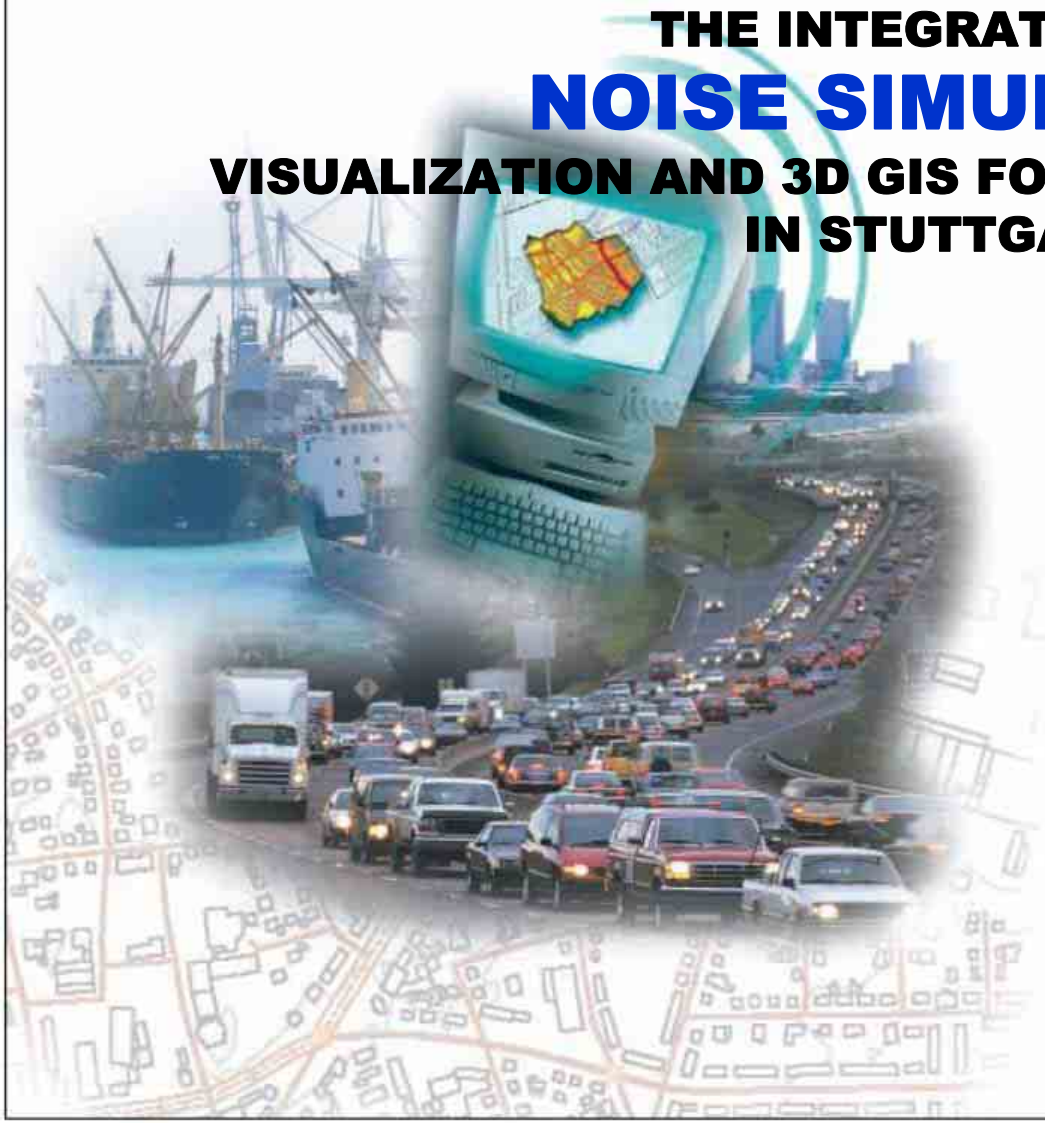
THE INTEGRATION OF NOISE SIMULATION, VISUALIZATION AND 3D GIS FOR ROSENSTEINVIERTEL IN STUTTGART



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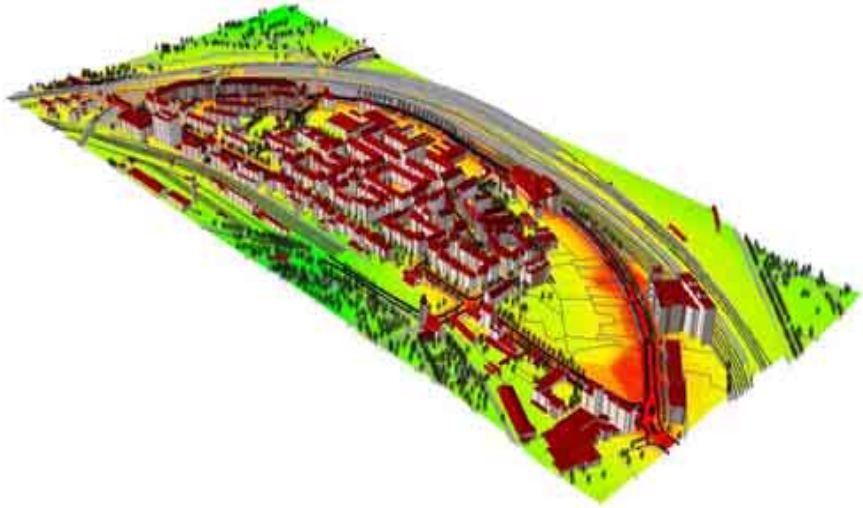
Supervised By
Prof. Dr. Volker Coors
MSc. Katja Huning

Contents

- Introduction
  - Sound Concept
  - Sound Propagation
- Objective
- Workflow
  - ArcGIS
  - MS Excel
- Results
- Summary

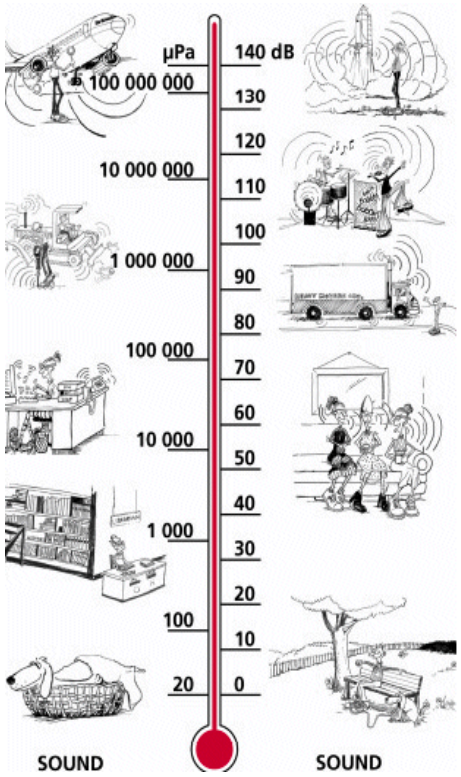


Introduction

- **Sound** can be defined as any pressure variation that the human ear can detect.
- **Noise** is defined as any unwanted human created sound.
- Scale for Noise:
  - Force per Unit Area
    - Dynes / cm^2 [Bar]
    - **Newtons / m^2 [Pascals]**
  - **Decibel [dB]**

$$SPL = 20 \log_{10} P/P_o$$

P_o = 20 µPa



Introduction

Adding and Subtracting Noise

$$NL = 10.\log[10^{\frac{NL1}{10}} + 10^{\frac{NL2}{10}} + 10^{\frac{NL3}{10}} + \ldots + 10^{\frac{NLn}{10}}]$$

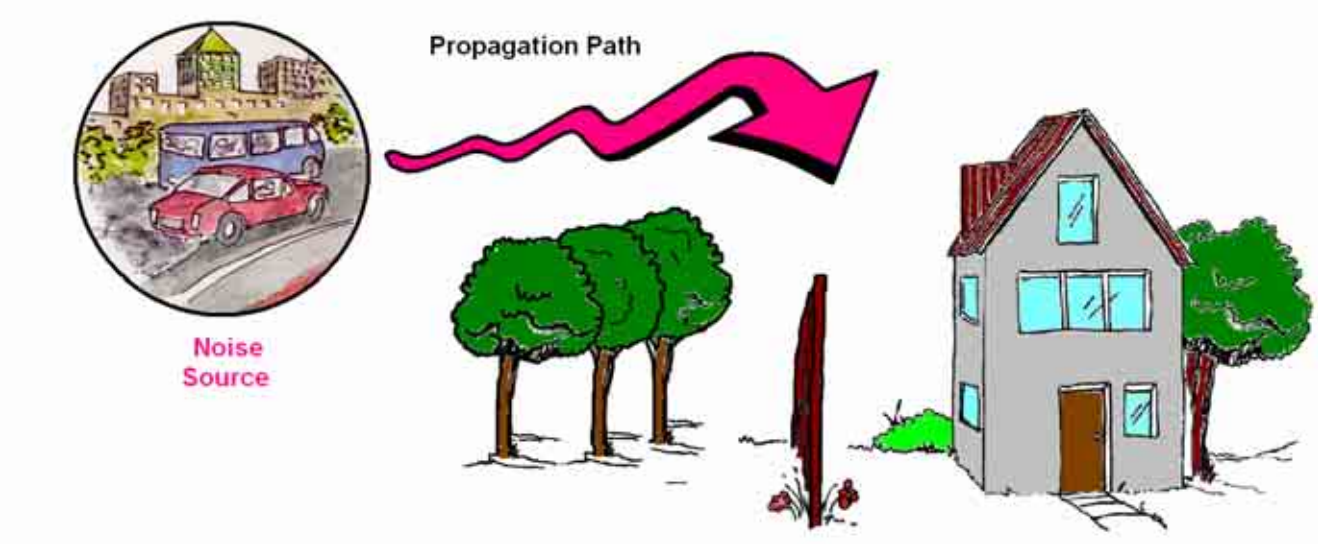
+ & - are Logarithmic Process

60 dB + **60 dB** = 63 dB

Adding NL's using a simple table - When combining sound levels:-

When Two Decibel Values Differ By:	Add This Amount To the Higher Value:	Example:
0 or 1 dB	3 dB	70 + 69 = 73
2 or 3 dB	2 dB	74 + 71 = 76
4 to 9 dB	1 dB	66 + 60 = 67
10 dB or more	**0 dB**	**65 + 55 = 65**

