

CityGML in Environmental Simulation Environmental Impact Assessment (EIA) Noise and Air Pollution Practical Experiences and potential future demands

Presented by

Hardy Stapelfeldt, Stapelfeldt Ingenieurgesellschaft mbH



Company Background

- **Stapelfeldt Ingenieurgesellschaft (SIG) was established in 1992
Softnoise GmbH (joint venture with DGMR) in 2006**
- **Initial focus of SIG on development of software
for Thermal Building Physics and Environmental Simulation
(noise, air pollution, solar radiation)
Product: LimA
Modular concept interfaces with 3rd party products:
Predictor-LimA, LimArc, ODEN, SAOS-LimA**
- **Partners**
 - Brüel&Kjaer, Denmark (measurement instruments, aircraft noise surveillance)
 - DGMR bv, Netherland, (software development and consultancy)
- **Development partners**
 - DGMR Software bv, The Hague
 - IVU Umwelt GmbH, Freiburg
 - NGIS Ltd., Hong Kong
- **Consultancy**
 - setting up model data for environmental simulation
 - environmental impact assessments



Legal requirements for noise mapping

In 2002 EU Environmental Noise Directive (END) set up demand for Europe wide assessment of population exposure to noise

- **Assessment in 5 year intervals**
- **Simulation model data must be less than 2 years old**
- **Relevant major traffic, depending on “traffic” criteria**
 - in 2007: 6 Mio cars or 60000 trains per year
 - in 2012: 3 Mio cars or 30000 trains per year
- **Agglomerates, depending on “inhabitant” criteria**
 - in 2007: 250000 inhabitants
 - In 2012: 100000 inhabitants

**Supporting LANUV (NRW) in 2007 and 2012
in setting up noise maps and statistics for END reporting**

In 2012 SIG also supported END Noise Mapping in

- **Federal states of Hessen, Thüringen, Sachsen, Mecklenburg-Vorpommern**
- **Grand Duchy of Luxembourg**

**Initial data in CityGML was partly available in Hessen
and fully available in NRW**

NRW Noise Mapping Concept

Partners: Interactive Instruments (ii), Bonn + IGG Bonn University

Initial data refinement

- **Initial data collected from various sources and stored on Xtra-Server, ready for download as well as upload via WFS-T, WCS**
- **Data refinement by ii with help of FME tools**
- **Data refinement by SIG with help of LimA macros.**
Data refinement as well as quality analysis was based on predefined processes defined in LimA macros.
Both kind of processes require pre-knowledge of actual data situation
- **Final quality check by IGG, bases on outlier analysis, i.e. not requiring pre-knowledge of actual data situation**

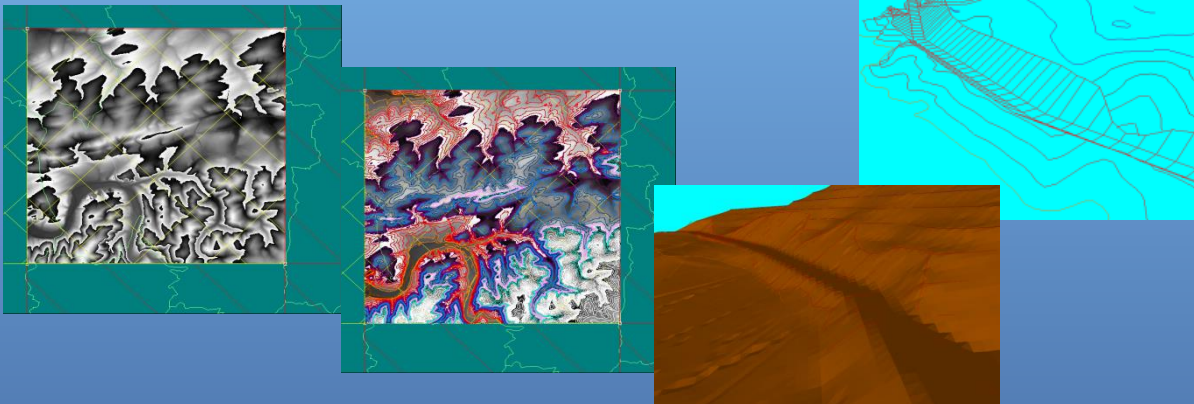
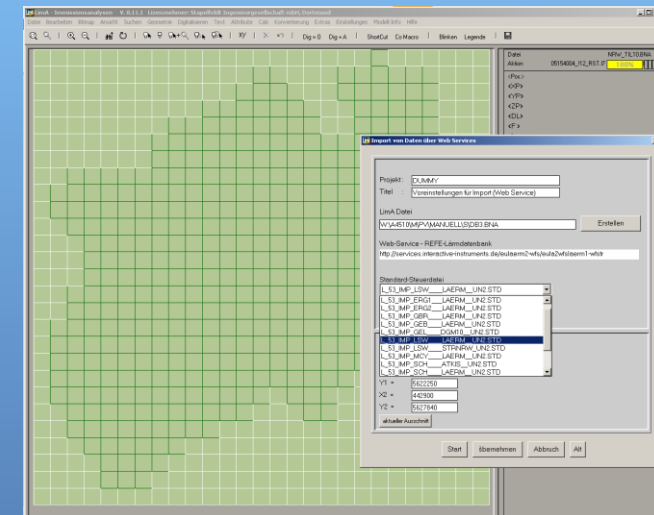
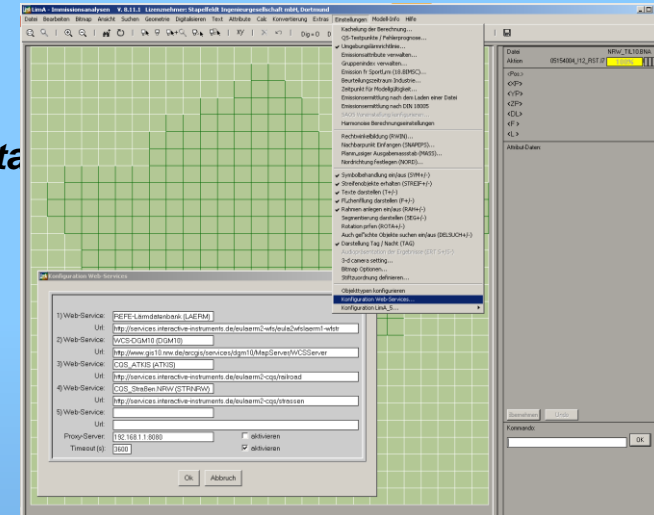
Terrain refinement

