3D noise mapping of outdoor music events in the built environment

M.Sc. Geomatics thesis proposal
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1 Introduction

The Netherlands is experiencing a steep increase in festivals. According to a press release of the the Dutch association of event producers (V.V.E.M.) (Westermann, 2015) the amount of events has risen from 708 events in 2012 to 801 in 2014. Subsequently the amount of visitors went from 19.7 million to 22.7 million. The trend is still continuing according to V.V.E.M and this is most notable in the Dutch capital Amsterdam. According an article in Het Parool (van Geuns, 2015) in 2015 350 festivals were spread over 22 weekends in Amsterdam. By advertising the increasing diversity and the growth of festivals it is clear that it is part of Amsterdam's marketing plan to attract more visitors towards the city. This increase in festivities does come with a downside. Communities and neighbourhoods complain about nuisance. This social dilemma between what is commercially good for the city and what the residents desire is often addressed last few year in news papers, on TV and social media. There are many sources of nuisance during an outdoor festival but noise is the most occurring according the municipality of Amsterdam and numerous news articles e.g. (van Geuns, 2015) (Julen, 2015) (Huiskamp, 2015).

The World Health Organization (WHO) document "The Guidelines for Community Noise" (Berglund et al., 1999) summarized the scientific evidence that environmental noise is harmful for the public health. The European Union responded with a directive on the assessment and management of environmental noise (The European Parliament and The Council of the European Union, 2002). The directive's scope is to reduce and prevent the harmful effects of environmental noise by defining a common approach as well as requiring strategic noise maps. Strategic noise maps are maps 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 (The European Parliament and The Council of the European Union, 2002). The directive obliges European Union (EU) Member states to create strategic noise maps of major road, railway, airports and other agglomerations that comply to the directives specifications. Hence studies and software packages have been developed that are specialized in producing strategic noise maps for these situations. The need for noise maps for outdoor music events is growing and these maps are already being made but are in its infancy according DGMR, a Dutch consulting engineering company. Acoustic companies use often the same software packages and directives as for example a railway or a highway which is not suitable for music events. Little to no studies have been made regarding noise maps for festivals while the city of Amsterdam and event producers could clearly benefit from a tool to that can offer better insight to this increasing problem.

1.1 Scientific relevance

The European Directive intended for traffic noise states the use of a noise map in 2D that indicates noise levels at a certain height. While this 2D approach has been successfully used in environmental studies it is disadvantageous compared to a 3D approach due to the lack insight into the 3D character of noise (Stoter et al., 2008). Remarkably the output of noise calculation software is described in 3D and does take 3D data like buildings into account. It is the 3D interpolation of the output from the noise calculation software that can be seen as the scientific challenge. Several studies (Law et al., 2011; Pamanikabud and Tansatcha, 2009; Stoter et al., 2008; Kurakula and Kuffer, 2008; Chi Wing et al., 2006; Ranjbar et al., 2012) exposed the need of 3D noise mapping and with the advancement of geographical information systems (GIS) developed methodologies that has proven to be advantageous. Most of these studies apply to the impact of traffic noise, none of the studies found analyzes outdoor music events. Obviously this makes sense. Road traffic is the most widespread source of noise in all countries and the most prevalent cause of annoyance and interferences (Bruel, 2002). Besides the usefulness for the city of Amsterdam to acquire 3D noise maps for outdoor music events it could also benefit the scientific world. Loud music festivals could be categorized as loud, intermittent, impulsive and low frequency noise. The extremity of the sound goes beyond most standard noise calculation methods. Another unique element is the possibility to test the simulation not only with measurements but with actual noise nuisance complaints.

2 Research objectives

The main research question of this thesis is:
Could 3D noise mapping be a valid tool for predicting noise nuisance from outdoor music events in the built environment?

The main objective of this research is to lay the foundation for a methodolgy that effectively disseminate noise information and facilitates well-informed decision-making concerning the impact and assessment of outdoor music events. From my research question and main objective the following goals are derived.

- Develop an accurate 3D city model of the relevant areas and to investigate which of the attributes are necessary to correctly calculate the propagation of sound.
- Simulate as effectively as possible the conditions of an outdoor music event, this refers to audio installations and set-ups (the amount of speakers, the direction, the location, etc) and the music specification (sound level, frequency, tempo, style, etc.).
- Generate a 3D noise map where the best suited interpolation technique is applied to the output of the noise calculation software.
- To map the location and take measurements at the site of the actual noise nuisance complaints made during an event and relating it to the 3D noise map.
- Validate the 3D noise map as a tool for predicting noise nuisance complaints.