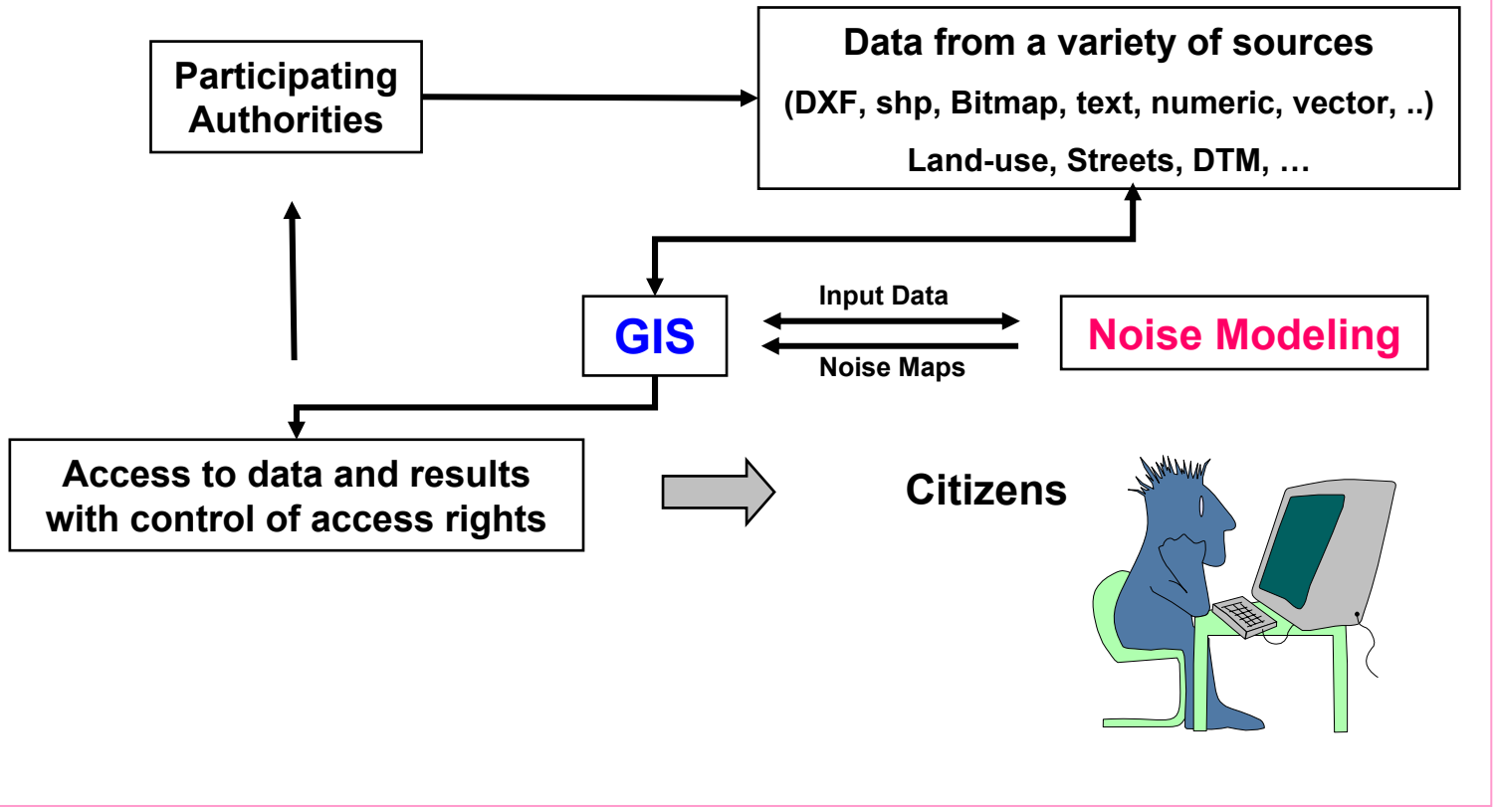
Introduction



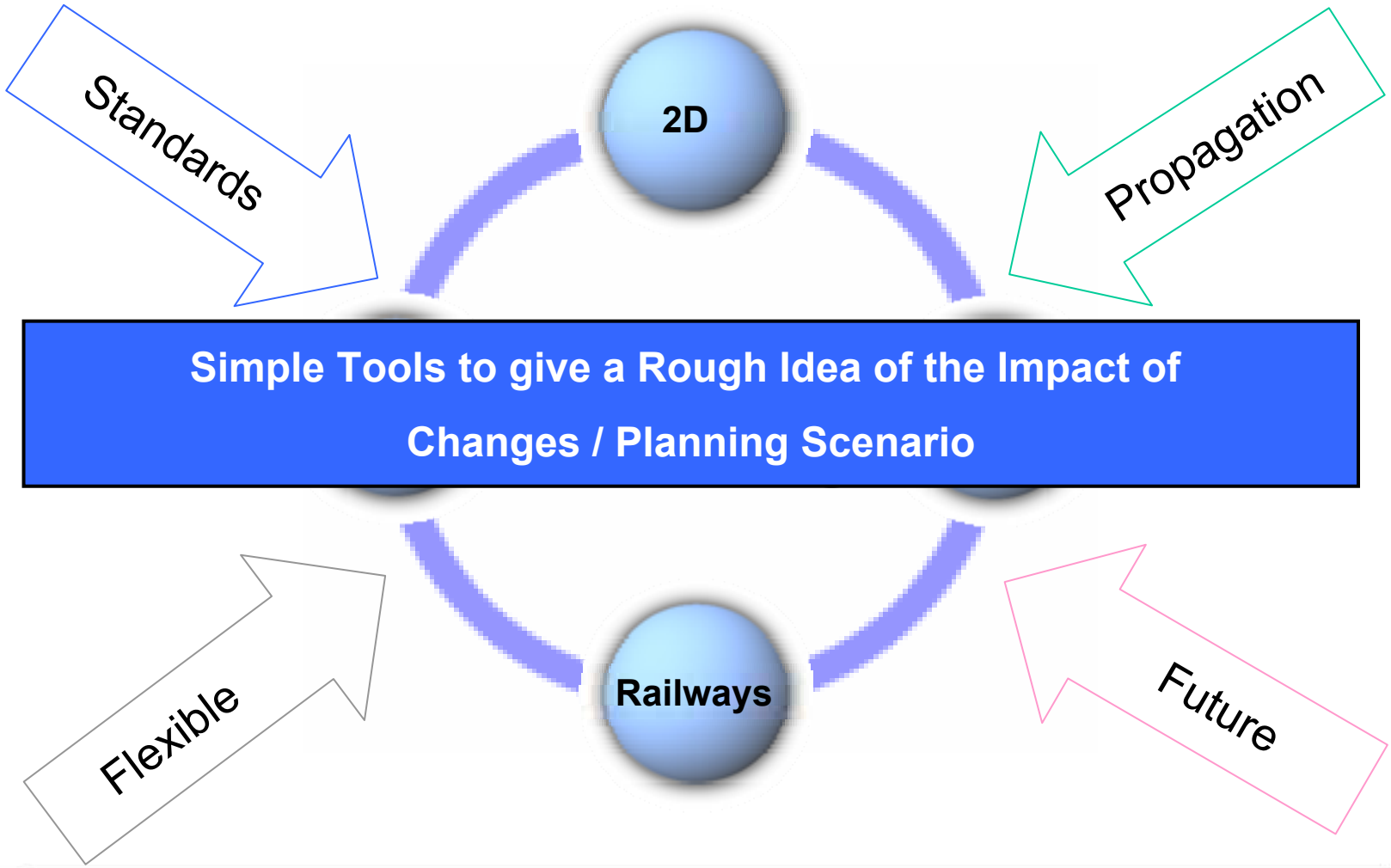
Sound Propagation / Attenuation

- Spreading
- Air Absorption
- Ground Effect
- Screening
- Volume Type Absorption
  - Vegetation
  - Built-up
- Reflection

Objective


Participating Authorities
Data from a variety of sources
(DXF, shp, Bitmap, text, numeric, vector, ..)
Land-use, Streets, DTM, …
GIS
Input Data
Noise Maps
Noise Modeling
Access to data and results with control of access rights
Citizens

Objective


Standards
2D
Propagation
Simple Tools to give a Rough Idea of the Impact of
Changes / Planning Scenario
Flexible
Railways
Future

Noise Level

Noise Level Value

Road [RLS 90 / DIN 18005]

$$L_{m,E} = Lm_{(25,basic)} + \Sigma C_i$$

C's are:

- **Speed Correction**
  - Speed
  - Traffic Flow
  - Truck Percent
- **Road Surface Addition**
- **Road Gradient Addition**
- **Multiple Reflection Addition**

RLS : Richtlinien für Lärmschutz an Straßen

DIN : Deutsches Institut für Normung

Railway [Schall 03 / DIN 18005]

$$L_{m,E}=10*\log\left[\Sigma 10^{(0.1*(51+\Sigma Ai)+\Sigma D_i}\right]$$

A_i's are Adjustment for:

- Type of Train
- % of Disk Brakes
- Train Length
- Train Speed

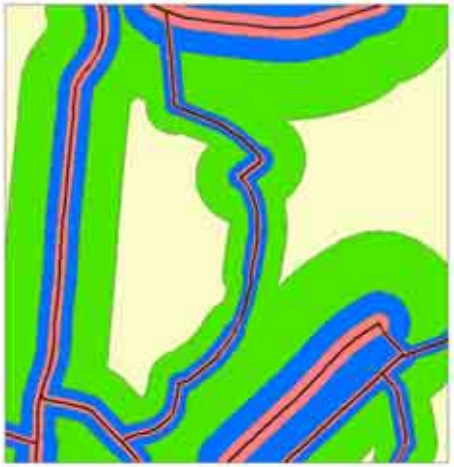
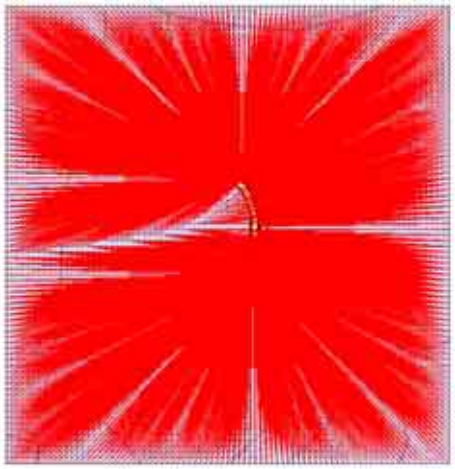
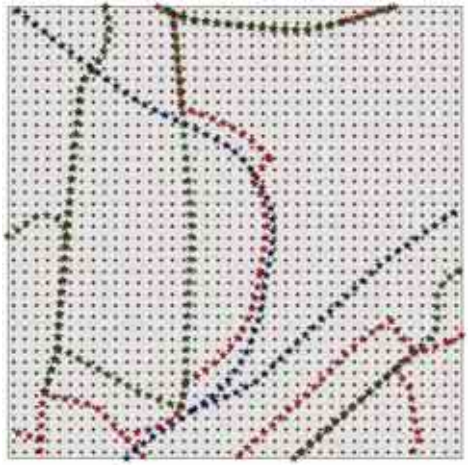
D_i's are Additional to train track:

- Track Type
- Bridges
- Level Crossings
- Small Radius

Noise Mapping

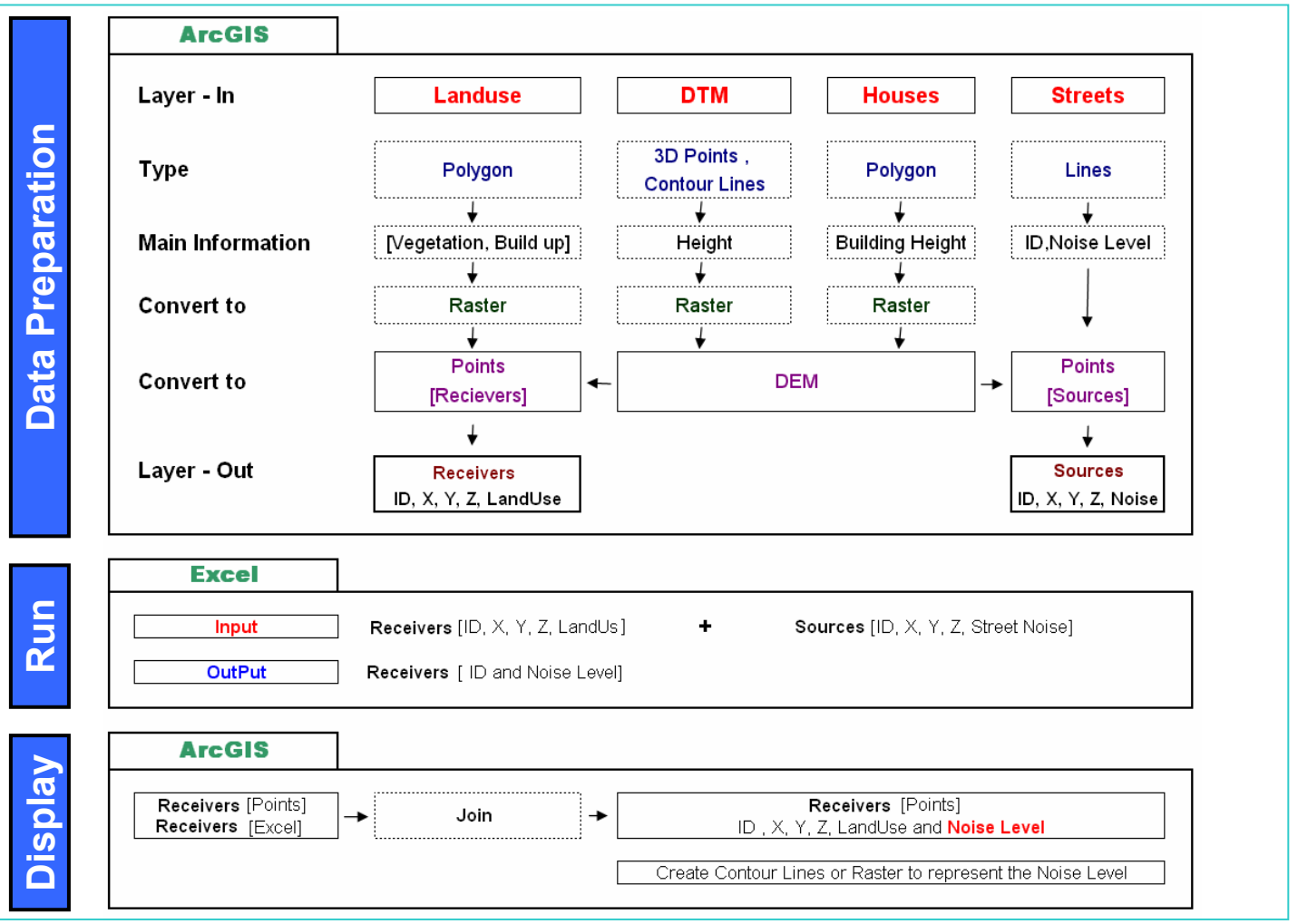
Methods
Buffering
Shortest Path
Search

Methods of Noise Mapping

Buffering	Shortest Path	Search Method
		
2D	2D	2D / 3D
Low Running Time	Average	High
No Propagation	No	Yes
Low Accuracy	Average	High