Processing steps:

1. **WCS providing terrain grid data**
2. **Contour lines are generated and simplified to reduce data**
3. **3-d road data is merged together and near road terrain is reshaped**
4. **Breaklines represent new near road terrain (implemented in CityGML during 2007 NRW project)**
5. **Breakline regions define effected areas**

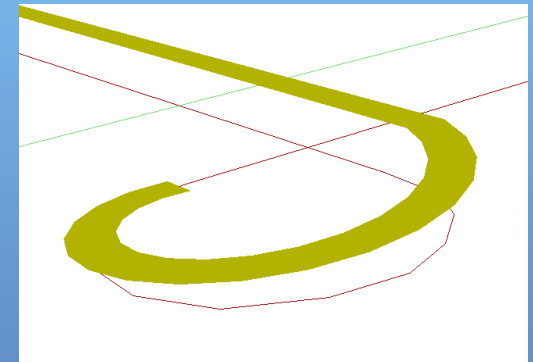
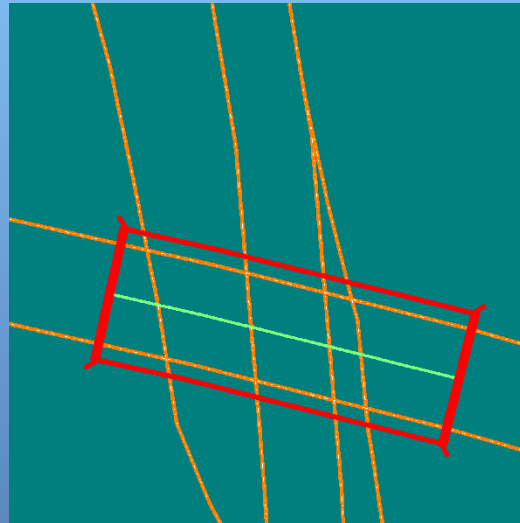
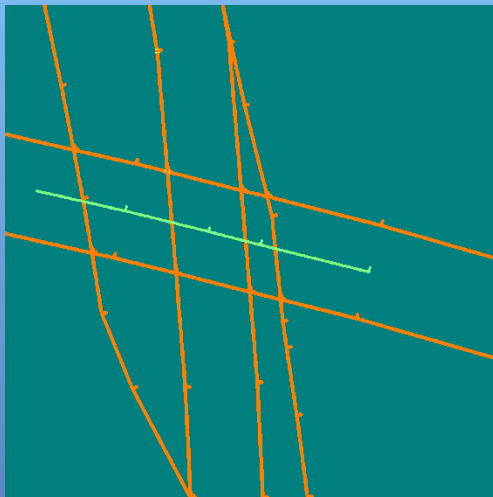
Parallel processing

1. **Process described above organised in LimA macro**
2. **Macros runs on multiple parallel instances for 10 x 10 (km) tiles, with ~ 400 tiles for the total region**