The result could be a methodology that enables greater insight into the scale and location of the affected residents by an outdoor event. This could help position the event on more suitable locations or notify the future affected houses more targeted. To achieve the main objective and the goals several difficulties should be handled with. A part of these challenges can be answered after the literature study while others need implementation and statistical testing to be responded.

For the propagation and calculation of sound the first questions that need to be answered are: What are the (most extreme) sound levels that can occur during an outdoor music event? Is there a noise calculation software available that can handle the wide spectrum of sound that can arise during an outdoor music festival? What are the requirements of the 3D city model to support the most accurate output for the noise calculations software? The author intends to gain external expertise in the noise calculation science and music industry to answer these questions.

The scientific challenge will be the 3D interpolation of the generated sound levels. Questions surrounding this topic will be: Which 3D interpolation technique can offer the best result from the output of the noise calculation software? Which software/method is most suitable for the 3D interpolation and which for visualizing the 3D noise map? With the help of previous research, acquired knowledge during the masters geomatics engineering and the expertise of the mentors the author will try to tackle this challenge.

For the social impact of this research insight into legislation, demographics and statistics is desired. Which demographic datasets are needed to analyse the relation with the noise nuisance complaints? Is there a relation between the noise nuisance complaints, the measurements, and the simulated noise levels? This information is essential to be able to answer the main research question. When the main research question is answered there could be a possibility to reflect critically upon the contemporary approach but what are the current legal limitations surrounding noise nuisance in Amsterdam and how are they enforced? And finally; Is there need to change current legislation or enforcement protocol?

2.1 Research scope

This thesis will focus upon the use of 3D noise mapping as a valid tool for well-informed decision-making relating to outdoor music events. This research will be limited to using existing software and methodologies to develop a 3D noise map. Only when all available means are deficient to the situation existing methods need consideration. While the generation of the 3D noise maps will likely be most challenging and time consuming the novelty of this thesis should be the application for outdoor music events and the integration with location of the noise nuisance complaints.

The research will focus on popular outdoor event areas in Amsterdam and mostly concerning electronic dance music festivals. The choice for electronic dance music festivals is because of the shear increase in popularity and amount of festivals in this genre. Preliminary research has also shown that these festivals cause the most agitation in neighbourhoods. Clashing with the profile of Amsterdam as dance capital of the world and host of the the biggest dance related festival in the world, the Amsterdam Dance Event.

Next to the obvious reason to choose Amsterdam, namely the amount of activities, another reason is that this research is in collaboration with the Amsterdam Institute for Advanced Metropolitan Solutions (AMS). The goal of this institute is to create solutions for the complex challenges a metropolitan region like Amsterdam is facing. Together with them the decision is made to focus on the interdisciplinary nature of this research and to use metropolitan data. The project will be solution oriented and societal relevant next to the engineering decisions sought by the Delft University of Technology (TU Delft).

3 Theoretical framework

To answer the (sub-)research questions a theoretical framework must be established. This framework will demonstrate an understanding of theories and concepts relevant to the topic. It will give a basis for the choice of research methods and will clarify the relation between the thesis and existing theory and scholarly literature. Finally the goal is to identify which key variables influence the phenomena's that shape this project.

The backbone of a theoretical framework is a literature study. The literature study will consist of four parts that discuss the main scientific elements of this research: sound propagation (a), noise calculation methods (b), legislation (c), 3D interpolation techniques (d).

3.1 Literature study

3.1.1 Sound propagation

This subchapter will discuss the basic principles of sound. Although the science of sound is established knowledge, it is essential for understanding the challenges that occur during noise calculation and 3D interpolation methods. The formula's and definitions in this subchapter are mostly extracted from *IISc Lecture Notes Series, Volume 3 - Noise and Vibration Controll* by M.L. Munjal and *Acoustics: Sound Fields and Transducers* by Leo L. Beranek and Tim Mellow.

Sound is a longitudinal wave in air, and wave is a traveling disturbance (Munjal, 2013). The speed at which the longitudinal disturbances travel trough a medium is called sound speed or the speed of propagation, *c*. The speed of propagation of sound is finite, these means there is an increasing delay in the arrival of the signal when the distant from the source increases (Beranek and Mellow, 2012). A wavelength is equal to the speed of propagation divided by the frequency of vibration.

$$\lambda = \frac{c}{f} \tag{1}$$

Where λ is the wavelength in meters, *c* is the speed of propagation of the sound wave in m/s, and *f* is the frequency in hertz (or cycles/s).