Search Method

Workflow
ArcGIS
MS Excel



Search Method

Land Use

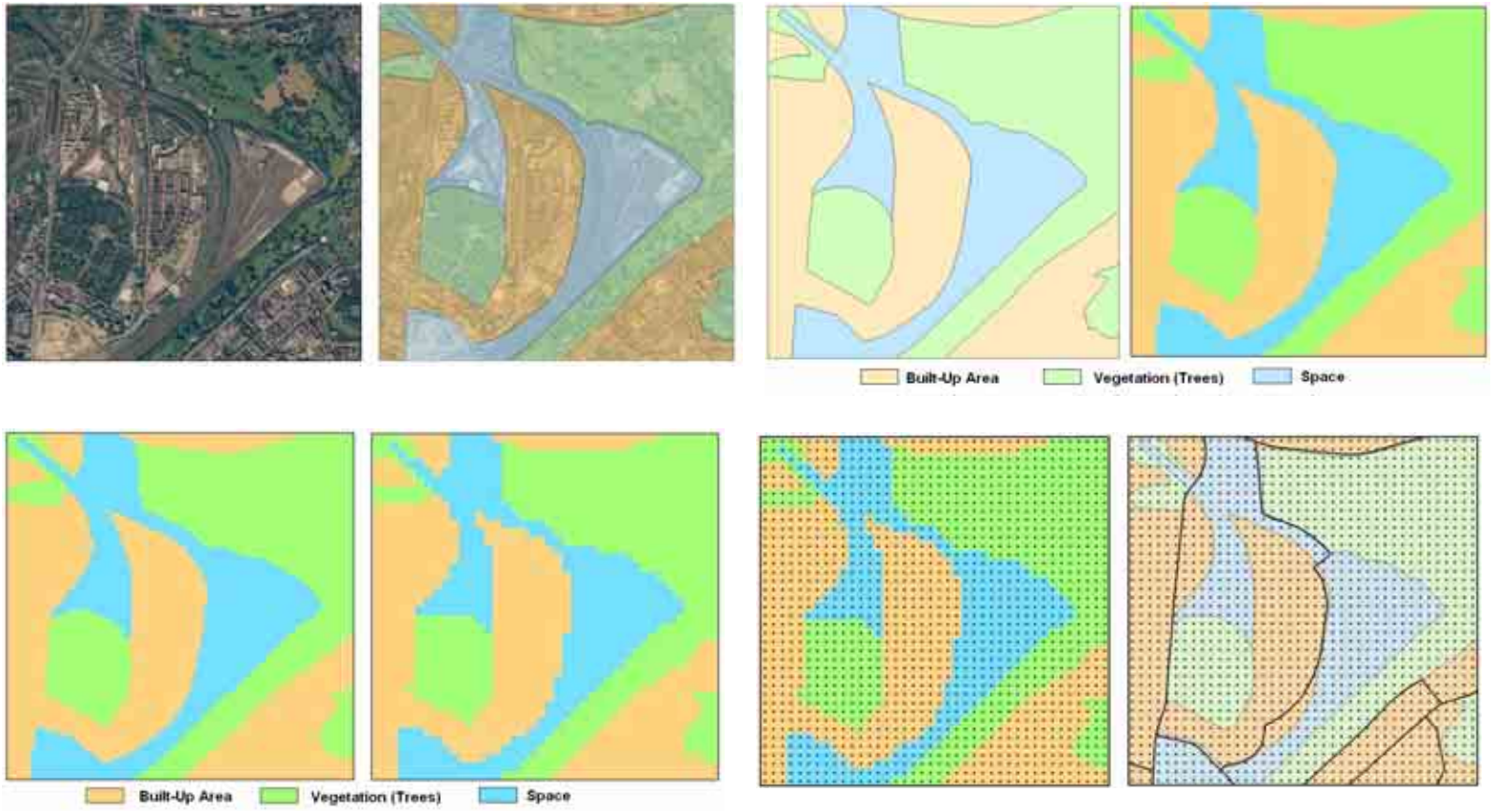
Image

Polygons

Raster

Points

Land Use



Search Method

DEM

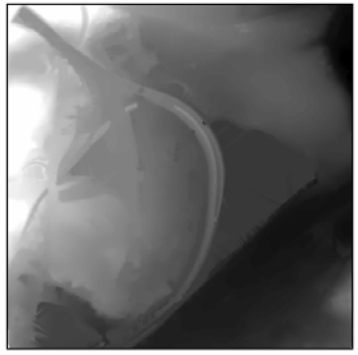
Buildings

DTM

Digital Elevation Model

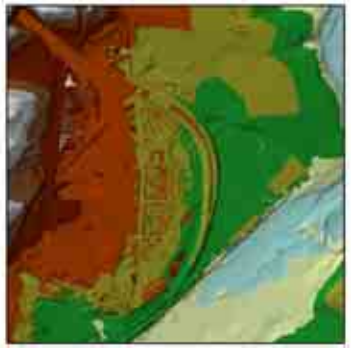
Buildings

Area around Buildings



DTM

DTM – Building Location



Digital Elevation Model

Search Method

Land Use

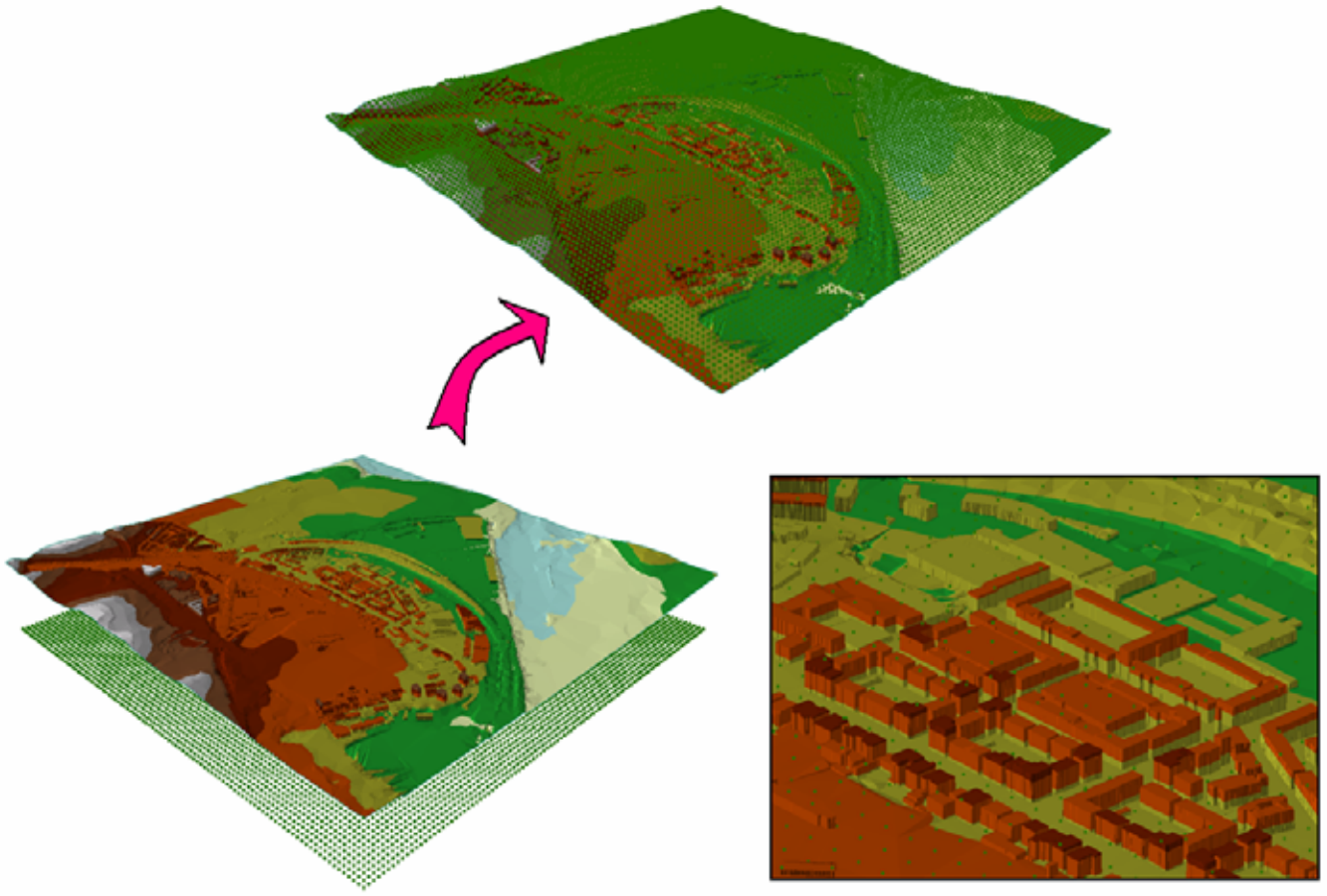
Image

Polygons

Raster

Points

3D Receivers

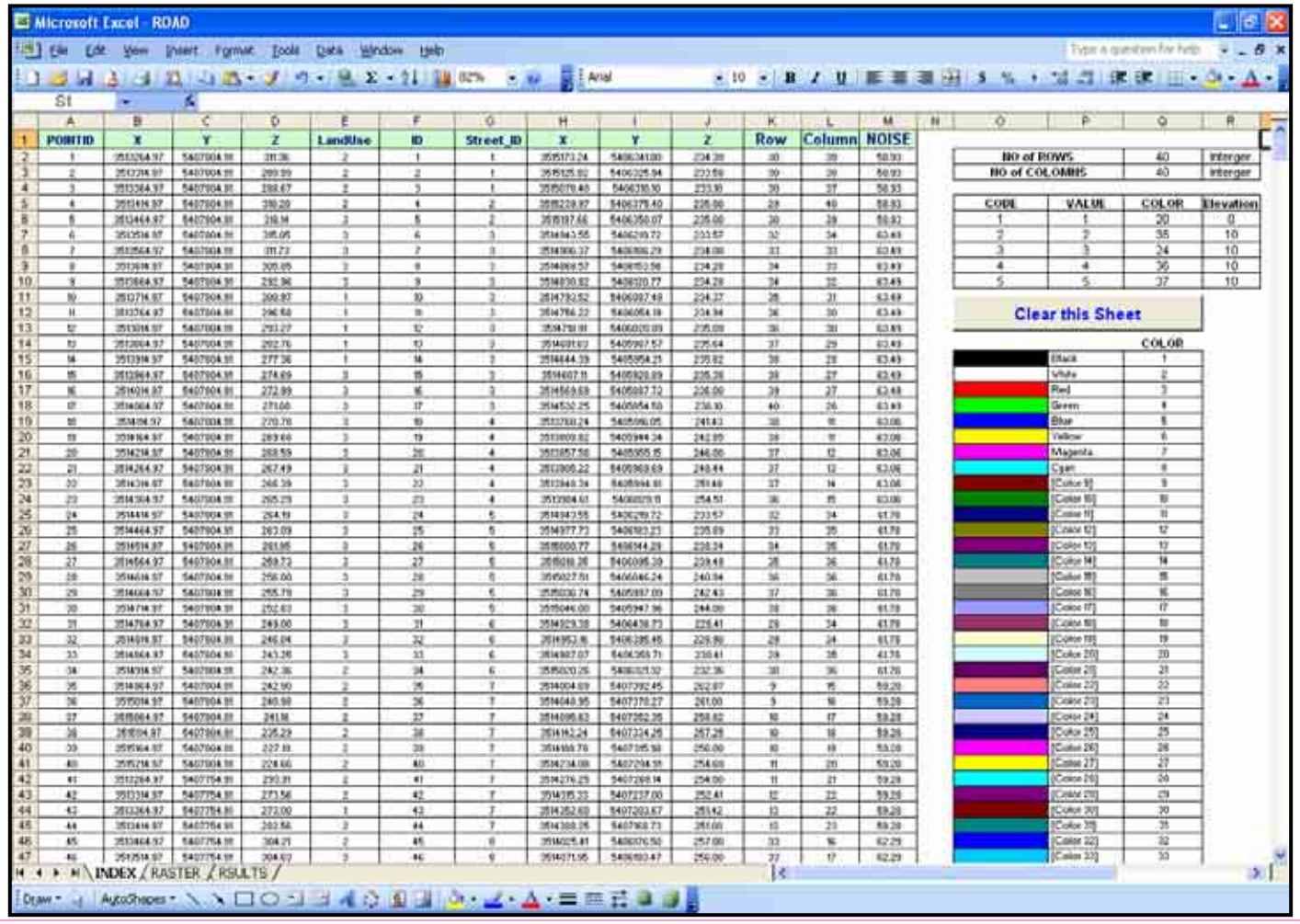


Search Method

Input Sheet

Sources

Receivers



Search Method

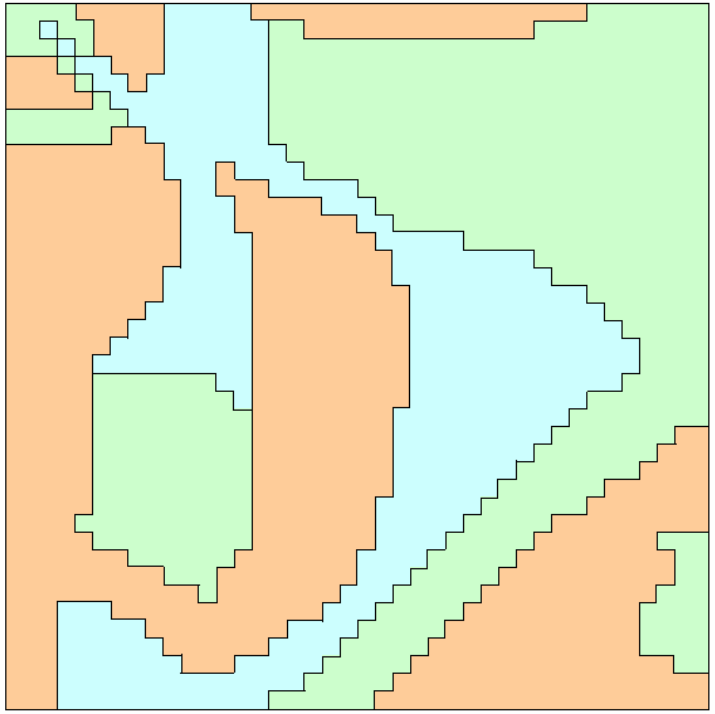
Raster Sheet

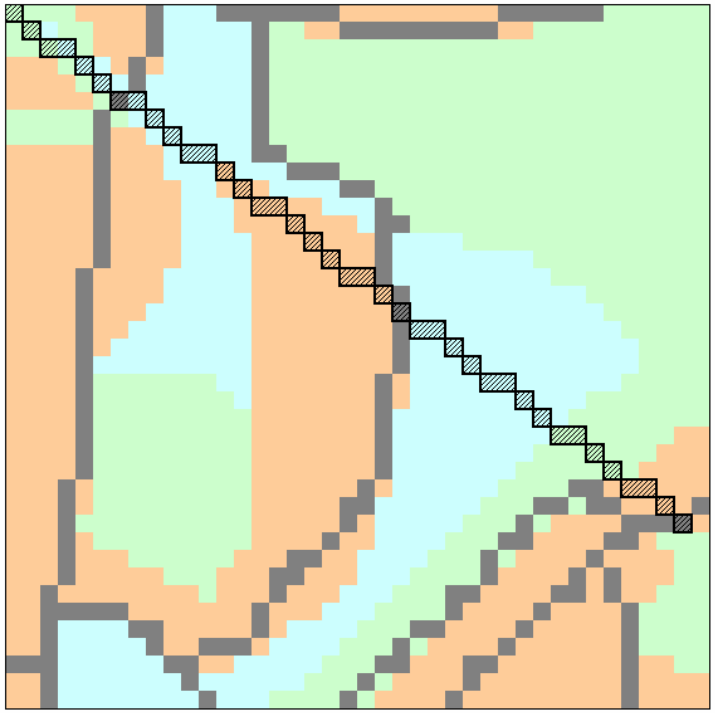
Land use

Noise Rays

Working with Excel

- Reconstruct the Raster
- Define the Noise Ray Path between the Receiver and Sources



