Institute of Acoustics

Noise mapping: Uncertainty in Calculation Models

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Content

- Introduction
- What is noise prediction
- What is a model
- Error propagation
- Good practice guide
- Uncertainty caused by unclear methods
- Quality assurance
- Summery and conclusion

Noise predictions

Why?
- Quantification
- Effect or impact on the environment
- Check on laws, guidelines or recommendations
- Calculations with measures (source and propagation)

Where?
- House/dwellings
- Other noise sensitive buildings/areas like: hospitals, etc.
- Offices, hotels and other places where people live, stay or work
- Nature areas, recreation areas, cemeteries, etc.

What?
- Annoyance due to noise. (Equivalent noise level at the facades)
- The L_{eq} representative for a specific facade for a long period (years)
- The L_{eq} must be reproducible.

What is a Noise Prediction Model?

Meta Model, Framework or Method

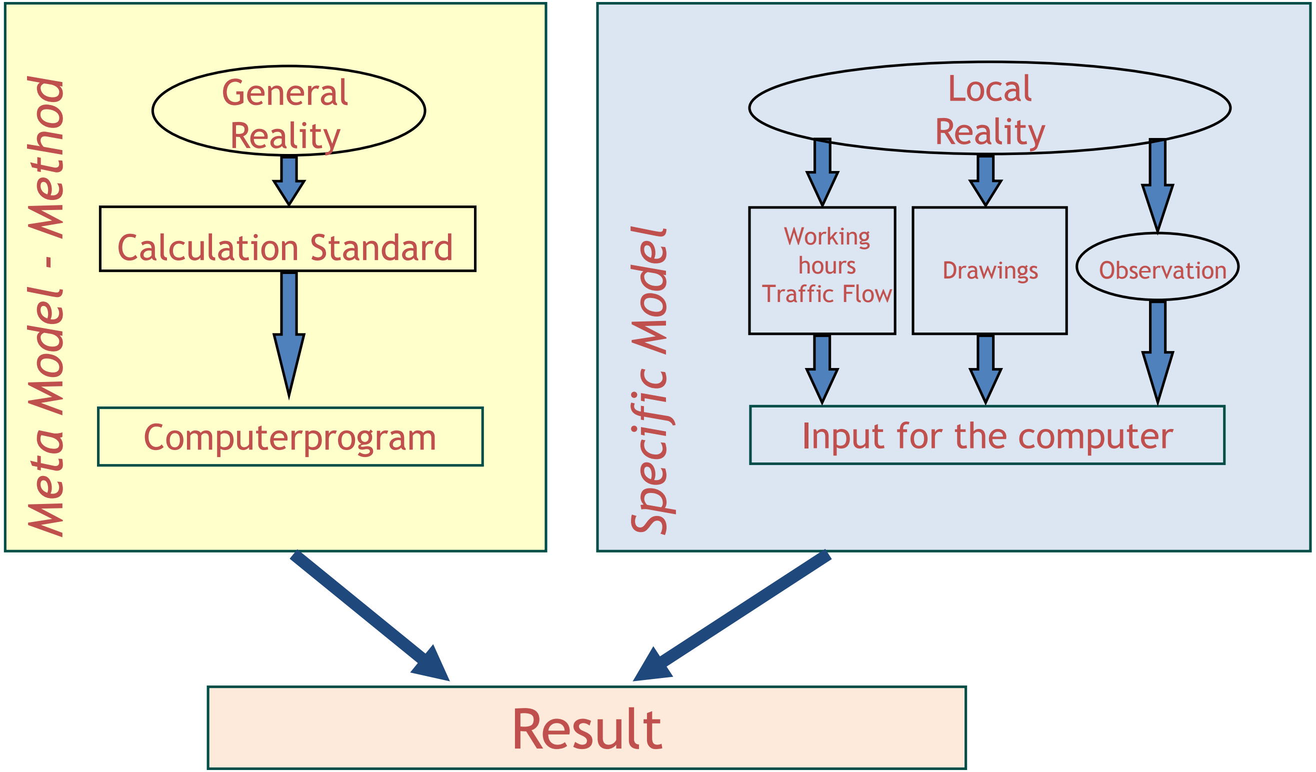
- A set of ideas for organizing a process about a particular situation:
  - ✓ General
  - ✓ Higher level
  - ✓ Conceptual
  - ✓ ‘A description of’
  - ✓ Tool

Specific Model

- A useful representation of a specific situation
  - ✓ Typical for a situation
  - ✓ Specific applicable
  - ✓ Discrete

→ Selection
→ Abstraction
→ Idealization

What is a Model?



