

KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

CITY & REGIONAL PLANNING DEPARTMENT

CRP514: INTRODUCTION TO GIS



TERM PAPER: USING GIS IN NOISE MAPPING

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INTRODUCTION

Noise can be defined as the disturbance caused by sound. Or, simply, noise is any unwanted sound. In this modern world, excessive noise levels became a major threat to the environment. Noise pollution is regarded by many as a serious source of concern. It is on the same bar along with water or air pollution. Traffic is a major source of noise. Trains, cars, and airplanes contribute to increasing noise levels, particularly, in rush time.

Noise can be harmful to humanity. It is reported that long exposure to high noise levels can cause hearing loss, in what is known as “Noise Induced Hearing Loss”. In addition, exposure to noise has many psychological effects. It causes distractions, reduces performance and productivity, and affects clarity of speeches. Figure below gives an indication for what each sound feels like when measured in Decibels.

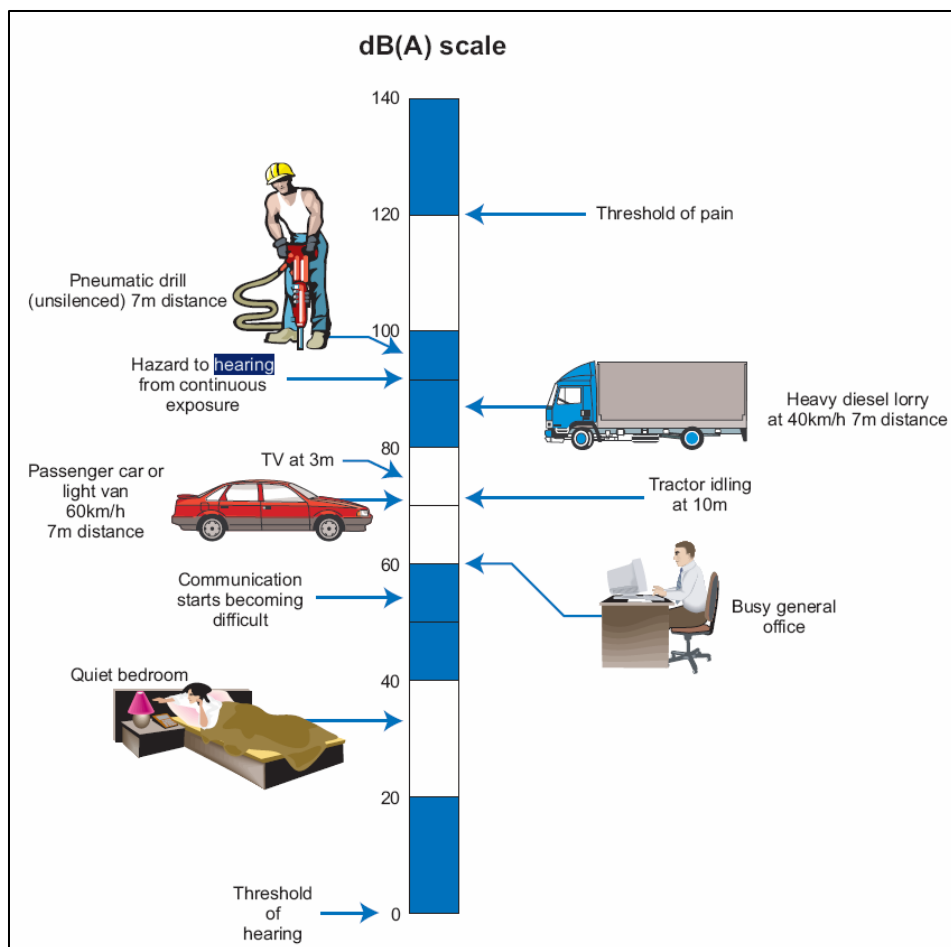


Figure 1: Scale Showing Levels of Common Sounds

In many developed countries, laws and directives have been set to limit and control noise levels in cities. City councils, ministries, health organizations and government agencies are trying to reduce noise levels, as well as reducing the number of people affected by noise pollution. Keeping in mind that noise studies are complicated due to number of factors, a tool like GIS can help in quantifying problems, and presenting them in a visually appealing and practical manner. Displaying noise levels on city maps helps the city planner or noise consultant to identify areas of problems and then propose timely solutions.