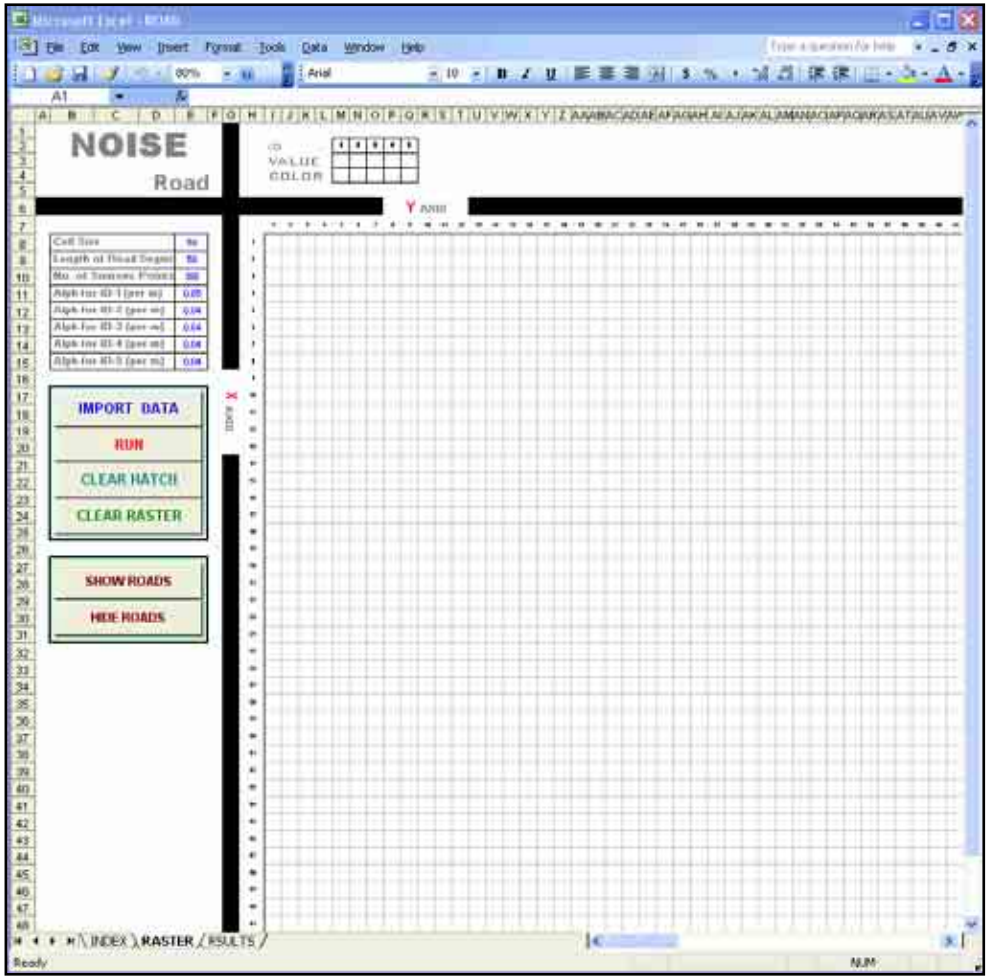


DEMO

Raster Sheet

Land use

Noise Rays



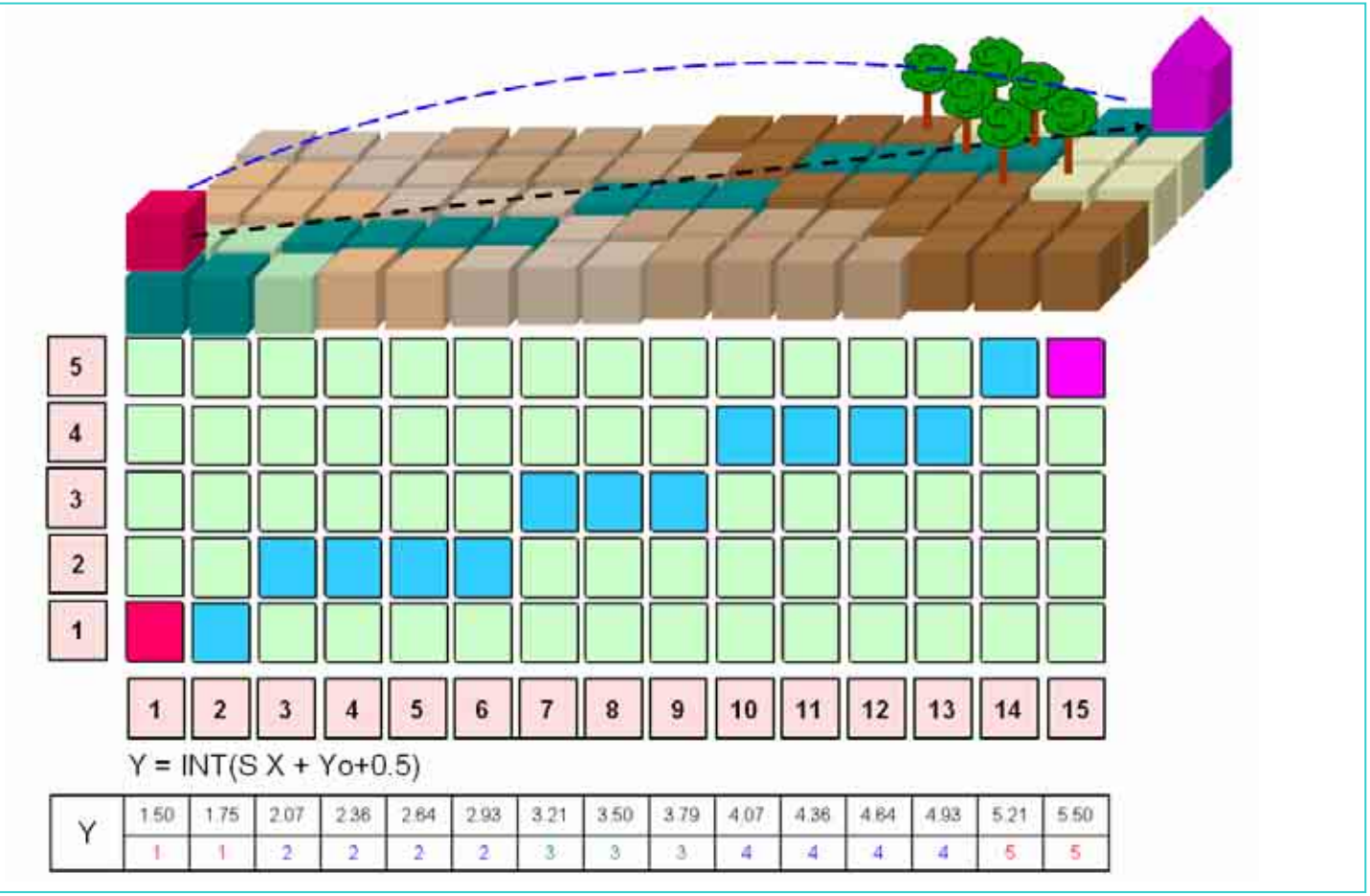
Search Method

Noise Rays

Path

Curve

Propagation Path



Y	1.50	1.75	2.07	2.36	2.64	2.93	3.21	3.50	3.79	4.07	4.36	4.64	4.93	5.21	5.50
	1	1	2	2	2	2	3	3	3	4	4	4	4	5	5

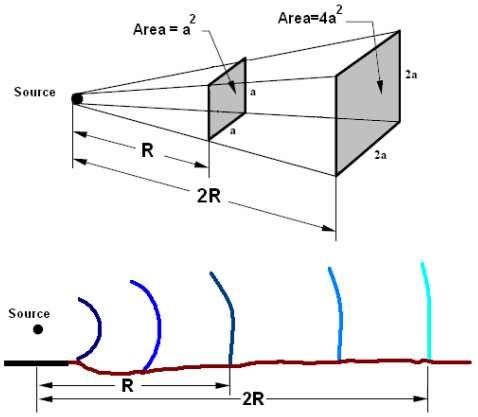
Search Method

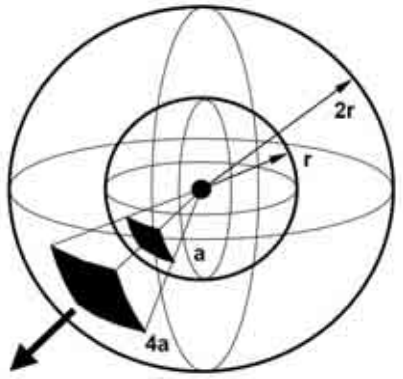
Noise Attenuation

$$NL_{\text{Reciver}} = \sum_{all-sources}^{\log} [NL - \sum_{1}^{n} (Ai)]$$

Spreading

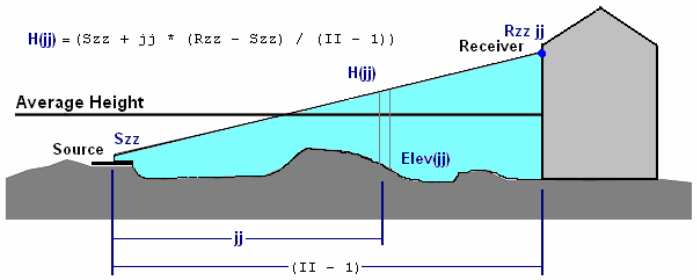
$$Spreading = 10\log(4\pi R^2)dB = [20\log(R) + 11]dB$$



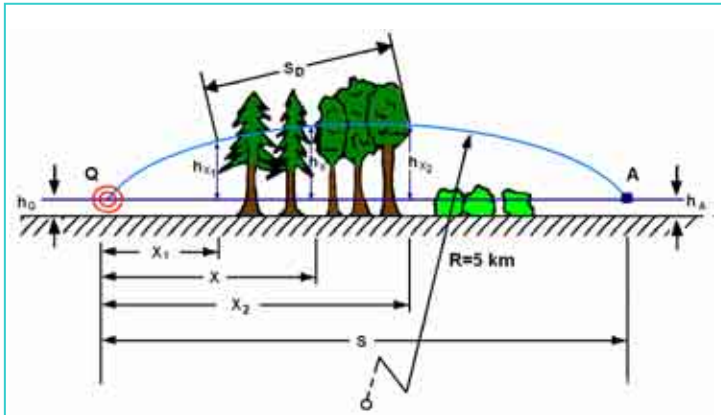


Search Method

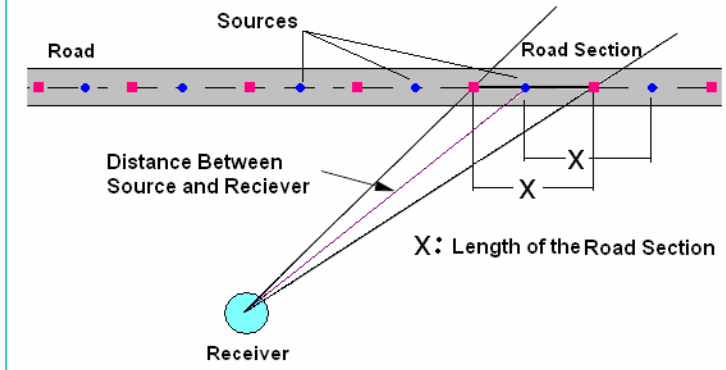
Air Absorption & Ground Effect

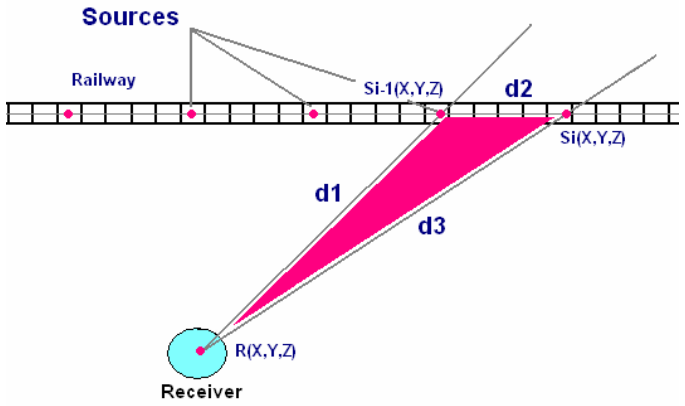


Volume Type Absorption



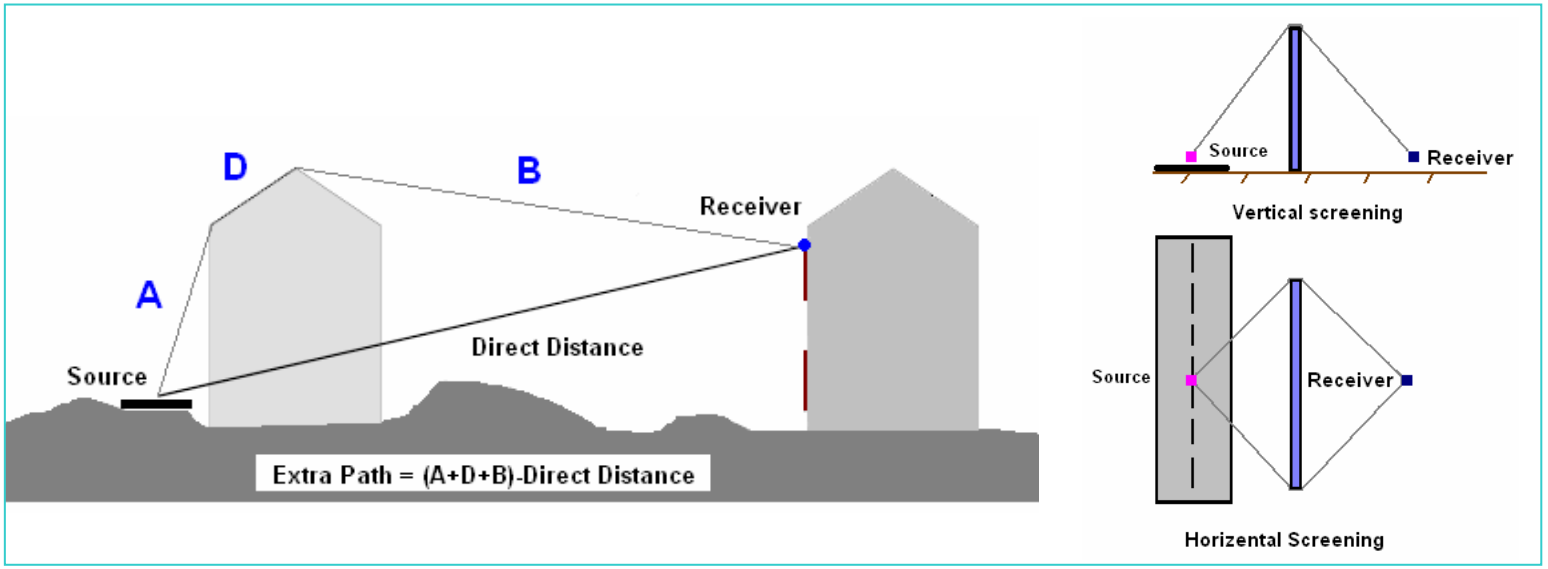
Street / Railway Section Correction

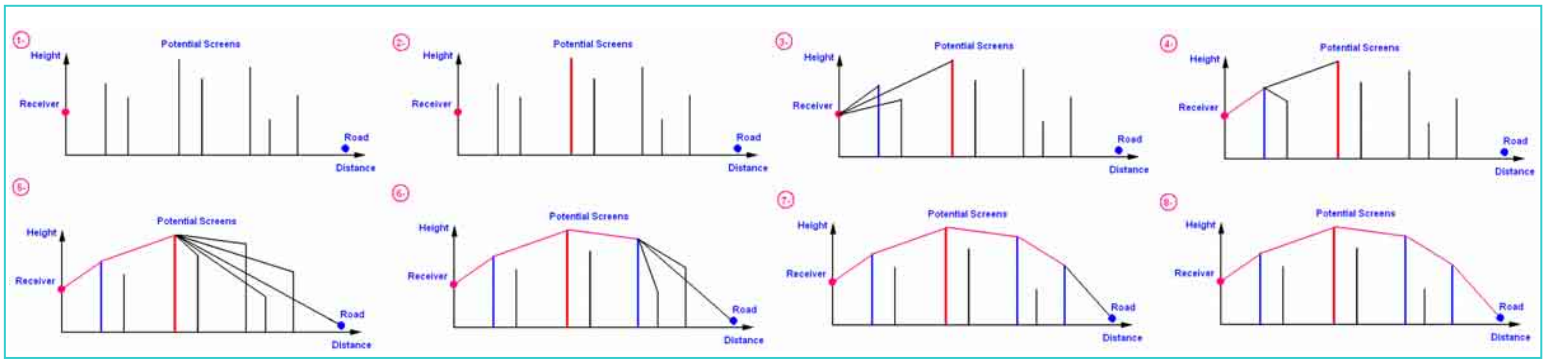




Search Method

Screening





Search Method

Results

Case 1

Case 2

Case 3

Noise Level Results

Case 1

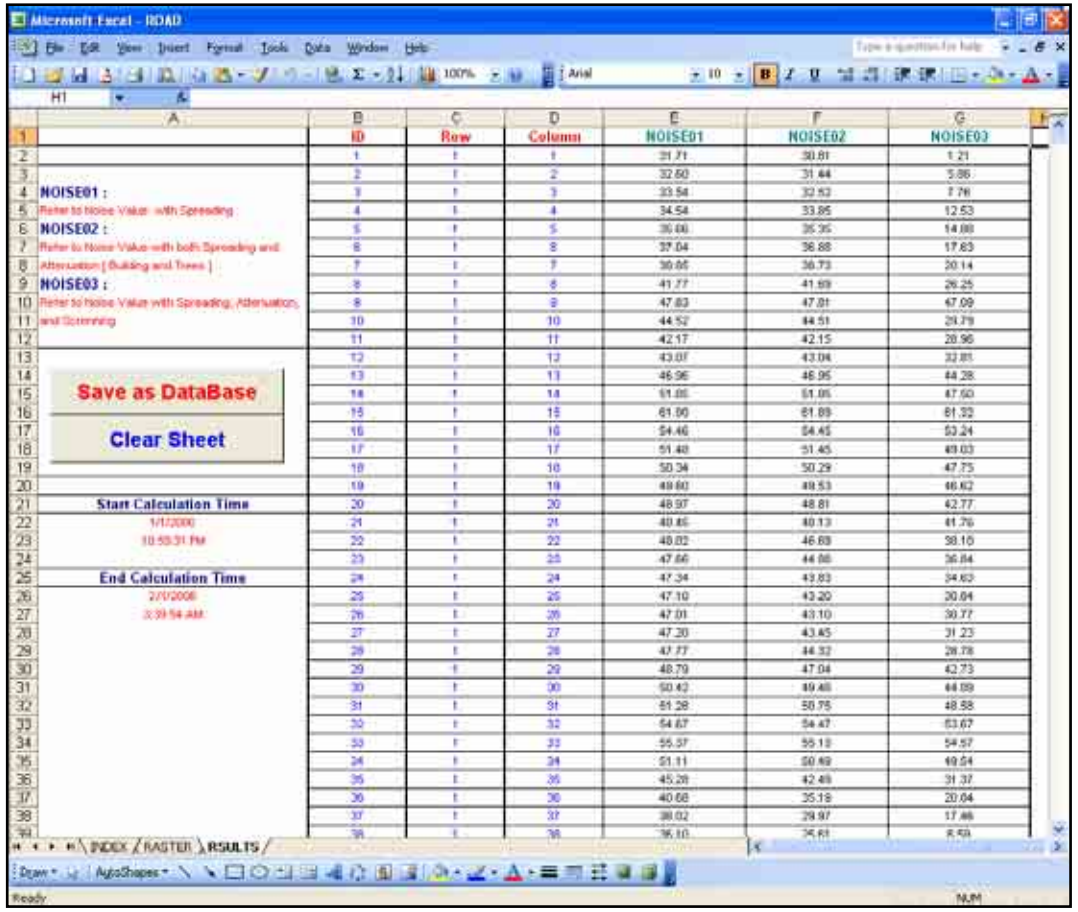
Noise Value with Spreading & Air Absorption.