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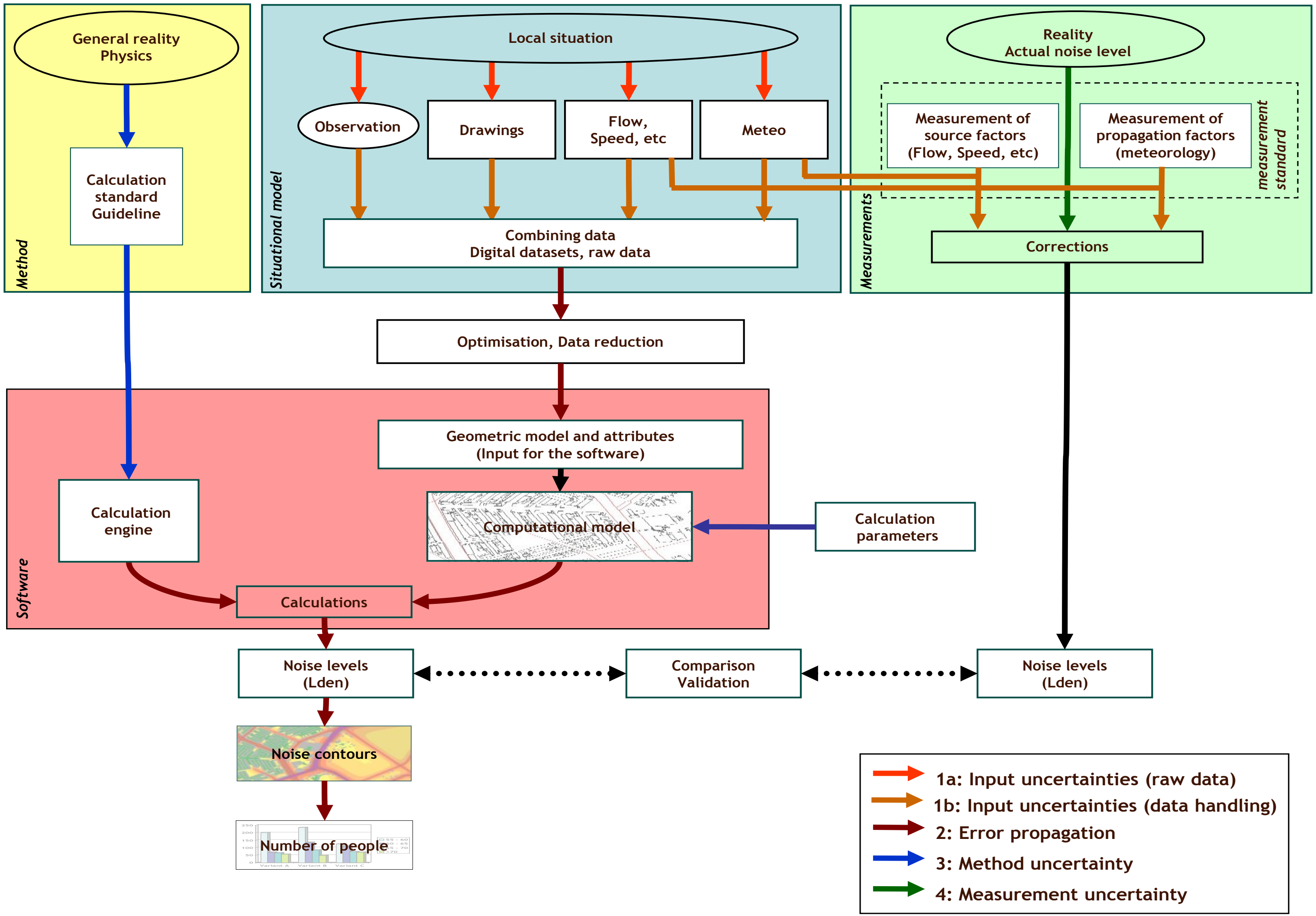