The measurable aspects of sound start with the measurable elements of the medium before a wave is initiated in it. In this thesis the focus is on waves trough gases, the medium where audible sound is created. The first measurable element is the *pressure* throughout the gas and this is equal to the ambient pressure. The second element is the *density*, this equals the ambient density when there is no disturbance in the medium. *Temperature* can be measured and the final measurable element is the *particle displacement*, the motion of the medium itself (e.g., wind) (Beranek and Mellow, 2012). When a sound wave is propagated several detectable changes occur in the medium; particles are displaced causing particle velocity, *pressure* starts fluctuating around the ambient pressure, as for the *temperature* and the *density*. The speed in which this disturbance trough a medium is propagated differs for different gases.

$$c = (\gamma RT)^{\frac{1}{2}} = (\gamma P_0/\rho_0)^{\frac{1}{2}} \tag{2}$$

Here γ is the ratio of specific heats C_p and C_v, *R* is gas constant, P_0 is static ambient pressure, ρ_0 is mass density, and T is the absolute temperature of the medium and *c* denotes the speed of sound.

When understood what happens when a wave propagates through a medium the focus now is on the measurable elements of the wave. *Sound power* is the rate at which sound energy is propagated per unit time. This unit is distance independent and the International System of Units (SI) unit is watt (W). *Sound power* is a theoretical value that is not measurable but it is the sound energy constantly transferred from the sound source Eq.(3). This sound energy generates sound pressure fluctuations in the medium. *Sound pressure* is measurable and distance dependent, the SI unit is the pascal (Pa) Eq.(4). *Sound intensity* is the energy the *Sound pressure* combined with the particle velocity produces per unit area, the SI unit is the watt per square meter (W/m^2) Eq. (4).

$$P = \frac{Ap^2}{\rho c} \cos(\theta) \quad (3)$$

Here P is the *sound power* in watt, A the area of the surface, p the *sound pressure*, ρ the mass density, ϑ the angle between the direction of propagation and the normal to the surface.

$$\boldsymbol{I} = p\boldsymbol{v} \quad (4)$$

Here $\boldsymbol{I}$ and $\boldsymbol{v}$ are both vectors with direction and magnitude, respectively *sound intensity* in watt per square meter and particle velocity, p is the *sound pressure*.

test When these waves enter the human ear a new scale of sound intensity, sound power and sound pressure is used. Because the ear can pick up pressure fluctuations of the order of 10^{-5} Pa to 10^3. Therefor a logarithmic unit of decibels has been created. Sound power level Eq.(5), sound pressure level Eq.(6) and sound intensity level Eq.(7) all have decibel (dB) as SI unit, this can be confusing.

$$SPL = L_p = 10 \log \frac{p^2}{p_{th}^2} = 20 \log \left(\frac{p}{2 \times 10^{-5}}\right) \quad (5)$$

$$IL = L_l = 10 \log \frac{I}{I_{ref}} = 10 \log \left(\frac{I}{10^{-12}}\right) \quad (6)$$

$$SWL = L_w = 10 \log \frac{W}{W_{ref}} = 10 \log \left(\frac{W}{10^{-12}}\right) \quad (7)$$

P_{th} is the faintest sound of 1000 Hz a human can hear namely 2×10^{-5} Pa. The corresponding I_{ref} and W_{ref} are 10^{-12} W/m^2 and 10^{-12} W.

The audible frequency range lies between 20 Hz and 20,000 Hz but 1000 Hz has been recognized as the standard reference frequency. The total audible range is divided in octaves and 1/3-octave bands. The sound pressure level increases by 3 dB when an octave band doubles from one to the next. Because the human ear reacts differently upon frequencies weighted factors have arise. The three weighted sound levels are shown in Figure 1. A-weighting is for levels below 55 dB, B-weighting for level between 55 and 85 dB and C-weighting for levels above. A-weighted sound pressure level is written LP_p in dBA and is used in most noise measurements and noise limit directives.

3.1.2 Noise calculation methods

The process of noise mapping and the role GIS is corroborated clearly by Kluijver and Stoter in the paper "Noise mapping and GIS: optimizing quality and efficiency and noise effect studies" (de Kluijver and Stoter, 2003). Kluijver begins with stating that to quantify and visualize noise effects an extended spatial database, spatial tools and computation force are needed. Their goal was to make noise effect studies more transparent. meaningful, reliable, unambiguous and the examination more efficient. Their proposed process is shown in Fig. 2.