Case 2

Noise Value with both Spreading, Air Absorption, Ground Effect and Volume type Absorption.

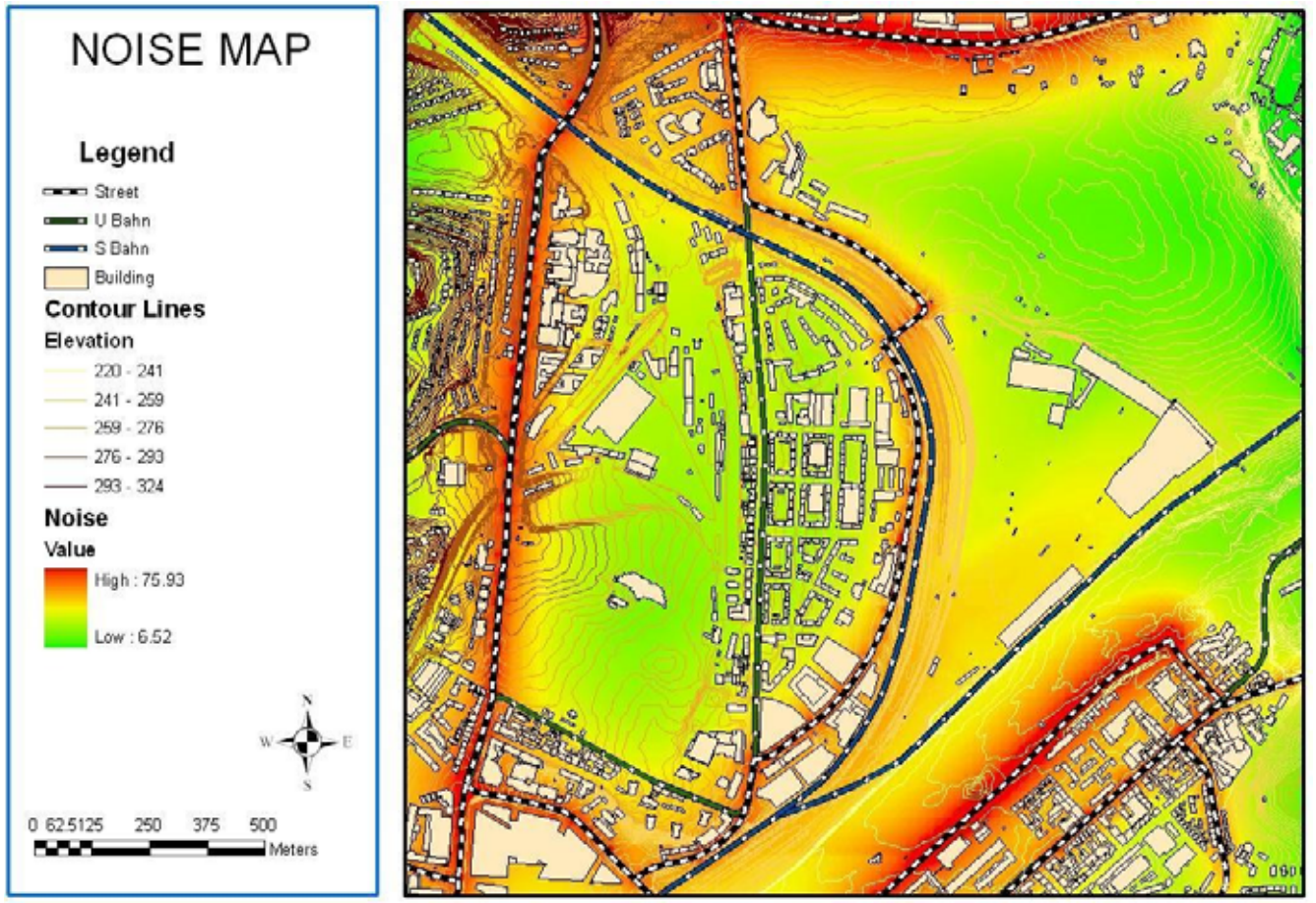
Case 3

Like Case 2 + Vertical Screening.