This paper discusses the importance of utilizing GIS in noise mapping. It starts by identifying noise mapping and its techniques. Then, it gives examples of how noise mapping is implemented in selected cities. After that, the paper concludes with discussion of potential of noise mapping.

NOISE MAPPING

What is noise mapping?

Noise mapping is reflecting sound levels at a certain period of time on geographical maps. This can be done for a city, a village, university campus, or a facility. Such maps show noise levels from different sources like roads, industrial facilities, or airports. Some maps show noise levels from one single source at a time. The contents of the map depend on the purpose it is made for. Noise maps are usually made for the following purposes:

- To assess noise levels in a certain geographical area at a certain period of time.
- To develop solutions for the reduction of noise levels in a certain geographical area at a certain period of time.
- Or, to aid in future city and regional planning.

How to Create a Noise Map?

With the use of GIS, creating noise maps became a lot easier. GIS tools allow for users to enter data, edit the data, reflect them on maps, and then update them without much hustle. In the presence of GIS tools, what remains is noise data. Sound levels can be in a certain area can be acquired by:

- Field measurements: following ISO standards, field measurements can be carried out to collect noise data for an existing area. Data will usually be accurate. However, field measurements don't allow for the separation of sound sources. The map resulting from data based on field measurements will likely show noise levels from all sources combined.
- Prediction (Simulation): acoustical simulation software packages can help in generation data for noise maps. They can be as accurate as field measurements, and they allow for detailing data about noise sources. Prediction can be very helpful for city planning.

Once the GIS tool and noise data are available, creating maps can be done smoothly. Usually, such process will require a GIS consultant and an acoustical consultant.

Who is Developing Noise Maps?

In the European Union, cities with population exceeding 250,000 are obliged to create noise maps. In 2005, that directive became in effect. Many other countries and region have followed the footsteps of Europeans. All this stems from the importance of limiting noise pollution and providing a comfortable environment for city inhabitants.

Government bodies or agencies responsible for noise mapping differ from one place to another. But, noise maps are usually developed by:

- City Councils and Municipalities
- Health Departments
- Real Estate Developers
- Traffic Departments
- Universities and Scientific Institutions
- Airports or Aviation Authorities.

TECHNIQUES IN CREATING NOISE MAPS

There are many techniques for creating noise maps. Technique means the visual presentation of the map and what information it shows. Generally speaking, there are 3 techniques for creating noise map; 2D Maps, 2 1/2D maps, and 3D maps.

2D Maps

Those maps display noise information for fixed height. The fixed height can be for example the assumed height of ears of a standing man. Those maps are widely created by city councils to assess noise levels of a broad geographical area.

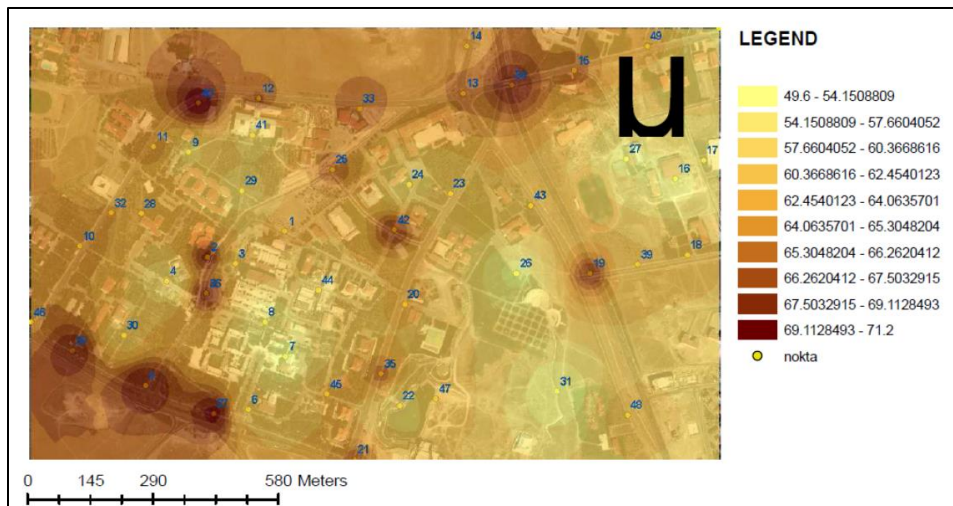


Figure 2: Sample 2D noise Map

2 ½ D Maps

2 ½ D maps identify noise levels at different height values in 3D space model. Those are the same 2 models but, their surfaces are projected to match the actual natural height.