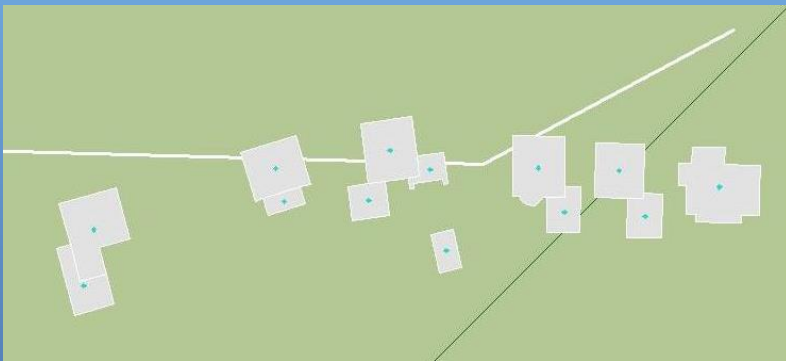
Bridge refinement

- Only bridge centre lines were available
- Automatic recognition of roads related to bridge
- Width of bridge taken from road data
- 3-d surfaces generated and stored in new a CityGML object type



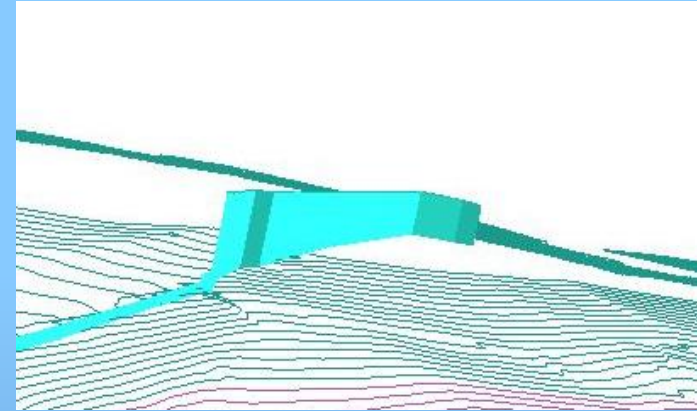
Initial data refinement

- False terrain data was erased based on position of bridge centre lines
- False screen positions were re-arranged (in a pragmatic manner ensuring min. distance to buildings)

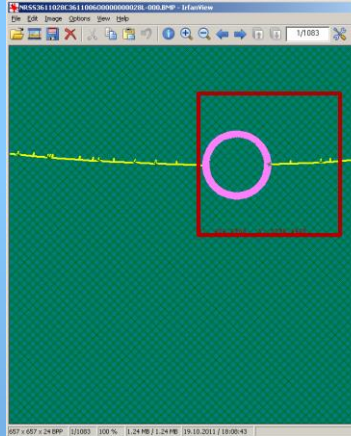


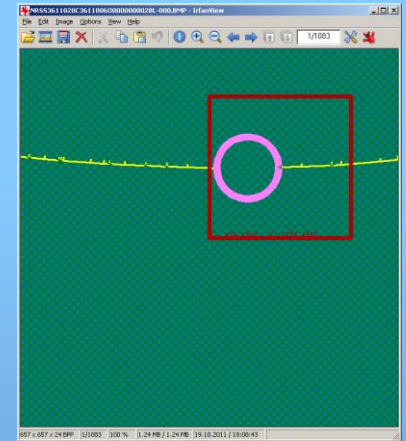
Initial data refinement

- Unrealistic screen heights
- Unrealistic heights of earth walls checked against height of neighbouring road under assumption of max. slope gradient 1:1.5



Refinement process audit trail

- **General login of GUI user action or macro data manipulation in session related log file**
 - **Automated screenshots of critical situations or automated corrections.**
 - In some instances up to 1000 bmp were generated with geo-referenced list of warning
 - KML was used to communicate via telephone a web visualisation
 - **Object related logging of manipulations was stored in attribute MODI**
 - MODI takes a string of brief keywords separated by special character:
`<MODI> -DF:V-DF:SH0-`
`-DF.V-` default speed limit assumed for road object
`-DF:SH0-` Missing 3-d height substituted by height of 0 m above terrain
 - Separate project related XLS file, contained all keywords introduced by any of the project partners
 - **An attribute like MODI might be of general interest for all kind of CityGML objects, which are subject to modifications**
 - The list of keywords will be project related and might best be part of the total data set
- 
- The screenshot shows a software window titled 'H:\SCL\110208\361100600000000206_0000.bmp - GifView'. The main area is a green textured surface with a yellow line running horizontally. A red square highlights a pink circle on the right side of the image. The status bar at the bottom indicates '507 x 457 x 24 BMP', '32000', '300 %', '1.24 MB', '1.24 MB', '16.10.2011', and '10:06:43'.