The schema above presents a clear process and shows the relation of every step to each other. The step of computing noise levels - the noise calculation method - is done by specially developed computer models. In many countries environmental noise calculation methods have been developed, mostly related to traffic noise. Due to the different vehicle types and roads surfaces many countries use different standards for the effective analysis and prediction

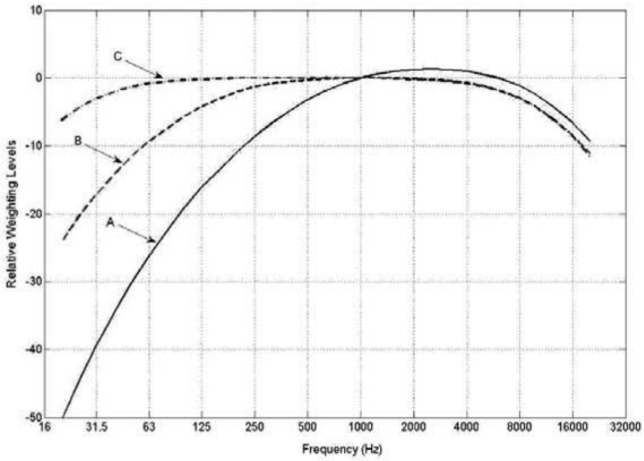

Figure 1: Approximate electrical frequency response of the A-, B-, and C-weighted networks of sound level meters (Munjal, 2013).

of traffic noise (Seshagm Rao et al., 1989). As mentioned before The Environmental Noise Directive (2002/49/EC) requires EU member states to determine the exposure to environmental noise through strategic noise mapping (European Commission Joint Research Centre, 2012). This directive resulted in for example CoRTN and PRTN by the Department of Environment in the United Kingdom, RLS-90 by Germany, MITHRA by a French firm, StL-86 by the Swiss Federal Office for Environmental Protection and the Dutch noise calculation methods (Ranjbar et al., 2012). A new European methodological framework for strategic noise mapping is under development namely CNOSSOS-EU, till than the manual measuring and calculating industrial noise is the mandatory noise calculation method in the Netherlands according to the 2012 Calculation and Measurement Regulations (State Secretary for Infrastructure and the Environment, 2012). The calculation method in this manual is the Standard Noise Calculation Method 2.

The Standard Calculation Methods (SCM1) and the Standard Calculation Method 2 (SCM2) are based on extensive measurements done in the 1970s and 1980s (Kurakula and Kuffer, 2008). SCM1 is the simplified version of SCM2. SCM2 defines noise paths from the source to a calculation point. This method also includes obstruction and defraction of noise by objects and buildings and their heights while SCM1 does not. Even second and third order reflections can be calculated to any number of calculation points (de Kluijver and Stoter, 2003). The Dutch legislation obligates the use of SCM2 for industrial noise, the use of SCM1 and SCM2 depending on the situation for traffic noise, a derivative of SCM2 for rail track noise. The manual measuring and calculating industrial noise (Ministry of Housing, Spatial Planning and the Environment, 2004) is the Dutch directive were all the guidelines to calculate noise according the legislation is stated. The software packages mostly used or created by established acoustic engineering companies in the Netherlands are focused surrounding these calculation methods. The overall regulations are enforced from The Environmental Noise Directive (2002/49/EC) (European Commission Joint Research Centre, 2012) this includes the use of certain noise indicators when making these strategic noise maps, namely L_{den} and L_{night}.

Another influential noise sound propagation model is Harmonoise. The Harmonoise propogation model is an accurate engineering model for outdoor sound propagation (Salomons et al., 2011). An important element of the model is the inclusion of a daily adjustable meteorological module. It is a flexible model and can be used both for detailed computations in case of noise assessment and for noise mapping (Nota et al., 2004). Harmonoise was developed to be the new European noise calculation standard but was never enforced because member states

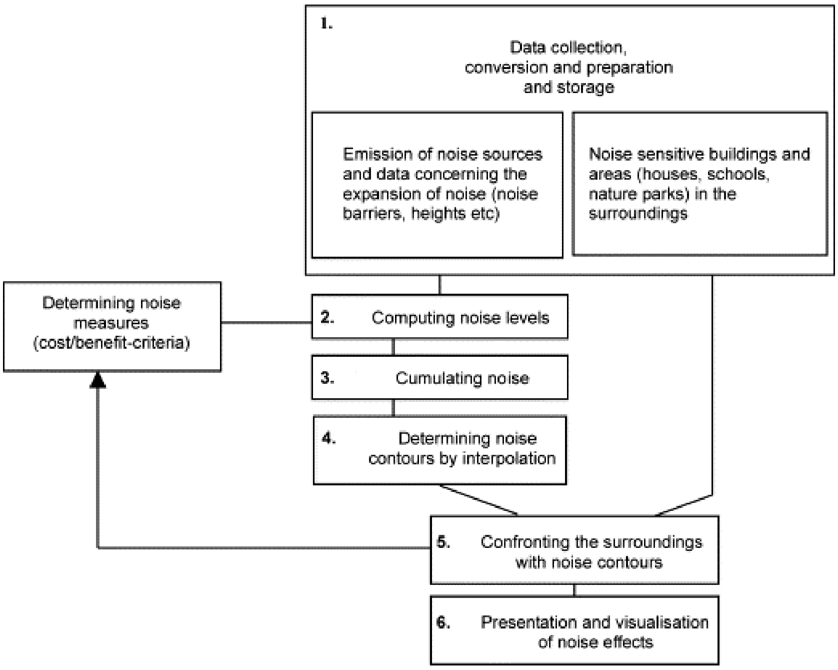

Figure 2: Schematization of the noise mapping process (de Kluijver and Stoter, 2003).

criticized the methodology for being too computational expensive.