3D Maps

Maps show noise data in full 3D space. They give volumetric information about noise levels.

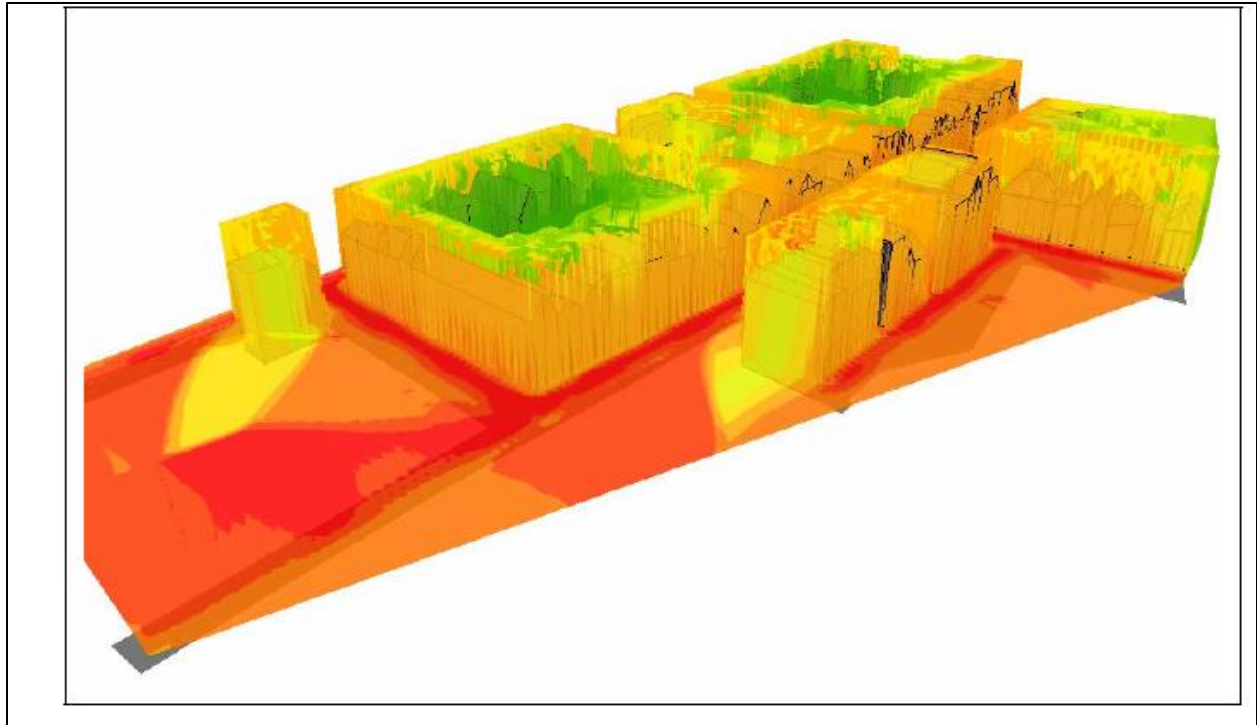


Figure 3: Sample 3D Noise Maps

Why are 2 ½D and 3D Noise Maps Needed?

With the vast development in modern cities, noise pollution is becoming more critical each day. Careful assessment of noise mapping is needed to address the problem properly. Noise differs in different heights. For example, an apartment in the ground floor is not subjected to the same level as an apartment in fifth floor. Keeping in mind that sound propagates in all directions, 2 ½ D and 3D are essential. In some European legalization, it is recommended to create maps for different heights in the same geographical area. Thus, instead of creating various maps to represent different height values, 3D maps can be a useful tool. GIS power allows for the use of 3D maps and supports.

CASE STUDIES

It is very useful to see how foreign countries are dealing with noise pollution, and how they built their own noise map. In this paper, some selected for cities from different countries around the globe are discussed.