Method
General reality
Physics
Calculation standard Guideline
Situational model
Local situation
Observation
Drawings
Flow, Speed, etc
Meteo
Combining data
Digital datasets, raw data
Measurements
Reality
Actual noise level
Measurement of source factors (Flow, Speed, etc)
Measurement of propagation factors (meteorology)
measurement standard
Corrections
Optimisation, Data reduction
Software
Geometric model and attributes
(Input for the software)
Calculation engine
Computational model
Calculation parameters
Calculations
Noise levels (Lden)
Comparison Validation
Noise levels (Lden)
Noise contours
Number of people
1a: Input uncertainties (raw data)
1b: Input uncertainties (data handling)
2: Error propagation
3: Method uncertainty
4: Measurement uncertainty

Field of application

Research
For experts

For individual
objects

For areas
> 1000 inhabitants

Detailed
calculation

Assessment and
detailed noise maps

Noise mapping
(large scale)

Highly detailed data

Default values

Minimum requirements for data

More generalized data (defaults)

Punt	Geen maatr.	2 m	3 m	4 m
13	62	57	54	52
14	61	55	53	52
15	61	56	55	54
16	60	56	55	54
17	61	55	53	51
18	61	54	52	50
19	60	53	50	49

Representative and reproducible

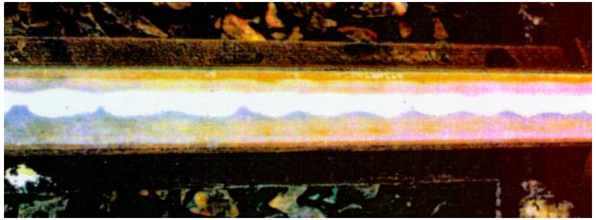
For road traffic noise this means that the calculation is based on:

- average traffic flow;
- average noise emission of cars and light and heavy trucks;
- average of the type of tyres (e.g. winter tyres);
- average speed of the traffic;
- average road surface;
- average asphalt temperature (e.g. -0.1 dB/^{o}C).

Defined meteorological situation (weather situation):

- average propagation;
- down wind propagation;
- wind direction;
- air temperature;
- humidity;
- air pressure;
- including/excluding reflections water/snow;
- etc.

Generation mechanism of rolling noise

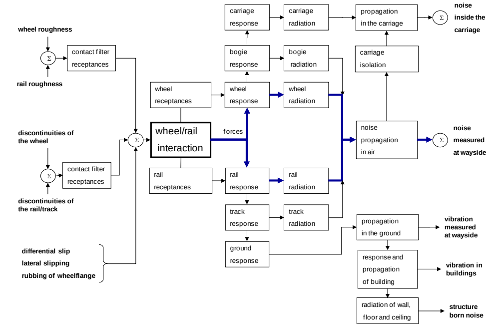


The excitation is the result of 'fine' irregularities on the running surfaces of wheel and rail.

- Roughness:
  - amplitude between approximately 0,2 μm and 200 μm.
  - wavelengths between approximately 2 mm and 200 mm.

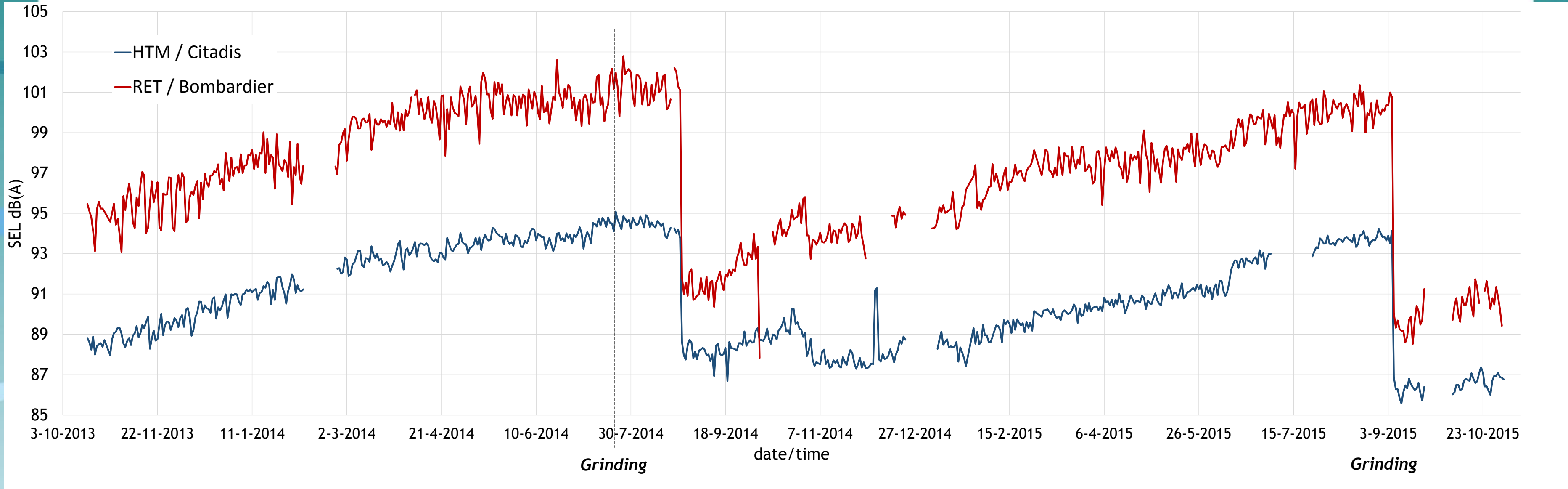
- Long-pitch corrugation:

  Visible roughness or roughness in an extreme form.



dgmr Diagram of the excitation mechanisms for noise and vibration.

Noise monitoring railway line over more than 2 years



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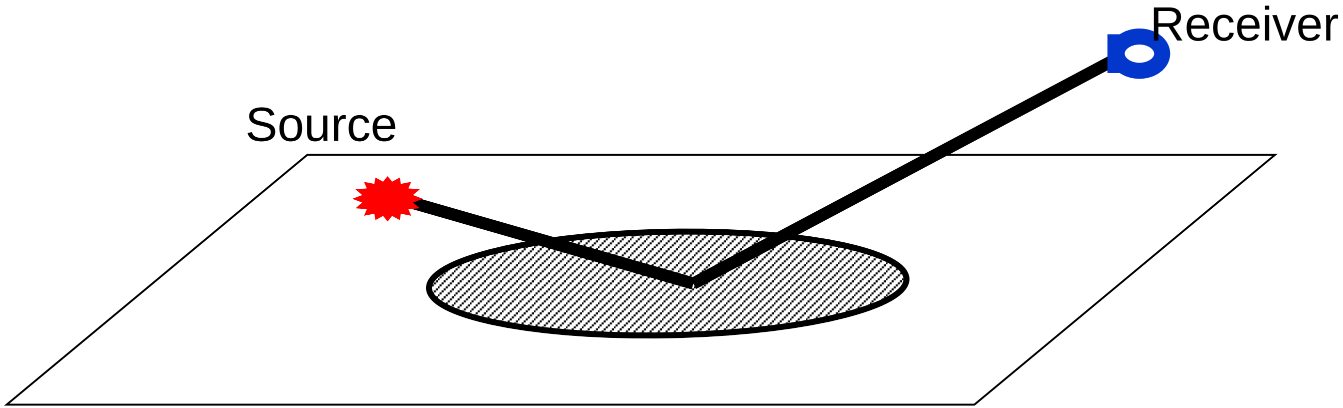
Propagation - Reflections