3.1.3 Legislation

Central legislation concerning limitations or calculation methods about outdoor music events is non-existing. Thus municipalities measure the legal boundaries encircling an event by setting up an General Local Regulation (Algemene Plaatselijke Vordering)(APV). This legislation on a municipal level is far from congenial across the Netherlands. The APV of Amsterdam states that every event should be approved by the Mayor. A manual is made how to apply for approval (Municipality of Amsterdam, 2015). This application should include a ”simple” noise-report were the specifications of the sound source(s) is mentioned, the music genre, the duration and the expected dB(A) value on the facade of the nearest residential house. The corresponding city district (that again can handle their own limitations concerning noise) regularly involves an independent acoustic expert to validate the noise report. This validation is only done according simulation when the noise report offered includes the necessities to accomplish this. Mostly the validation is done upon past experiences, simple calculations, which software is used, and if the report is set-up by another established acoustic company. The validation of the correctness of the noise report is usually honored by the concerning city district.

There are no standardized prerequisites for the sound levels of outdoor music events, the maximum sound level on the facades of local residents, which sound level weighting is used when measuring, the noise reports submitted for approval or the validation of those noise reports. What can happen is that during the event the city district executes measurements, occasionally upon request from residents, to check if the levels mentioned in the approved noise report are maintained.

3.1.4 3D interpolation techniques

The subsection "Sound propagation" made clear that sound is a 3D phenomena, the subsection "Noise calculation methods" showed the parting between the computed noise level and the successive interpolation of the data and finally the subsection "Legislation" revealed that noise levels on facades of residential buildings should be known. This medley of reasons affirm the need of 3D representations of noise levels for this research. This opinion is disputed because the sound engineers the author interviewed did not comply with this need.

When the output of the noise computation is a point dataset, interpolation can predict the unknown values of the places that are not computed. 3D interpolation is often done for geographical phenomena with continues fields were the amount of available values are sparse due to high costs of measurements or lack of computational power. There are many different techniques, they can be beneficial depending on the distribution of the data set or the propagation characteristics of the phenomena.

Ledoux and Gold mention the importance of spatial interpolation techniques and the use in geosciences (Ledoux and Gold, 2005).They discuss the quality of several interpolation methods - that are intrinsically a two-dimensional operation - to preserve the appropriate properties of the dataset when extended to 3D. An ideal interpolation method is exact, continues, smooth, local and must be able to adapt to different densities and distributions of data. While not concluding it, the best result in their research was yielded using Natural Neighbor Interpolation.

Several studies implemented true 3D noise mapping. In "Advancement of three-dimensional noise mapping in Hong Kong" (Law et al., 2011) the benefits of successfully implementing 3D noise mapping is elaborated. They mention the use of a 3D GIS but not the specific interpolation method. Stoter and Kluijver present their initial experiments of 3D noise interpolation in the paper "3D noise mapping in urban areas" (Stoter et al., 2008). They succeed in representing a noise map in 3D but their interpolation of the noise levels is done in 2D. Kurakula is able to create a true 3D noise map using FIELDS software which is the extension of ArcView 3.3 (Kurakula, 2007). The interpolation method Kurakula used with this software was 3D-inverse distance weighted (3D-IDW), while being content with the results he mentioned the lack of software packages for 3D interpolation and the not user-friendly software. Ranjbar and Gharagozlou used a whole range of interpolation techniques to fit surfaces around the cloud of observations points (Ranjbar et al., 2012). The used interpolation techniques were: linear, cubic, nearest neighbor, biharmonic. These were executed in a MATLAB environment and visualized in a 3D GIS.

There is no standard spatial interpolation method that can deal with the logarithmically reduction of noise levels with distance (Oosterom, 2008). Oosterom continues explaining that some studies use 2D interpolation methods to drape noise contours over a 3D city model, while not using a 3D interpolation method it does serves the purpose with respect to the accuracy required by the specific application, which is visualizing and quantifying overall noise impact in 3D where 3D effects are relevant. A 3D noise map can be made without 3D interpolation techniques when the purpose is improving the overall picture. Weighing the effort to change the whole process of noise application to research "true" 3D noise maps, or to use the drape method when the purpose is better visual presentation and only specific 3D effects is an important choice.