Case Study 1: Noise Map of Adelaide

Adelaide is the capital city of the state of South Australia. It is located in the south of the Australian continent, and it is home 1.23 million people. Adelaide city council is pretty much concerned with noise pollution, and they are trying to limit it by all possible means. For that, they have developed their noise that represents averaged noise levels from 7am to 7pm. The council states on their fact sheet that the benefits from the road noise map are:

- Improved noise management
- Assistance with planning for new development
- Help new residents understand the noise environment within the city
- Potential of benchmarking the city to other cities.

The map is attached in appendix A.

Case Study 2: Dublin Noise Maps

Dublin is the capital and most populous city in Ireland. With population exceeding 500,000, Dublin is following EU directives for noise control. Dublin City Council is designated as noise mapping body, and is therefore required to develop and update noise maps. The council created day time maps and night time maps, and those maps are published for the public to see and review. The desired goals from publishing such maps are:

- To monitor environmental noise problems
- To inform the public about noise pollution and long term noise exposure
- To address local noise issue and develop action plans and solutions.

Day time map of the city of Dublin can be seen in appendix B.

Case Study 3: San Francisco Noise Map

It is interesting to know that noise maps in San Francisco, California are developed by the Public Health Department. This serves like an evidence on how dangerous can noise be to health. The department aims to assess the noise conditions in the city, and then determine to percentage of people affected by the variant noise sources. The map is attached in appendix C.

Case Study 4: Barcelona City Internet Noise Maps

Barcelona city council is the body generating noise maps for the city. As the city is dense and compact, assessing noise levels became essential. However, they have decided to create maps using internet GIS. The visitor is required to enter street name and number in order to see noise levels. This sort of interactive maps allows for update. Printed maps can't be update, and a new map would be required to see the latest updates. Again, with internet maps, update is always possible.

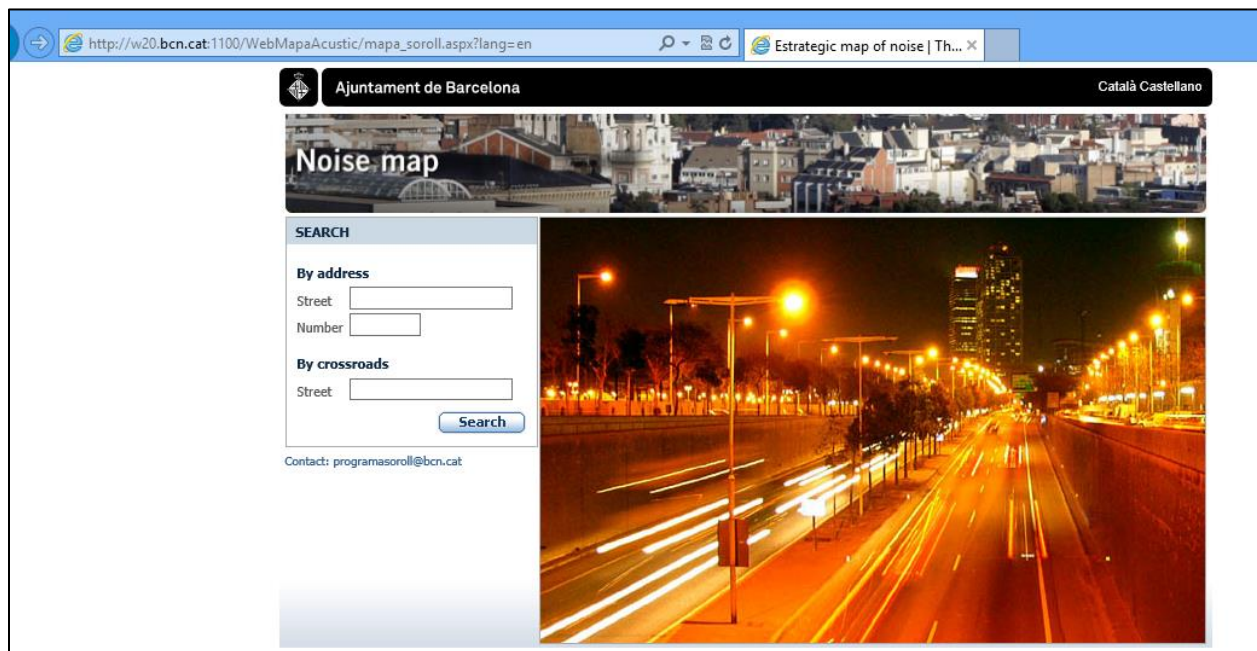


Figure 4: Screenshot of Barcelona City Council Internet Noise Map

CONCLUSION

Noise pollution is a serious concern for the environment, and for that counter measures have to be taken. Many cities have developed noise maps to control the effects of noise pollution, and this reflects the level of awareness about the threats in many parts of world. In addition, the availability of GIS packages makes the whole process a lot simpler.