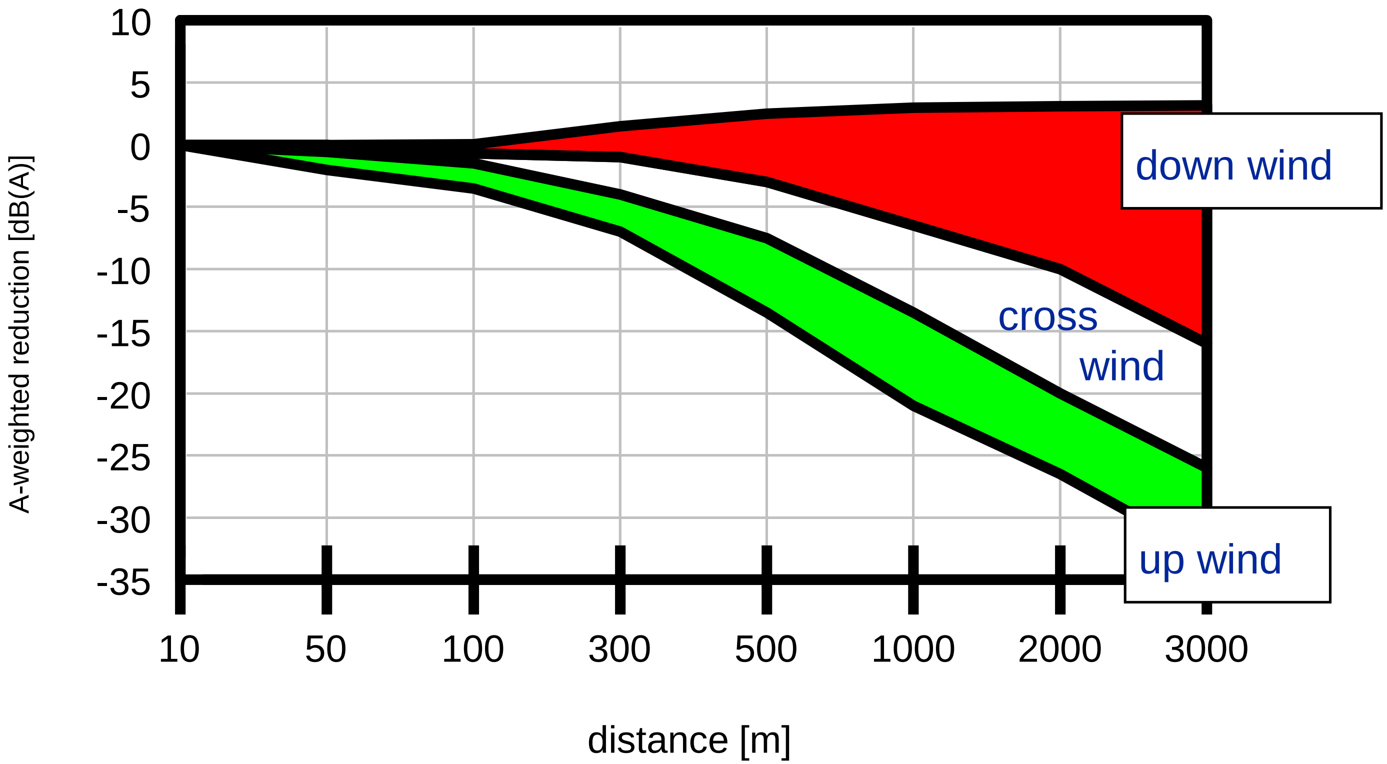





Propagation - Fresnel Zone



Influence of meteo

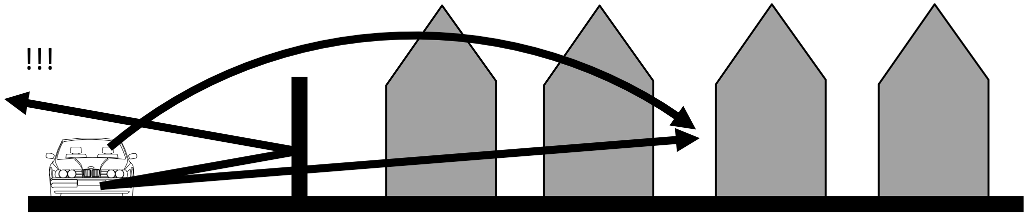


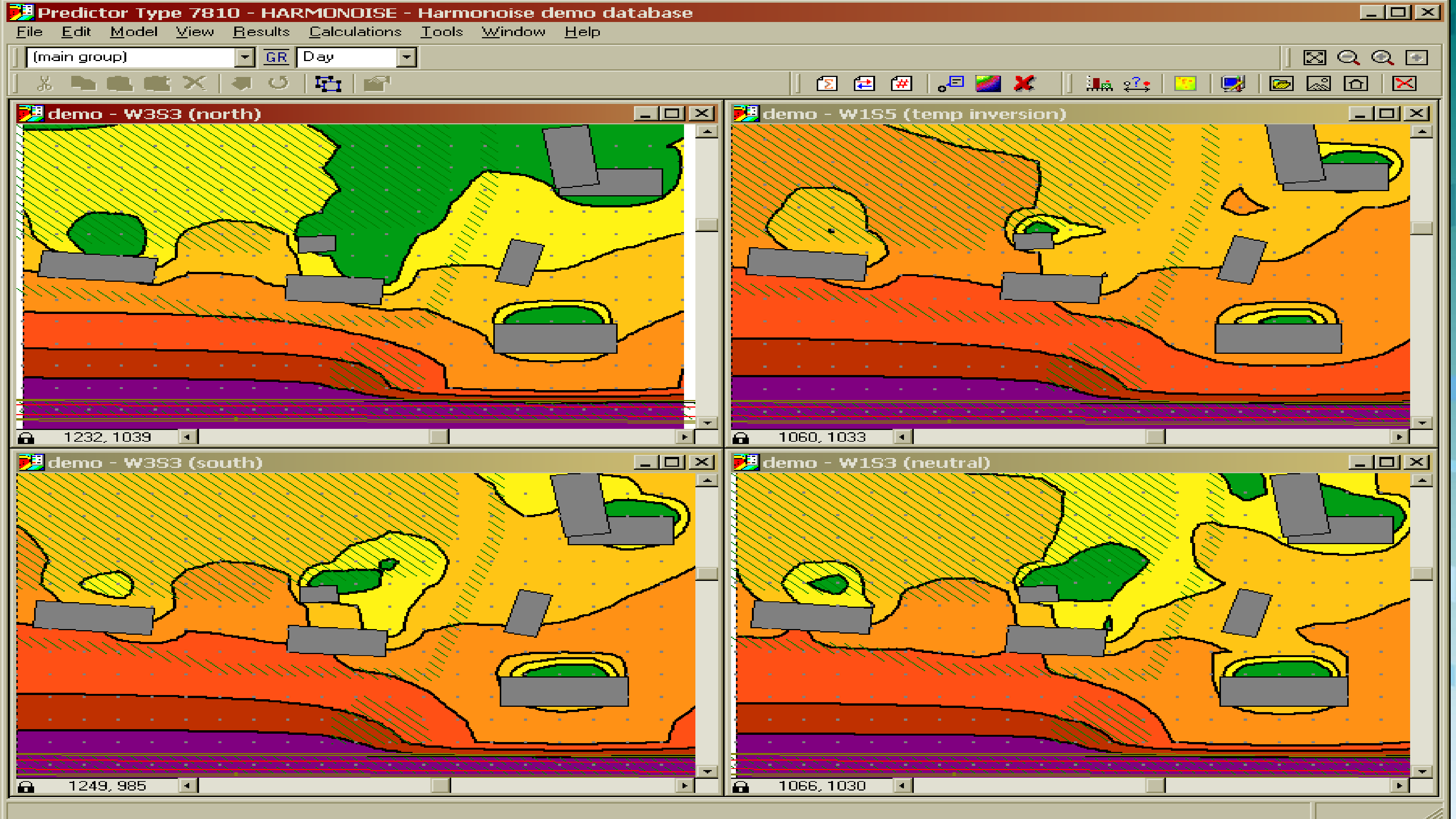
Meteorology

Ray curvature caused by vertical wind speed and air temperature gradients

Sound speed profile influenced by “macro terrain roughness”

Special attention for reflected propagation paths




Predictor Type 7810 - HARMONOISE - Harmonoise demo database
File Edit Model View Results Calculations Tools Window Help
(main group)
GR
Day
demo - W3S3 (north)
1232, 1039
demo - W1S5 (temp inversion)
1060, 1033
demo - W3S3 (south)
1249, 985
demo - W1S3 (neutral)
1066, 1030

Noise mapping process/steps

1. (GIS) Data selection
   Height lines, buildings, ground cover, roads/railways/industry, barriers etc.

2. Data validation and economization
   Missing data, wrong data, out of date, too detailed etc.

3. Calculation
   Optimization settings e.g. error margin, fetching radius

4. Results validation
   Compare with (long term) measurements

5. Results analysis
   Confront with demographic data: number of inhabitants per 5 dB noise class

6. Publication noise maps
   Web site

Good practice guide

- The user of the software
  - must know exactly what he/she is calculating
  - should be aware of the limitations of the calculation method
  - must also be aware of the sensitivities of the standard

- Other guidance for making correct calculations
  - Low flow roads and the lowest flow
  - Calculation distance for busy roads / highways i.r.t. low noise levels
  - Number of reflections….
  - Etcetera, etcetera