Results

Noise Map



Results

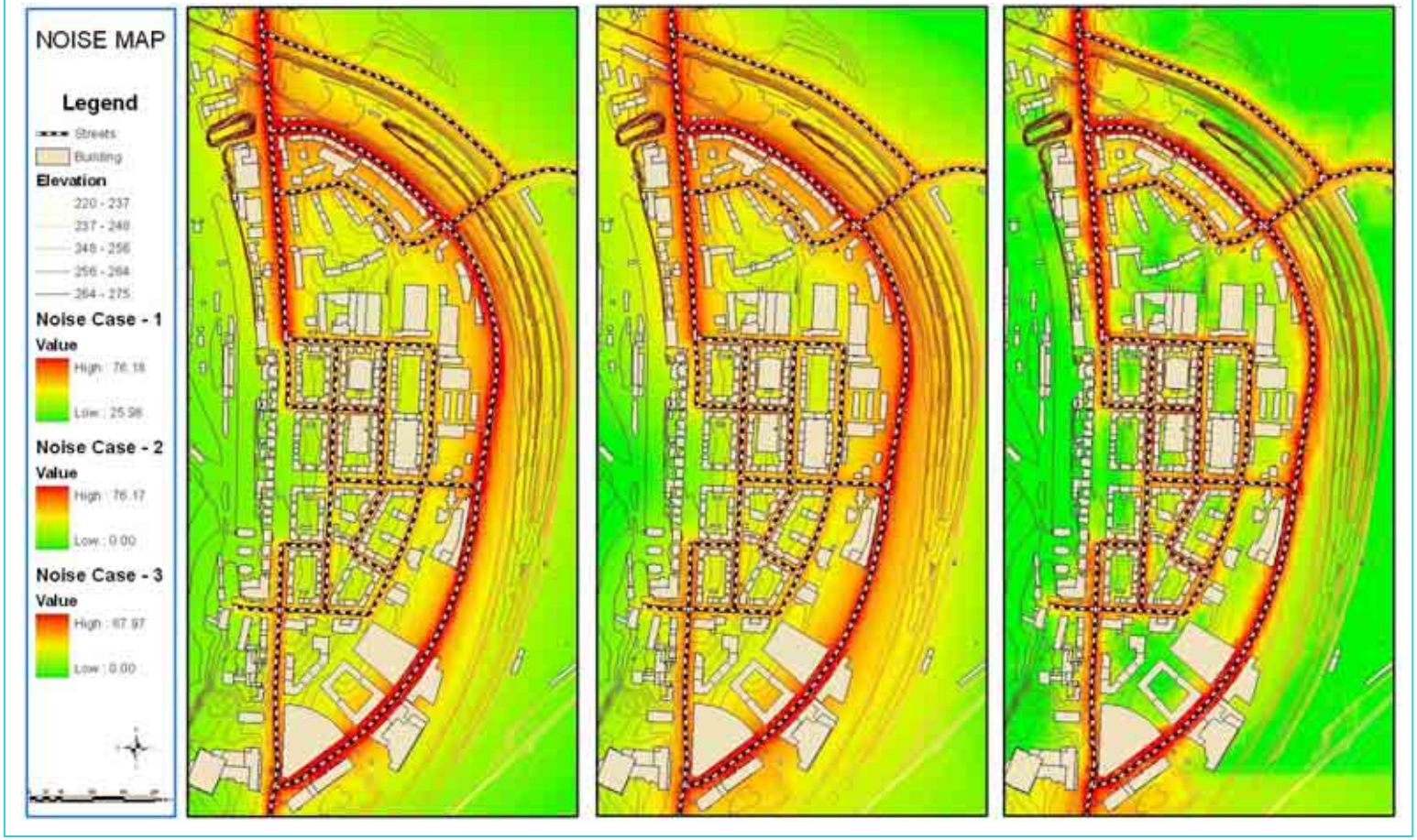
Results

Case 1

Case 2

Case 3

Results of Noise Cases



Results

Results

H = 0 m

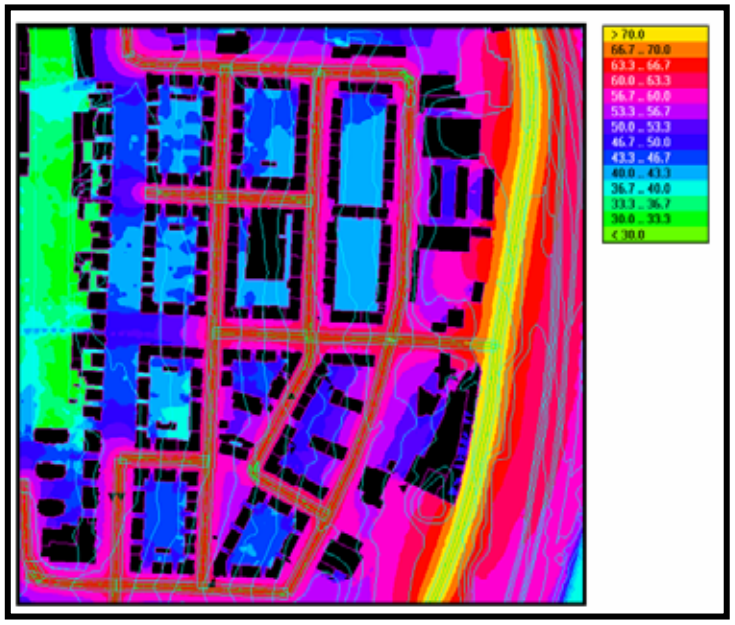
H = 5 m

H = 15 m

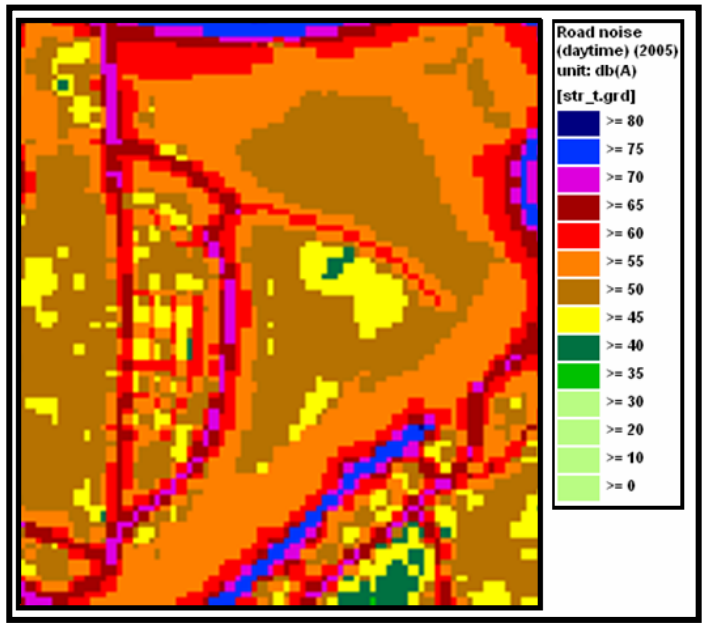
Noise at different Heights

Existing Results

Existing Noise Maps



CSTB



Stuttgart 21

Summary
What Cover
Accuracy
Problem

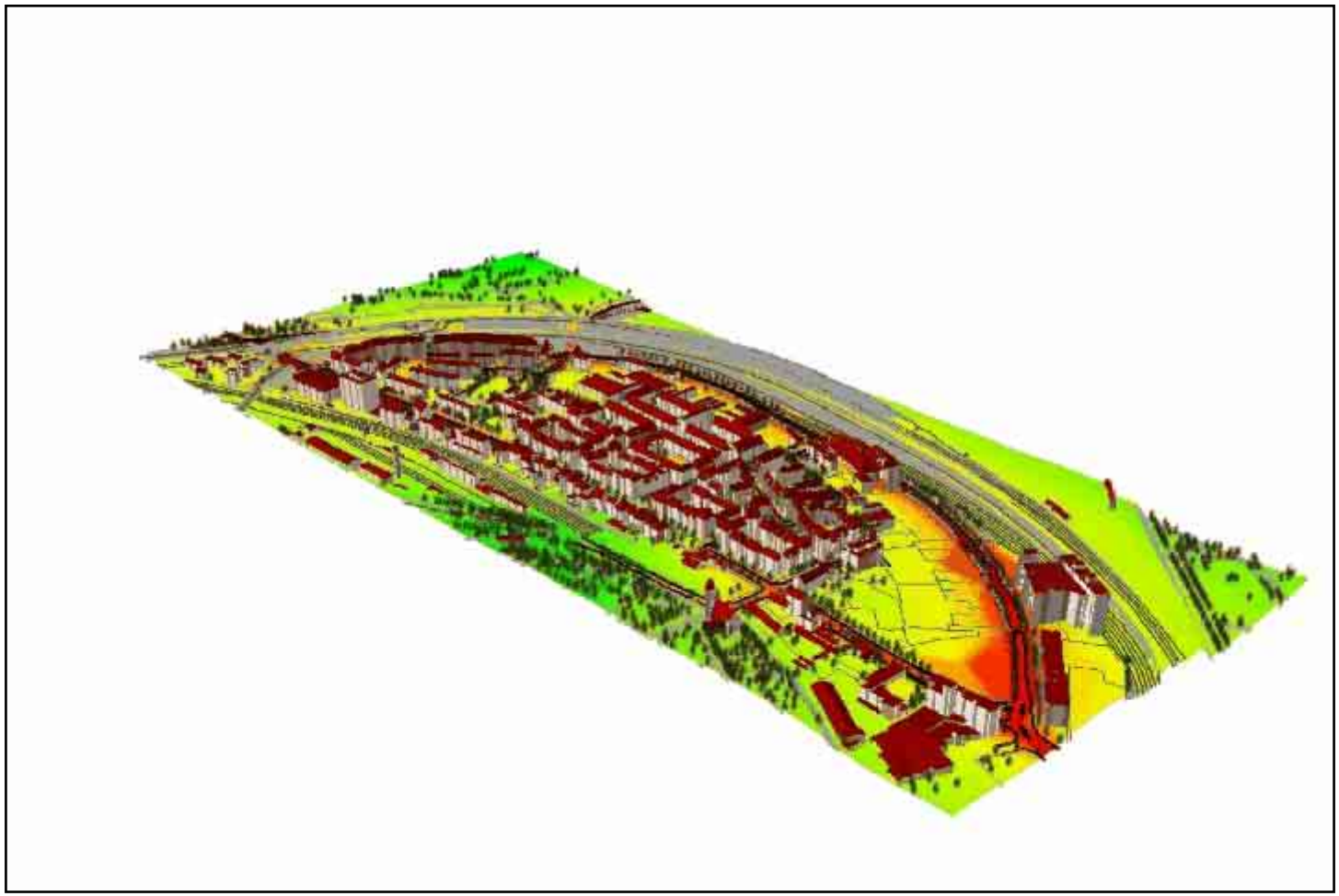
Summary

- This method does not cover Horizontal Scanning and Reflection.
- Simple and easy way to map the Noise.
- The Accuracy depend on the Receivers Distances.
- Running Time Problem

Case	No. of Receivers	No. of Sources	Running Time (Hours)	Time per one Process (sec)
R50 S50	1600	186	6.5	0.079
R 20 S50	10,000	186	44	0.085
R10 S20	8,450	297	60	0.086

  - Using Java
  - All Calculation process done behind one Button.