4 Methodology

The author proposed methodology to achieve the research objectives is based on the theoretical framework and the advice of several experts and his supervisors. To collect real data a

Name	Date	Location	Expected turnout
Nomads	25-06-2016	Sportpark Riekerhaven	5000
Verknipt	02-07-2016	Sportpark Riekerhaven	5000
Manifestival	02-07-2016	Ruigoord Dorp	6500
Georgies Wundergarten	09-07-2016	Ruigoord Dorp	6500
22 Fest	23-07-2016	Diemerbos	5000
Liquicity festival	24-07-2016	Diemerbos	5000
Vunzige deuntjes	30-07-2016	Diemerbos	6000
Vunzige deuntjes	31-07-2016	Diemerbos	6000

Table 1: Table with the planned events to use for the research

collaboration is made with an Amsterdam based event production company named Chasing the Hihat BV (CTH). CTH is specialized in electronic dance music festivals and recognizes the need for better noise maps, quantifiable legislation and is very interested in the relation between the noise nuisance complaints, the simulation values, and the actual measurements. As disclosed in subchapter 3.1.3 they are obliged to hand in a noise report when requesting approval for an event, next to that they monitor their sound levels during the event to prove their compliance with the values agreed in advance. This can also be demanded in the permit. CTH has given permission to the author to have insight in the made noise reports, use their monitoring data and gather location data of the noise nuisance complaints addressed to their events. The locations and the events of CTH the author wishes to use for his research are listed in table 1. All the locations are of the Amsterdam region and will have two or more events. All the events are electronic dance festivals and have multiple stages.

The desired end product will be a 3D noise map with calculated sound levels in dB and a map or overlay with the sound levels in dB at the location of the noise complaints. Depending on the relation between these two datasets a statement can than be made about fitness of a 3D noise map as a valid tool to predict noise nuisance. The proposed methodology consist of three main pillars: the 3D noise maps (a), the measurements (b), the noise nuisance complaints (c). The steps needed to fulfill my goals are visualized in Figure 3. These main pillars will be combined in the end to be able to answer the main research question, this is displayed in figure 3 as step D.1 and D.2.

4.1 Pillar A, 3D noise maps

DGMR is a Dutch consulting engineers company that developed Geomilieu, a high quality software for environmental issues. This includes topics such as industrial noise, traffic noise, and air quality. Geomilieu is being used by more than 300 institutions and constantly adapts to changing laws and regulations. It includes multiple different noise propagation modules that can be implemented, including Harmonoise and the Dutch Calculation and Measurement Regulations. A 3D city model can be imported into Geomilieu and the outcome of the noise calculation is in 3D but can not be 3D interpolated inside the software. It does offer the functionality to export the data to a GIS.

The author made contact with ir. J. (Rob) Witte a senior advisor industry, traffic and environment at DGMR and co-writer of the Dutch manual for measuring and calculating industrial noise (Ministry of Housing, Spatial Planning and the Environment, 2004). DGMR is willing to support the research and act as an advisor. Together with DGMR the decision was made to use Geomilieu and the Harmonoise module. DGMR will advise and support the author to complete two essential goals namely; develop an accurate 3D city model of the relevant areas with the necessary metadata to correctly predict the propagation of sound (1), simulate as ef-