Noise maps are inter-disciplinary maps that require more than one expert to generate. This can somehow be seen as an obstacle. But, still making noise maps is still possible, and is still relatively easy. Merging of different science fields is important to human being development, and this can provide a platform for noise mapping to spread on a larger scale.

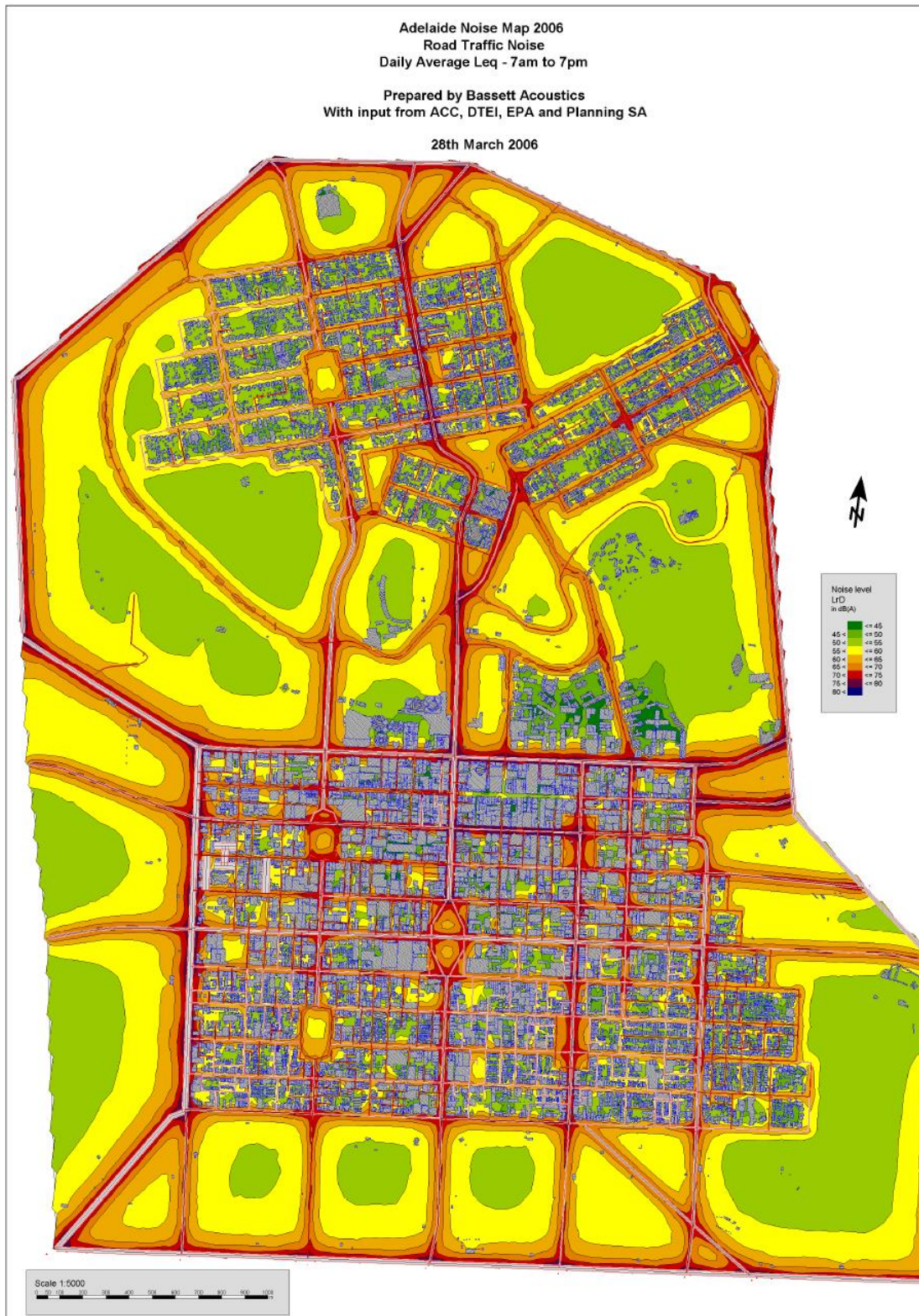
Finally, it can be seen that government agencies have taken steps towards educating the public about noise pollution, and how to stay away from long exposure to noise. Noise maps can serve as an ideal way to educate people on where to choose their home location. Noise maps can also serve solving in existing noise solutions. It is hoped that in the future the public in the middle east can see the noise map of their home city.