  - Conditional Statements to reduce the calculation process, i.e. checking the distance between the Receiver and the Source.
- Web publishing (2D and 3D Scene [VRML]).
- Air Pollution Modeling

DEMO



"Good Neighbors Keep their Noise to themselves"

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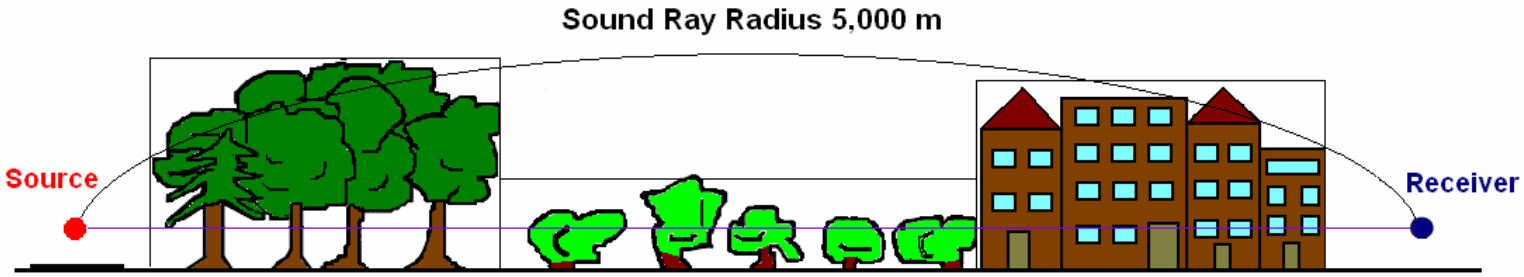
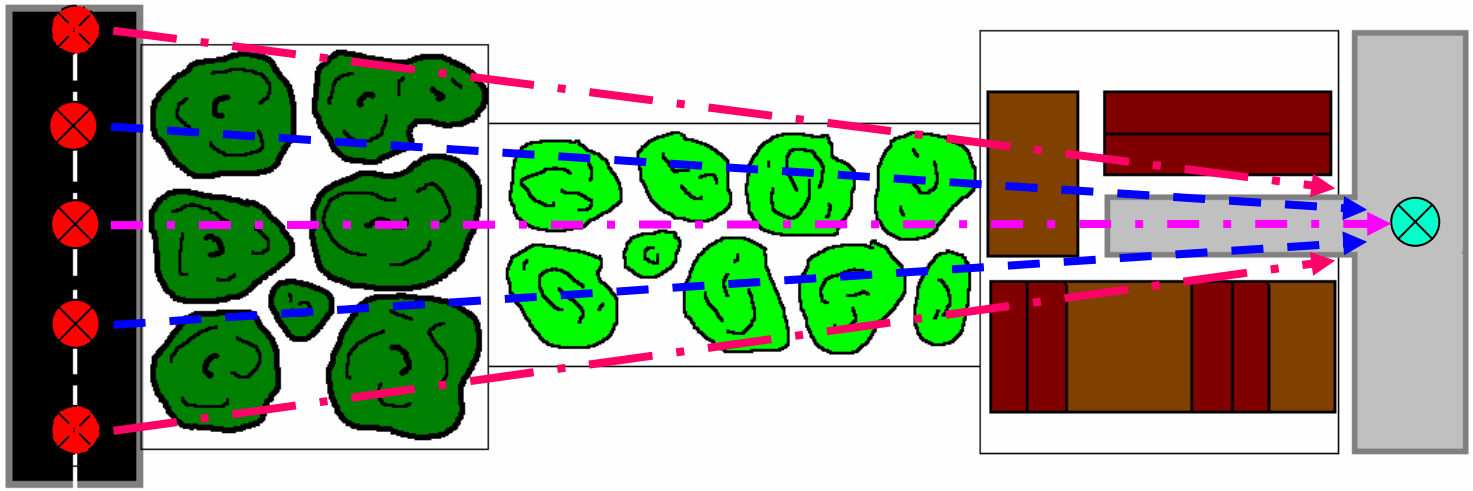
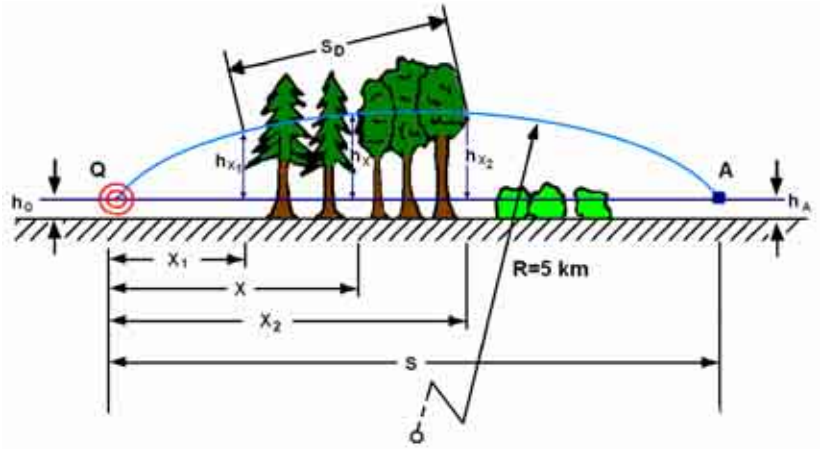
Search Method

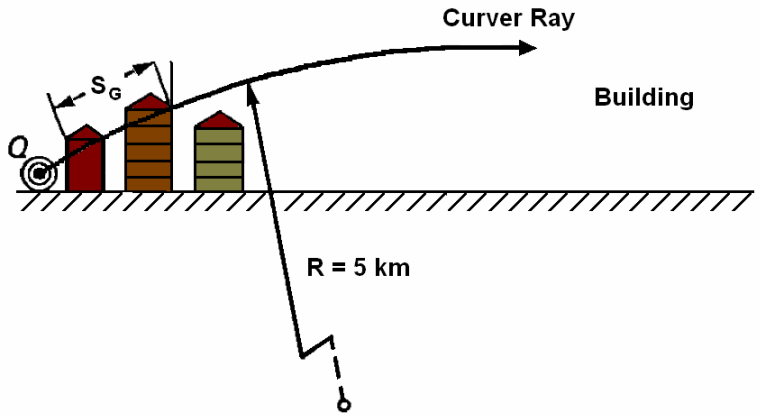




Search Method

Volume type Absorption





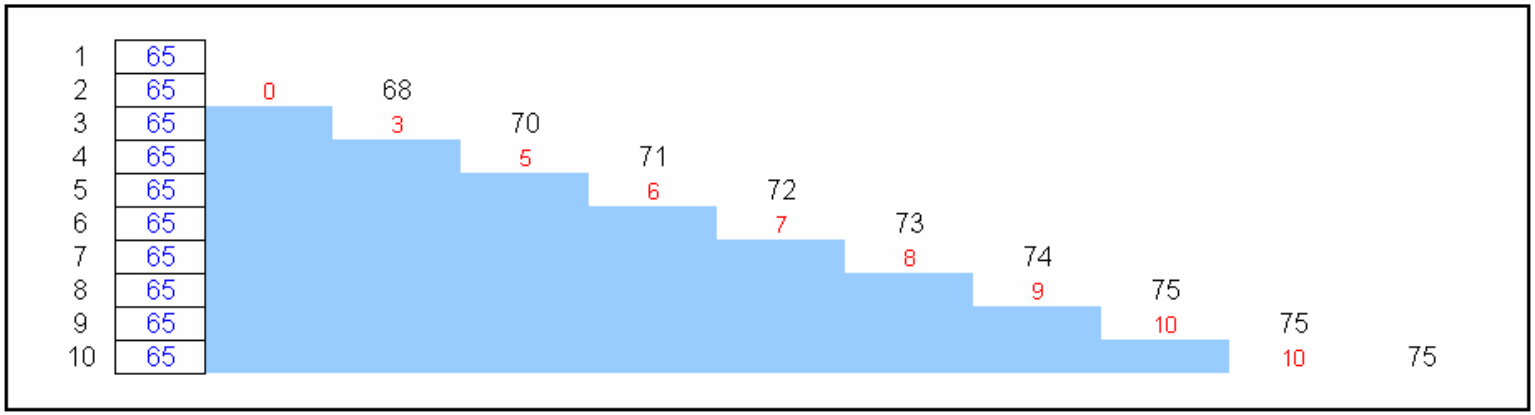
$$h_x = \frac{x(s-x)}{2R}$$

$$h_{xG} = \frac{x}{s}(h_A - h_Q) + \frac{x(s-x)}{2R}$$

$$R = 5000m$$

$$s_X = x_2 - x_1$$

Noise Addition



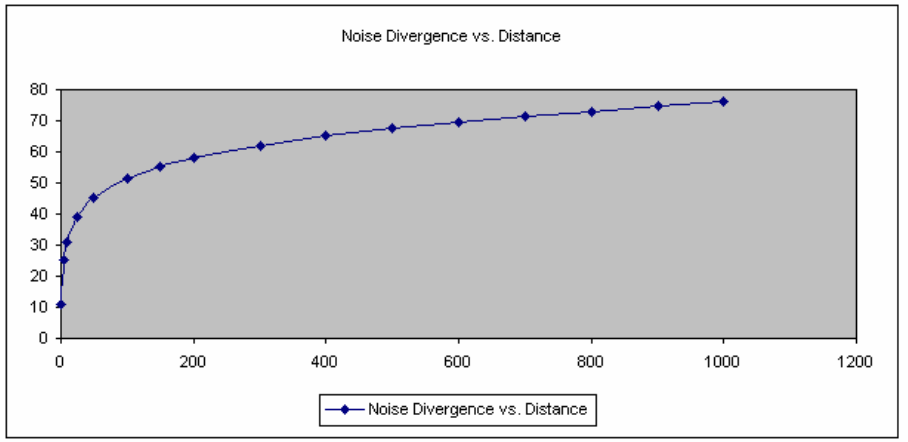
$$NL = 10.\log[10^{\frac{NL1}{10}} + 10^{\frac{NL2}{10}} + 10^{\frac{NL3}{10}} + \ldots + 10^{\frac{NLn}{10}}]$$