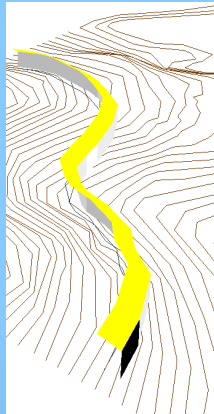
Attributes of general interest

During project work we found a number of additional attributes which might be of general interest

- **DATS, DATT** **Start und Termination time of object**
 - Easy approach for time stamp based simulation
- **QUE** **Origin of data (Lineage in CityGML)**
 - Who will provide new data?
 - Whom to inform about problematic data?
- **CEXP** **Local communities had the chance to revise data**
 - exported as SHAPE (NRW)
 - accessible as project related sub-set of total model in ODEN for editing in WEB
 - Revised data needed to be uploaded into central data base
 - Export notification per object
 - 0 → object may be delete from data base
 - 1 → object kept unchanged
 - 2 → update request form object, already existing in data base
 - 3 → insert request for newly introduced object

Principle Considerations on GML usage

- **Geometry is typically stored as 3-d geometry.**
Consider a 3-d cantilever barrier system in undulating terrain:
 - 3-d geometry is complex
 - 3-d geometry might be revised several times during planning
 - 3-d geometry can easily be generated from a base line and few parameters**Can we keep construction parameters as attribute information?**



- **Data standards like to provide strict rules for attributes and content.**
When several partners jointly work on a central data set, it would be highly desirable to use extra attributes and content on a preliminary basis.

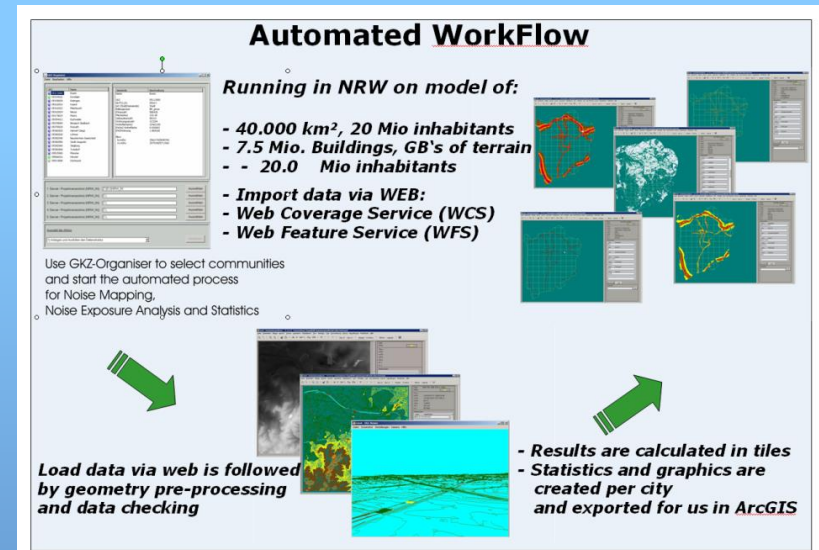
A general attribute available in all relevant object types, which takes any lengthy string content, will enable us add project related capacities for a limited period.

- **The Noise ADE will so far support German regulations for END noise mapping, i.e. VBUS, VBUSCH, VBUF, VBEB**
- **Development of a common European noise assessment method (CNOSSOS) is progressing – and SIG is involved in this.**
New methods should be supported by an enhanced NOISE ADE in time.

LimA workflows

Finally the total set of CITYGML based model was used in calculation
After a manual selection of relevant communities a LimA macro based workflow performed a range of steps:

1. Import CityGML data via WFS and WCS
2. Convert to LimA internal data and perform refinements on top of standard requirements of DIN 45687 QSI format
3. Arrange tiling structure 1 x 1 (km) for parallel calculation
4. Calculate in parallel on 8 client processors:
10 m grid + façade levels + random quality check
5. Generate graphics of results
6. Calculate population exposure
7. Write CSV file with statistics per community
8. Store statistics in CityGML “Municipality” object and update central data
9. Convert results per indicator (LDEN, Lnight) for dissemination to public
 1. ASC grid results
 2. SHAPE of exposed areas
 3. SHAPE of façade results



Synergy effects in environmental simulation

Already the existing Noise ADE offers synergy effects

- **Simulation of noise as well as air pollution propagation may be based on similar initial data with reasonable accuracy, i.e. pollutant emission can be estimated on traffic data information available in the Noise ADE**
- **More detailed road traffic information (extra attributes) might improve determination of air pollutants**
- **More detailed building geometry might improve air pollutant propagation analysis**
 - **LOD 1 is fine for noise propagation analysis**
 - **LOD 2 may be more useful for micro scaled air flow analysis**
- **Shadowing effects can be estimated on the same sort of model**
 - **Compare impact of height noise screen in North-South direction:
Advantages in noise abatement vs. significant shadowing effect in winter**

CityGML in Environmental Simulation

Thanks for listening