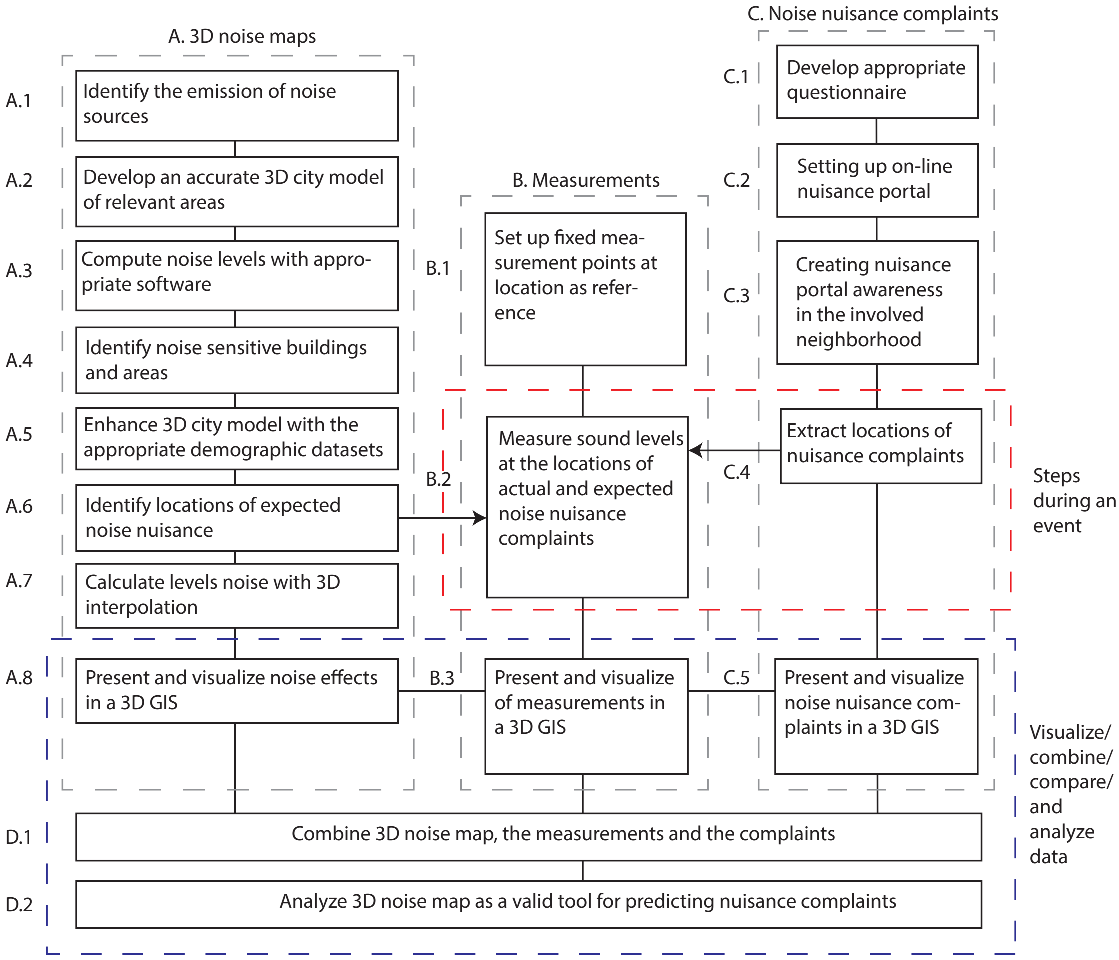

Figure 3: Methodology schema.

fectively as possible the conditions of an outdoor music event, this refers to audio installations and set-ups (the amount of speakers, the direction, the location, etc) and the music specification (sound level, frequency, tempo, style, etc.) (2). In figure 3 these are steps A.1 up till A.7. Step A.7 and A.8 in figure 3 will be the scientific challenge for the author and will include a lot of trail and error. Choices will be mostly based upon previous work and the expertise of Prof.dr. J.E. Stoter and dr. H. Ledoux.

4.2 Pillar B, measurements

Measurements during an event is essential for testing the simulation and relating the location of the noise nuisance complaints to actual sound values. The constant monitoring of the sound levels from the event is necessary due to the many variables that can influence the propagation of sound, not only metereologic but also change of speaker set-up, source power, music style and other unexpected influences. This information can be clarifying when analyzing the data. DGMR again offered help in this, for the author, unknown science. A sister company of DGMR called Sensornet will help with the measurements. Sensornet is a company specialized in accurate, long-term measurement of environmental noise vibration, air pollution and other environmental parameters. The internet is used to collect incoming data and to display the result in real-time. Sensornet will provide equipment and training to handle the tools accordingly.

Chasing the Hihat always monitors their sound levels using measurement equipment. They have given the author permission to use the data they gather and to make use of their equipment. The resources of CTH and Sensornet combined will hopefully insure good quality data. Step B.1 and B.2 in figure 3 will be executed this way. Step B.3 can be done in Geomilieu or in any other GIS, it depends on the quality of the data.

4.3 Pillar C, noise nuisance complaints

There is no noise nuisance caused by events hotline in Amsterdam. A resident does not know where to leave a complaint and where it has most effect. The need for a general reporting point is increasing. Festival producers are obliged to inform the neighborhood about the basic information of the event. This information is spread through the post addressed to the residents in a certain range from the event. This means that people that are outside this range but do experience nuisance have no clue what the source is and when it will stop and were to leave a complaint. This lack of insight aggravates the annoyance.

To comply with the steps C.1 and C.2 the author has obtained the website www.festivaloverlast.nl (meaning festival nuisance). This website will act as an online hotline where residents can leave their complaint by filling in a survey. This survey will include questions about the type of complaint and will ask the location. The simple website will show information about the events nearby and will inform them about the research.