NL = 65 + 65 + 65 + 65 + 65 + 65 + 65 + 65 + 65 + 65 = 75 dB(A)

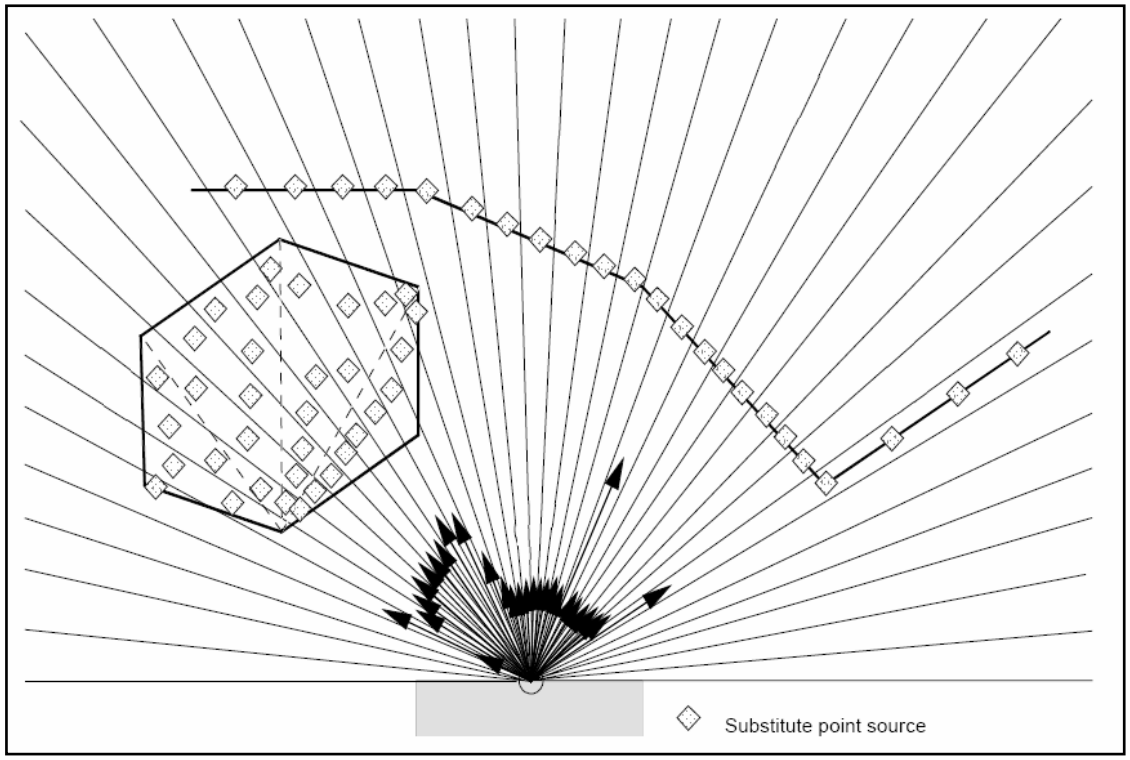
Noise Divergence vs. Distance

Noise Level **70**

Distance	Geometrical Divergence	Air Absorption	Total
1	11	0.01	11.01
5	25	0.03	25.00
10	31	0.05	31.05
25	39	0.13	39.08
50	45	0.25	45.23
100	51	0.50	51.50
150	55	0.75	55.27
200	57	1.00	58.02
300	61	1.50	62.04
400	63	2.00	65.04
500	65	2.50	67.48
600	67	3.00	69.56
700	68	3.50	71.40
800	69	4.00	73.06
900	70	4.50	74.58
1000	71	5.00	76.00



The Search Angle Method



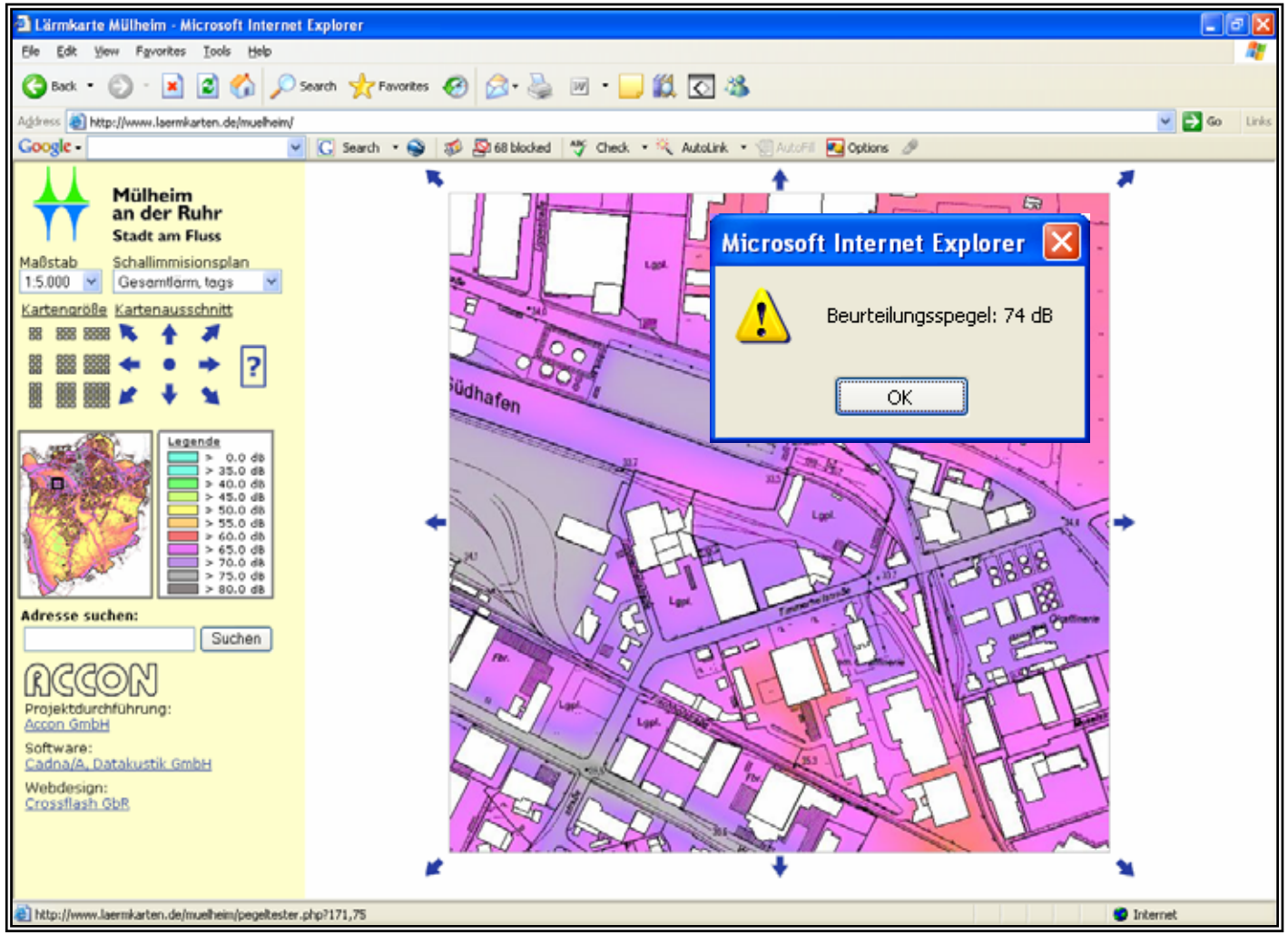
Line sources leading away from the receiver are divided so

That the condition **L< 0.5*distance** is fulfilled.

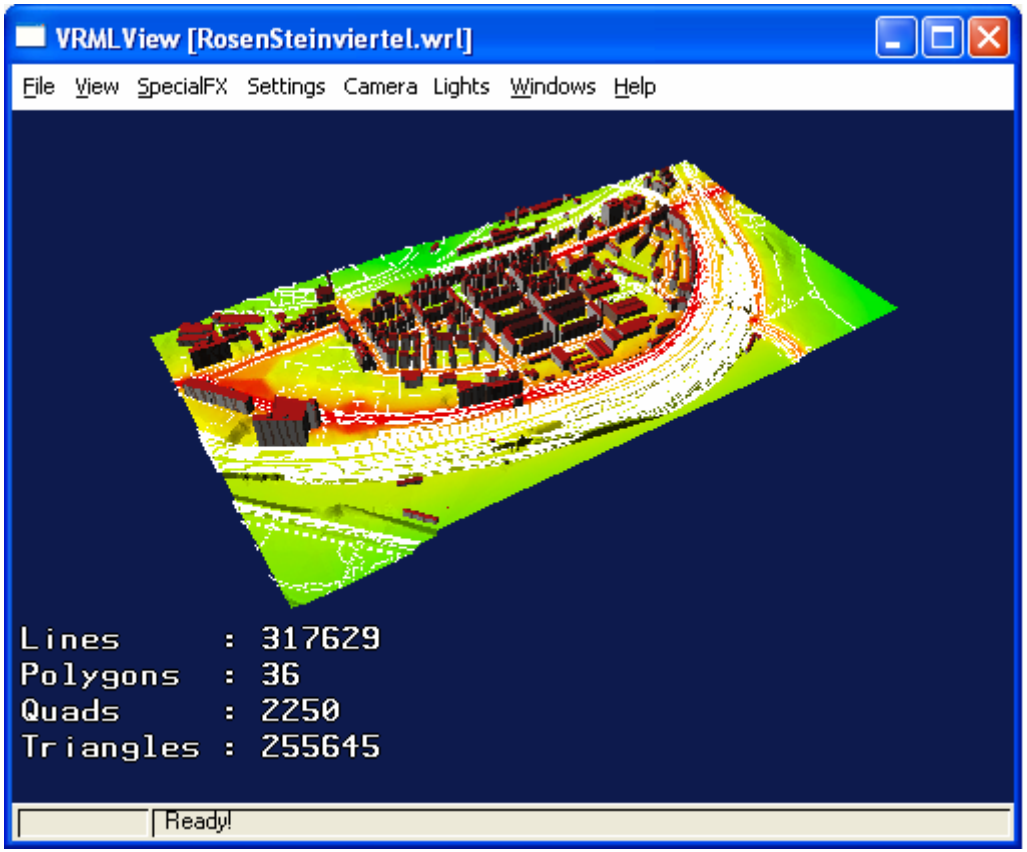
with **L** = Length of source segment

S = Distance source to receiver

Internet Noise Map



VRML


VRMLView [RosenSteinviertel.wrl]
File View SpecialFX Settings Camera Lights Windows Help
Lines : 317629
Polygons : 36
Quads : 2250
Triangles : 255645
Ready!

Quiz

-What is Noise?

Noise is defined as any unwanted human created sound.

-Write 3 Types of Attenuation Affect on Noise Rays?

- Spreading
- Air Absorption
- Ground Effect
- Screening
- Volume Type Absorption
  - Vegetation
  - Built-up
- Reflection

- Match the Following

- Point Noise Spreading → 6 dBA for Doubling of Distance
- Line Noise Spreading → 3 dBA for Doubling of Distance

-What is the Result of :

0 dBA + 0 dBA = **3**
3 dBA + 5 dBA = **7**
1 dBA + 1 dBA + 1 dBA + 3 dBA + 3 dBA = **8**