

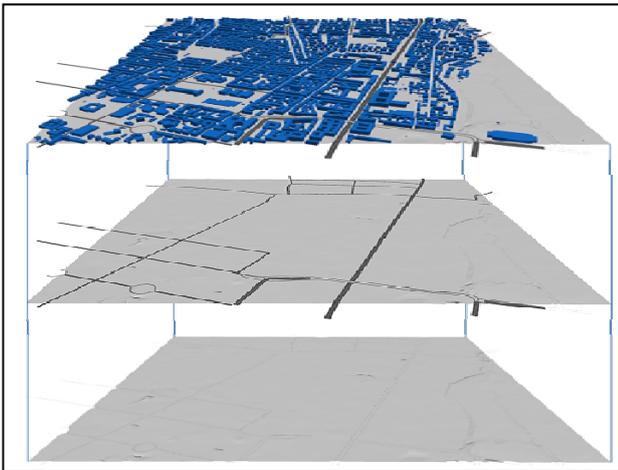
Noise modeling and noise cost calculation for different scenarios in Munich

Master's Thesis by Fabian Heidegger

Supervisors:

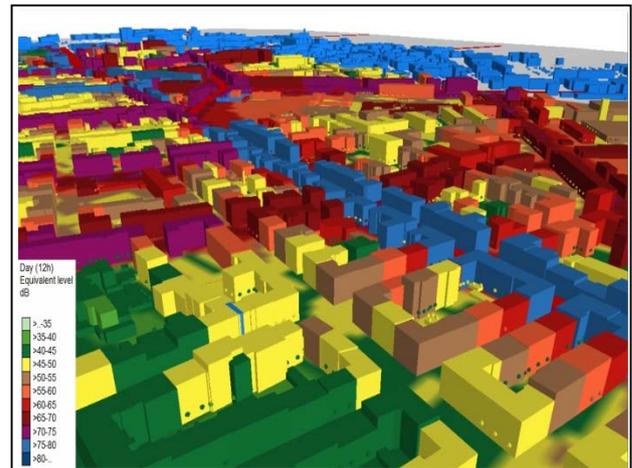
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Noise, especially traffic noise, is one of the most observable environmental problems. Noise disturbs communication, can cause various sleep disorders or may provoke physical stress reactions reflected in activation of the autonomic nervous system. Cardiovascular diseases can be consequences in the long run, too. Therefore the legislator has set thresholds to protect the citizens against uncontrolled propagation of sound. The "Bundesimmissionschutzgesetz (BImSchG)" and the "Vorläufige Berechnungsmethoden für den Umgebungslärm an Straßen (VBUS)" convert the European Environmental Noise Directive (2002/49/EC) into German law until compulsory rules exist for all member states of the European Union.



The second scenario dealt with calculating the impact of noise emitted from streets with a traffic volume less than 3 000 000 vehicles a year (digitalization of the secondary network). As no traffic data for these roads were available from the authorities, manual and computer supported traffic counts were conducted in the test area. The counted traffic volume was extrapolated to ADT, representing the decisive traffic volume for calculating noise emissions.

Equally distributed immission points were set at the outside of the housing façades in a height of four meters above ground level for obtaining the number of noise annoyed inhabitants.



Variables influencing the sound emission level of a street are traffic volume q , heavy goods vehicle share p , maximum allowed speed limit, road surface and longitudinal gradient. Noise immissions were not measured, but calculated with the noise mapping software IMMI. Therefore a digital terrain model based on triangulation (bottom layer), the street network (middle layer) and the buildings' geometry (top layer) were imported into IMMI.

The objective of the thesis was to calculate noise for different scenarios in a test area of 1 km² in a part of Maxvorstadt, a district of Munich. The first scenario was to calculate a noise map according to the requirements of the VBUS (Base case / Main network). Only streets with a traffic volume of more than 3 000 000 vehicles a year (8220 vehicles for Average Daily Traffic (ADT) were considered.



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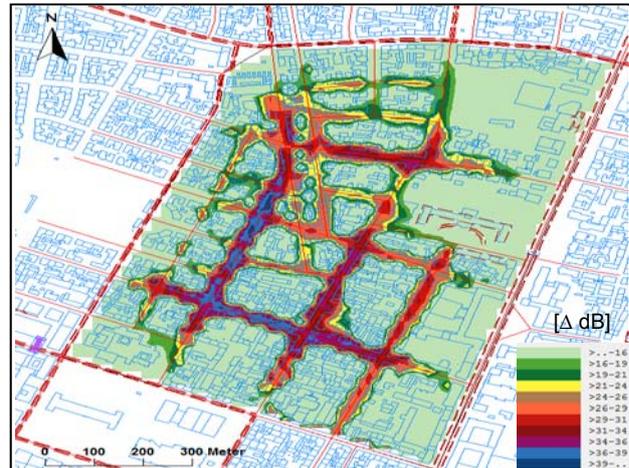
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Both scenarios were compared with the help of a difference raster for the noise level day/evening/night (L_{DEN}). The L_{DEN} is the averaged noise exposure per hour over a whole day; the evening value gets a penalty addition of 5 decibel (dB) and the night value gets a penalty addition of 10 dB due to the more damaging impact of noise during these two periods.

Result of the impact of the secondary network is that the emitted noise from the secondary network cannot be neglected as sound pressure level rose by up to 32 dB at junctions, nearly implying an eleven fold increase of sound energy.



Within the test area, two further scenarios were modeled, looking at the effects of a potential introduction of administrative law measures. Firstly, all heavy goods vehicle (HGV) were banned from the streets, secondly, a maximum allowed speed limit of 30 km/h was introduced. It can be stated that the ban of HGV leads to a maximum noise level reduction of 4 dB and the scenario "maximum allowed speed limit of 30 km/h" to a maximum noise level reduction of 3 dB (depending on buildings' geometry). Residents are less noise annoyed in the rather hypothetical scenario "ban of HGV" compared to the speed limit scenario. But this is predominantly due to the fact that most of the streets in the test area were already constrained with a speed limit of 30 km/h.

A further scenario involved calculating noise in an enlarged area (5 km²; parts of districts Laim, Hadern and Sendling-Westpark) in a proximity of two highways. Thus the calculation capacity of the computer was enlarged by multi-core calculation, automated cluster calculation via Local Area Network (LAN) and segmented calculation. Due to the proximity of two highways L_{DEN} of more than 80 dB were reached.

In a next step, willingness to pay analyses or hedonic pricing allow for a monetization of noise damages. A draft concept for assigning external noise costs back to streets and vehicles is presented in order to calculate average costs. Cost assignment in coherence with traffic psychological aspects could help to develop optimal road pricing tolls for traffic management systems in the future. The cost calculation is also embedded into microeconomic theory (standard congestion diagram, pigouvian tax) to internalize external costs to maximize social welfare. A spatial autocorrelation model, the impact of non-linear noise effects and cut-off levels are presented shortly to conclude the thesis.