- Guidance for input data - Garbage in, garbage out

Item	Aspect	Group A	Group B	Group C	Group D	Group E
Ground model	Ground height, contours, TINs etc (Vertical)	<0.5m	>0.5m-<1.2m	>1.2m-<2.5m	>2.5m-<5.0m	>5.0m
	Ground height, contours, TINs etc (Horizontal)	<1.5m	>1.5m-<4.0m	>4.0m-<8.0m	>8.0m-<15m	>15m
	Profile edges (Vertical)	<0.5m	>0.5m-<1.2m	>1.2m-<2.5m	>2.5m-<5.0m	>5.0m
	Profile edges (Horizontal)	<1.5m	>1.5m-<4.0m	>4.0m-<8.0m	>8.0m-<15m	>15m
	Equal height contour spacing (Vertical)	<1.0m	>1.0m-<3.0m	>3.0m-<8.0m	>8.0m-<15m	>15m
Buildings	Vertical	<1.5m	>1.5m-<4.0m	>4.0m-<8.0m	>8.0m-<15m	>15m
	Horizontal	<1.5m	>1.5m-<4.0m	>4.0m-<8.0m	>8.0m-<15m	>15m
	Minimum Size (m^2)	<5m^2	>5m^2-<15m^2	>15m^2-<30m^2	>30m^2-<50m^2	>50m^2
	Absorption coefficient	within 10%	Use absorption classes	Use absorption classes	Reflective by default	Reflective by default
Barriers	Vertical (re road surface)	<0.5m	>0.5m-<1.0m	>1.0m-<2.0m	>2.0m-<5.0m	>5.0m
	Horizontal (re road surface)	<1.5m	>1.5m-<4.0m	>4.0m-<8.0m	>8.0m-<15m	>15m
	Minimum Height (m)	<1.0m	>0.5m-<1.0m	>1.0m-<2.0m	>2.0m-<5.0m	>5.0m
	Minimum Length (m)	<10m	>10m-<25m	>25m-<40m	>40m-<100m	>100m
	Absorption coefficient	within 10%	Use absorption classes	Use absorption classes	Reflective by default	Reflective by default
Ground cover	Ground factor (%)	<5%	>5%-<10%	>10%-<25%	>25%-<50%	>50%
	Surface minimum size (m^2)	<5m^2	>5m^2-<15m^2	>15m^2-<30m^2	>30m^2-<50m^2	>50m^2

What is a Noise Prediction Standard?

A prediction standard is:

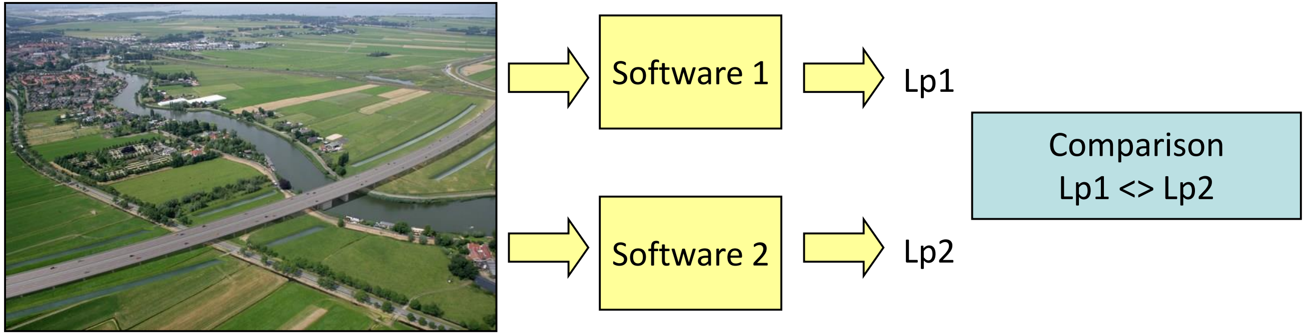
- described on paper and authorized by law, a standard or a guideline.
- not computer software.

Computer software is always an interpretation of a paper document.

The user must know exactly what he/she is calculating. The user should be aware of the limitations of the calculation method. The user must also be aware of the sensitivities of the standard.

