information

[1] Road traffic noise assessment at 4m above ground as recommended in a EU Directive relating to the assessment and management of Environmental noise (COM(2000)468) is insufficient to represent the road traffic noise exposure of population in Hong Kong because majority of the buildings are high-rise in nature.

(including both adverse impacts and benefits) at the earliest stage of PPP formulation processes. Also, with such tools, the decision makers could have a clearer and more comprehensive picture about the potential environmental noise impact of the proposed PPP plans, thus facilitating them in making the best choice of options, modifying PPP or evaluating the mitigation measures at the earliest stage, where necessary, and hence achieving an environmentally friendly decision to promote sustainability.

The authors in [4] also stated the constraints and blind spots of traditional indicators for evaluation of noise impacts in SEA. In order to communicate effectively with the public on such complex traffic noise information, the use of simple terms has become a must. It could be appreciated that without the help of the enormous computational power that was generally less available at that time, there would not be any alternatives but to use some much generalized assumptions in the assessment. Indeed, the focus to provide an overall general view of the noise impacts in SEA would necessarily be at the expense of loosing details.

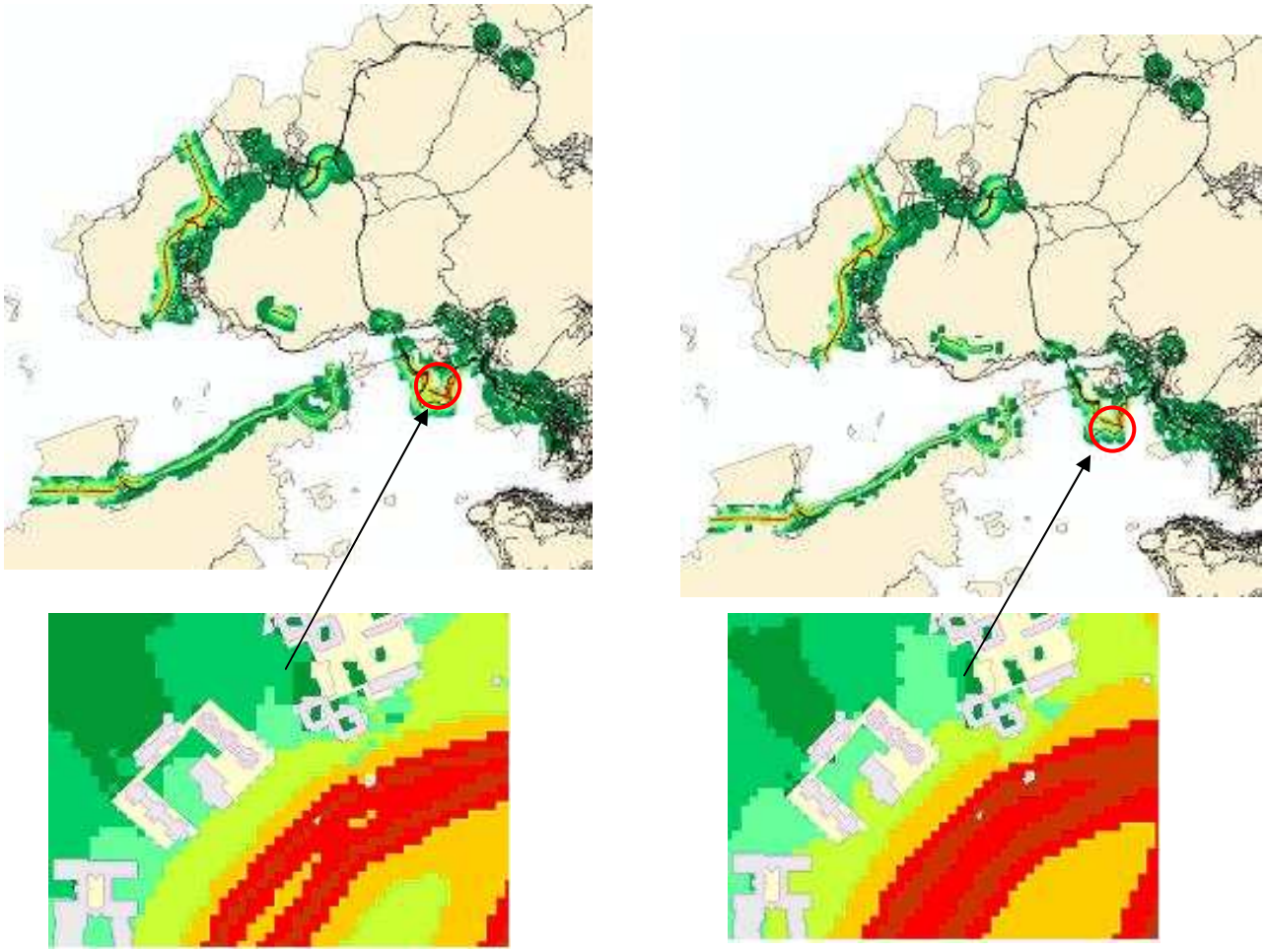
In the CTS3 study, noise levels at about 200 roads in the territory and the size of population exposed were estimated based on representative locations of selected roads. A single noise level was estimated for each road and it was used to represent the noise impact of the road to generalize the assessment. Detailed changes of noise distribution of affected residential dwellings in vicinity of the road were provided for various scenarios in CTS3 study. In contrast, the GIS based territory-wide noise model can provide more detailed information, for example, from noise distribution of affected dwellings along a road to detailed noise distribution of a particular building, for various scenarios.