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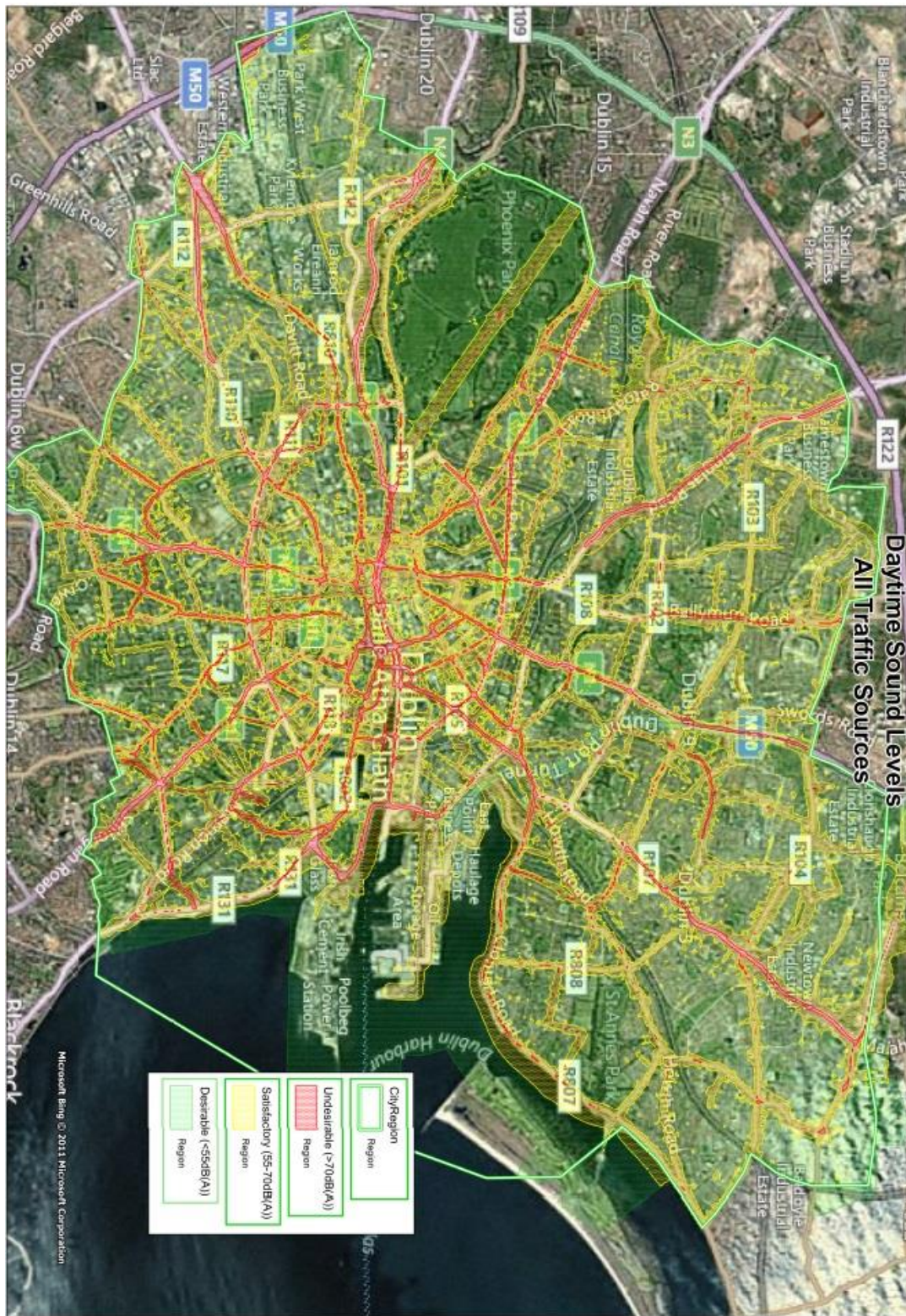
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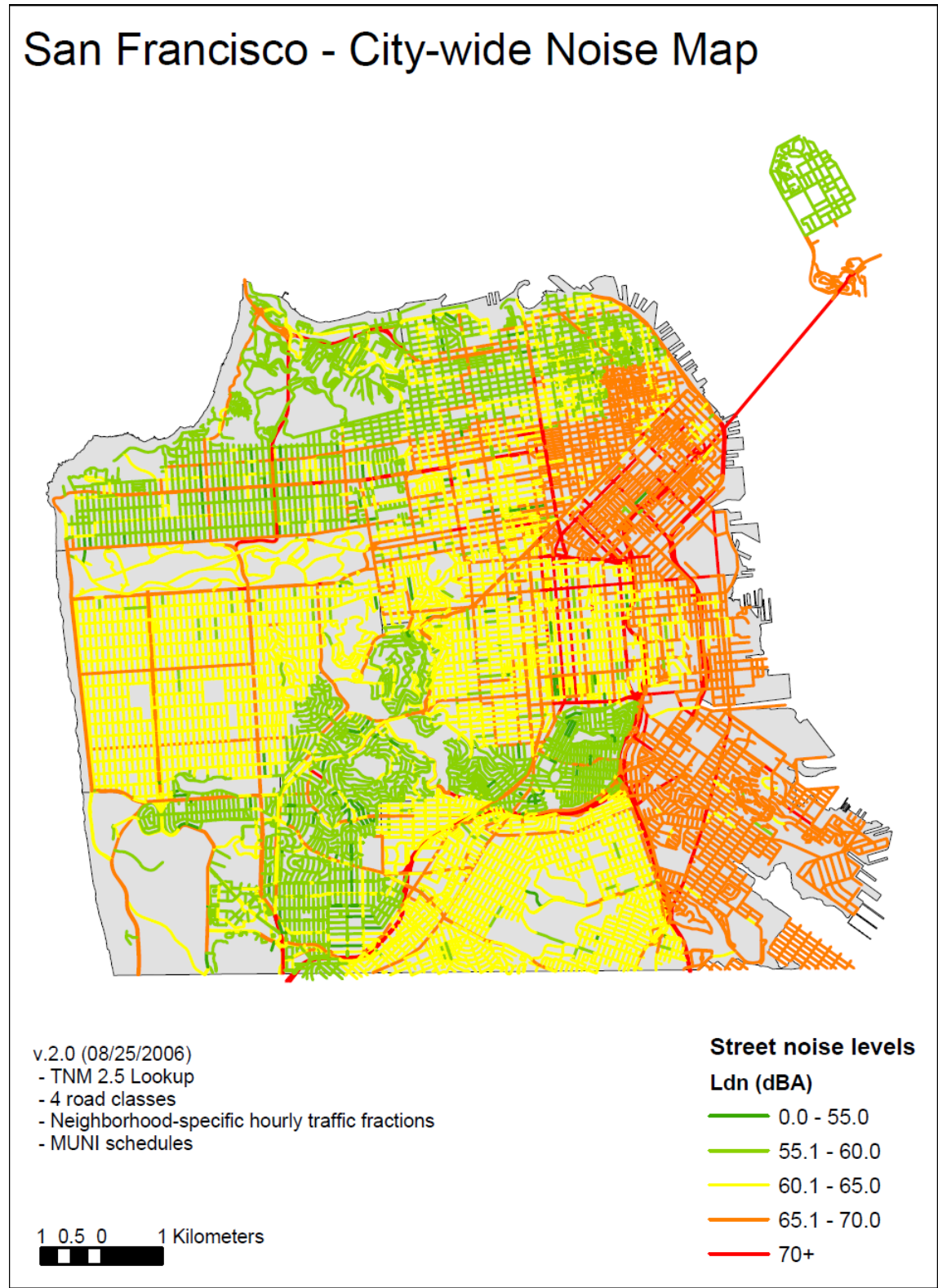
APPENDIX A: Adelaide City Road Traffic Noise Map



APPENDIX B: Dublin City Noise Map (Day Time).



APPENDIX C: San Francisco Noise Map



APPENDIX D: Presentation Slides