To make people aware of the website CTH will spread the websites information through the post and agreed to use the portal with all their events. The mention of this website by the CEO Daniel van Drunen of CTH during a town council got positive feedback. The author will try to get official endorsement from the Municipality of Amsterdam, Nederlandse Stichting Geluidshinder (the Dutch foundation of Noise nuisance) (http://nsg.nl), AMS and TU Delft. This will increase the trust and validate the website and hopefully will motivate the user more to share their complaint and location. During an event the website will be monitored and when people complain about noise nuisance the author will visit the location and will perform a measurement. As much locations as possible will be visited. The location of the complaint and the joint measurement will be stored and visualized in a GIS.

5 Planning and organization

This chapter will give more information about the responsibility and organization of the research project. The chapter will also list the important milestones and gave an overview of the planning.

5.1 Organization

Main mentor:
Msc. F. Biljecki, Researcher at TU Delft, member of the 3D Geoinformation Research Group.

Second mentor:
Prof.dr. J.E. Stoter, Professor 3D Geo-information, Department of Urbanism.

Advisor:
ir. R. Witte, Senior consultant Industry and Environment at DGMR.

Contact AMS:
Dr. ir. R. M. Rooij, Assistant professor, Chair of Spatial Planning& Strategy, AMS/ TU Delft education programme coordinator.

Contact CTH:
D. van Drunen, CEO of Chasing the Hihat BV.

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5.2 Planning

The graduation process exist out of two obligatory progress reviews (P1 and P3) and three formal assessments (P2, P4 and P5). The author complies with P0 (register for graduation) and P1 (progress review). This proposal is written as the graduation plan and to hopefully fulfill P2 (formal assessment graduation plan). According the graduation manual students will only be admitted to the P2 if they have completed all core courses (first MSc year) with a maximum of 5 EC unfinished. The author still needs to fulfill two common core courses, namely GEO1008 Geo Datasets and Quality (2015-2016 Q3) and GEO1007 Geoweb Technology (2015-2016 Q4), both 5 EC's. This has the consequence that the first moment P2 could be carried out is during the final week of Q4. The author will not be limit by these regulations and will continue working on the research, also for the fact the events where the data will be gathered are fixed dates. Table 2 will give an overview of the planning of this thesis project.

Till the P2 deadline the time will be devided between the courses and the thesis. After P2 the author will spend 20 full time weeks upon the research. The graduation project consist of 45 ECTS, this comparable with 1260 hours. After P2 two thirds still need to be done, this is 840 hours or 21 weeks.

Tasks	Start date	End date	Duration
Develop appropriate questionnaire	21-03-2016	28-03-2016	1 week
Get accustomed with Geomillieu software	28-03-2016	18-04-2016	4 weeks
Finish online nuisance portal	28-03-2016	04-04-2016	1 week
Develop 3D city model	18-04-2016	09-05-2016	3 weeks
Get used with measuring equipment	18-04-2016	02-05-2016	2 weeks
Make first noise map De Oeverlanden	02-05-2016	16-05-2016	2 weeks
Measuring at first two events	21-05-2016	22-05-2016	2 days
Evaluate gathered data and process	23-05-2016	30-05-2016	1 week
Create noise map for Ruigoord and Riekerhaven	30-05-2016	20-06-2016	3 weeks
Measuring at third event	25-06-2016	25-06-2016	1 day
P2 preparation and presentation	27-06-2016	01-07-2016	5 days
Measuring at fourth and fifth event	02-07-2016	02-07-2016	1 day
Develop first 3D interpolated noise map	04-07-2016	18-07-2016	3 weeks
Measuring at sixth event	09-07-2016	09-07-2016	1 day
Create noise map for Diemerbos	18-07-2016	22-07-2016	5 days
Measuring at seventh and eighth event	23-07-2016	24-07-2016	2 days
Comparison of 3D interpolated noise maps	23-07-2016	08-08-2016	2 weeks
P3 preparation and presentation	08-08-07-2016	12-08-2016	5 days
Complete all 3D interpolated noise maps	15-08-2016	05-09-2016	3 weeks
Bundling all data, draw conclusions	05-09-2016	19-09-2016	2 weeks
Documentation of thesis	05-09-2016	03-10-2016	4 weeks
Submit draft thesis	03-10-07-2016	07-10-2016	5 days
P4 presentation and preparation	10-10-2016	14-10-2016	5 days
Finalizing and correcting thesis	17-10-2016	07-11-2016	3 weeks
Submit hard copy final thesis	07-11-2016	11-11-2016	5 days
P5 presentation and preparation	14-11-2016	18-11-2016	5 days

Table 2: Planned tasks and dates

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