Since the estimation in CTS3 study for population affected by traffic noise were not exhaustive or comprehensive, only population affected by road traffic noise higher than 70dB(A)L10(1hour) was estimated in the study. With more computation data generated by the GIS based territory-wide noise model, histogram of noise level distribution can be obtained. The noise performance profile thus generated could be used to compare the relative merits of the various scenarios. In addition to the figures on population affected by traffic noise impact, the noise level increase/decrease distribution can be determined for different cases.

Therefore, the GIS based territory-wide noise model can better provide an overall view of the noise impacts in SEA without the expense of losing detail noise performance information.

4. APPLICATIONS

A territory-wide noise model can be a useful tool in the SEA process in many aspects such as site selection, comparison amongst various options, …… etc. Figures 4(a) and 4(b) demonstrate some major benefits of such model and its presentation. They indicate the road traffic noise impact predictions for two different scenarios in a SEA site selection process for a proposed development plan. One is the base case where there is no new development and the other is the case with a new development. The noise contours show the road traffic noise due to the natural traffic growth (Figure 4(a)) and the noise with the new development in place (Figure 4(b)). The differences in noise impact between the two scenarios can be observed. Even a non-professional can quickly identify the noise affected regions from the new development with the figures below. Much complicated information from more options or scenarios can be presented in this way in the SEA. It can enhance the effectiveness in disseminating the complicated information to general public than that in the traditional SEA.



(a) No new development scenario (b) New development in Tsing Yi scenario

Figure 4 Territory-wide noise contour maps of two different scenarios in SEA

The territory-wide noise model is also adopted in the SEA for HK2030: Planning Vision and Strategy Study which is a strategic planning study tasked with preparing a strategic land use planning framework for Hong Kong for up to 30 years. It will address 'how much, what type and where land for development should be provided' in Hong Kong. Referring to the Strategic Environmental Assessment - Options Evaluation Report[5], two spatial development patterns "Consolidation" and "Decentralisation" will be assessed in the study. Many factors including environmental noise impacts are considered in respect to proposed PPPs for the two spatial patterns. The Consolidation Pattern gives priority to making best use of land and infrastructure facilities in the Metro Area whereas the Decentralisation Pattern focuses on development of the non-Metro area in the medium term. Since the study is still on-going, detailed findings are not available at the moment.

However, it is anticipated that, the success of building a territory-wide GIS-based road traffic noise model for comparison amongst various options in this SEA, is highly dependant on the availability of relevant spatial and topographic data. Hypothetical city form and road traffic network for the coming 30 years have been assumed in the model to obtain at least, topographic data, buildings including layouts and heights, road alignments, spatial distribution of population, etc. for various scenarios including base, Consolidation Pattern, and Decentralisation Pattern.

The territory-wide GIS-based road traffic noise models would not only reveal the trend of road traffic noise impacts, it would also provide detailed changes of road traffic noise impact

for each district of the whole Hong Kong area. As breakdown of changes in traffic noise impact for each district can be obtained from the model, planners can evaluate factors affecting each district and recommend possible solutions to address problems at district level. From the public's perspective, they can easily appreciate how the proposed PPPs could affect or benefit their own districts because the findings of noise contour maps, 3D façade noise maps, etc. are in an easily understandable format. It is an approach to enhance their interests in contributing to the PPPs as public may sometime consider that the PPPs may be too far away from their daily life and cannot anticipate how various PPPs affect them. As such, the public can provide valuable comments with no misunderstanding of the anticipated future road traffic noise impacts. In decision makers' perspective, the territory-wide GIS-based road traffic noise models can provide comprehensive and details changes of road traffic noise impacts for various scenarios.

5. CONCLUSIONS

A territory-wide GIS-based road traffic noise model have been developed, providing an efficient way to provide quantitative and quality environmental noise information (including both adverse impacts and benefits) at the earliest stage of PPP formulation processes within a decision-making framework used in the scenario comparison processes of SEA. Applications of territory-wide GIS-based road traffic noise model in recent SEA were discussed. Territory-wide GIS-based road traffic noise model will be an important and useful tool to provide comprehensive quantitative environmental noise information in any SEA studies.

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