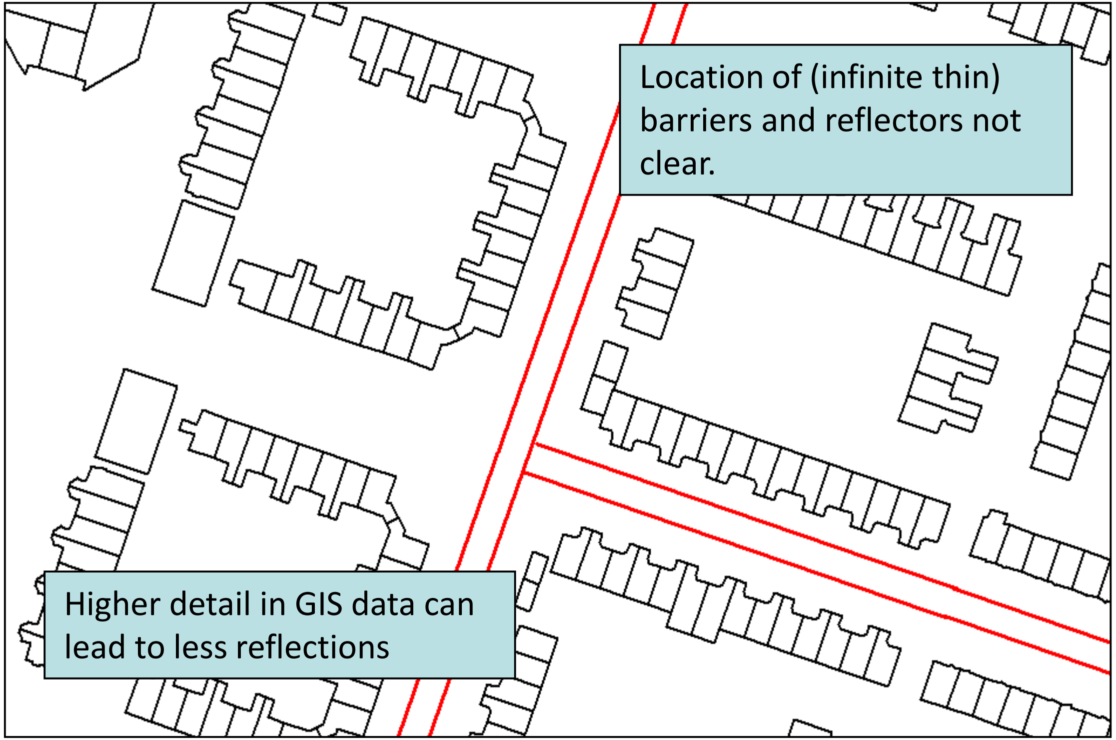
Uncertainties in the standards

- All prediction standards still contain ambiguous algorithms and unclear text.
- No guidance on converting general purpose GIS data into calculation data formatted in accordance with the standard
- This leads to significant differences between software products based on the same standard.



Uncertainties in the standards

Example unclear use of GIS data



Uncertainties in the standards

Some examples of unclear text

- “In case of parallel objects”
- “2 switches per 100 meter”
- “30% gaps along a road”
- “In case of multiple screens take the screen that has the highest screening effect”
- “Double diffraction will occur in the case of thick barriers and/or well separated objects”

Validations and quality assurance

- In most cases prediction standards do not include test cases.
- In most cases there is no official certification or validation procedure for noise prediction software.
- In most cases there is no official helpdesk available on the standard.
- In some cases authorities even ‘promote’ a certain noise calculation software as the ‘unofficial’ standard.
  As a result:
  - Black box, lack of transparency and explanation
  - Monopoly, no open market, no development

Quality assurance for noise calculation software ISO 17534

ISO 17534-1 (general introduction)

- A declaration of conformity for test cases, when available, is normative
- An estimation of uncertainty is informative.
  - This as a result of deviation from the reference configuration. E.g. optimization settings
- A quality assurance interface (QSI) is informative
  - This to exchange data in a standardized format

ISO 17534-2 (recommendations for test cases and QSI)

- 15 general test cases for 1 point source and 1 receiver are described
- For the QSI a reference is made to DIN 45687. For ISO 9613, SCHALL03 and RLS90 only

ISO 17534-3 (recommendations for interpreting ISO 9613.2)

- 19 detailed test cases for ISO 9613.2

ISO 17534 – 3 Recommendations for interpreting ISO 9613.2

- In the working group of ISO no general consensus regarding ISO 17534-3. As a result some countries (UK, NL DK,…) voted ‘no’ to the final proposal. However the standard was accepted anyway because of the large number of countries that did not vote. (default vote of ‘yes’).

- As a result DGMR is questioning the ISO 9613 recommendations and therefore in the DGMR software the user can select the following settings
  - **According** to ISO 9613.2
    This is the original ISO 9613.2 implementation.
  - With **reasonable suggestions**
    This is an adapted ISO 9613.2 implementation with those recommendations that were supported by all (active) members of the ISO 17534 working group.
  - With **suggestions in discussion**
    This is an adapted ISO 9613.2 implementation supporting all recommendations including the ones without consensus within the ISO 17534 working group.

Summery and conclusions

- What is noise prediction and noise mapping
- Field of application
- Error propagation
- Good practice guide
- Software is not the same as an calculation standard
- Uncertainty caused by unclear methods
- Quality assurance for noise calculation software ISO 17534

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Thanks for your attention

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