ETH zürich

Assessing the impacts of noise emissions of land-based mobility in Switzerland

Calculating a Swiss Noise Footprint induced by land based mobility needs of private households

Presented by Samuel Schiess

Stefano Cucurachi (Leiden University), Samuel Schiess, Andreas Froemelt, Stefanie Hellweg

ESD ecological systems design

Content

- Current situation of including noise impact into LCA
- Noise impact model
- Calculate a Noise Footprint for Switzerland
- Results Noise Footprint
- Electrical cars scenario
- Outlook and questions

Current situation of noise impacts in LCA

- Substantial part of the damage to human health
- Quantification possible
- Noise defined as unwanted sound
- Sound power level measured in dB or W
- Over a time period measured in J
- For road-based mobility: propulsion and rolling noise

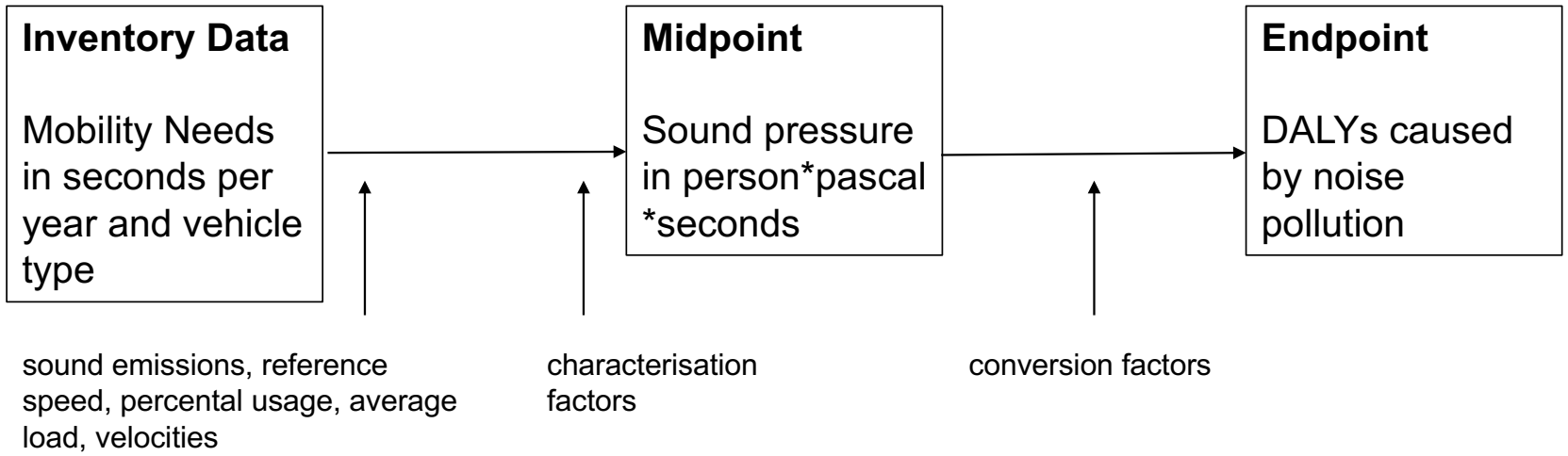
Current situation of noise impacts in LCA

- Work of the CNOSSOS report
- Several papers about measuring the noise impact
- No application to effective impacts
- Possibility to include noise as a usual measure in LCA (e.g. transport processes)

Noise Impact Model

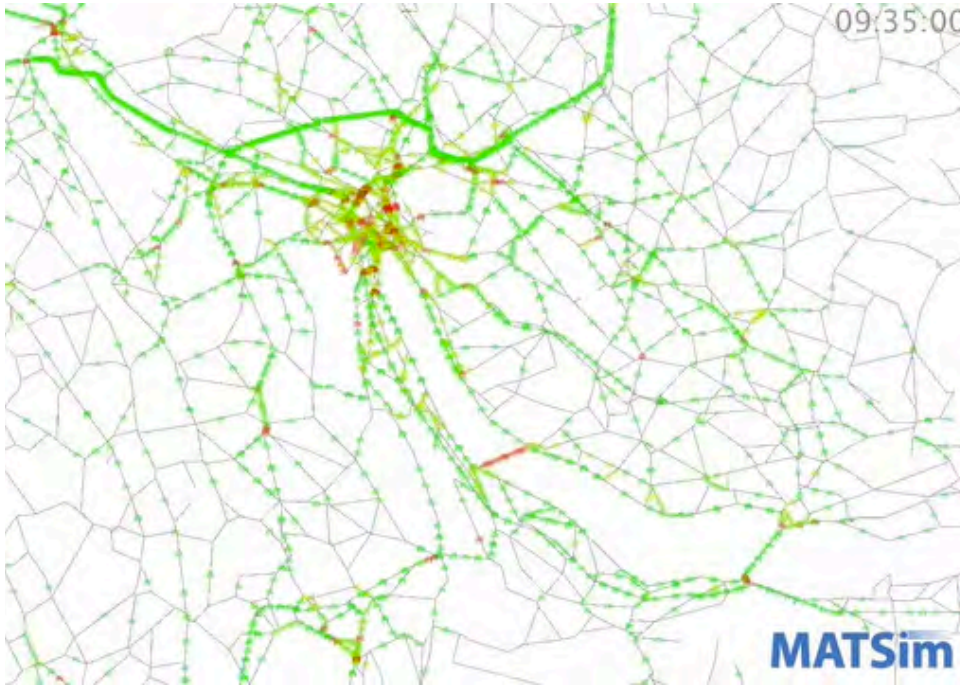
- Characterisation of the emission according to place, time, environment, vehicle type and population density into sound pressure in pascal (midpoint)
- Conversion of the results to a comparable unit (endpoint)
- DALYs caused by annoyance (day) and sleep disturbance (night)

Noise Impact Model



Calculate a Noise Footprint for Switzerland - MATSim

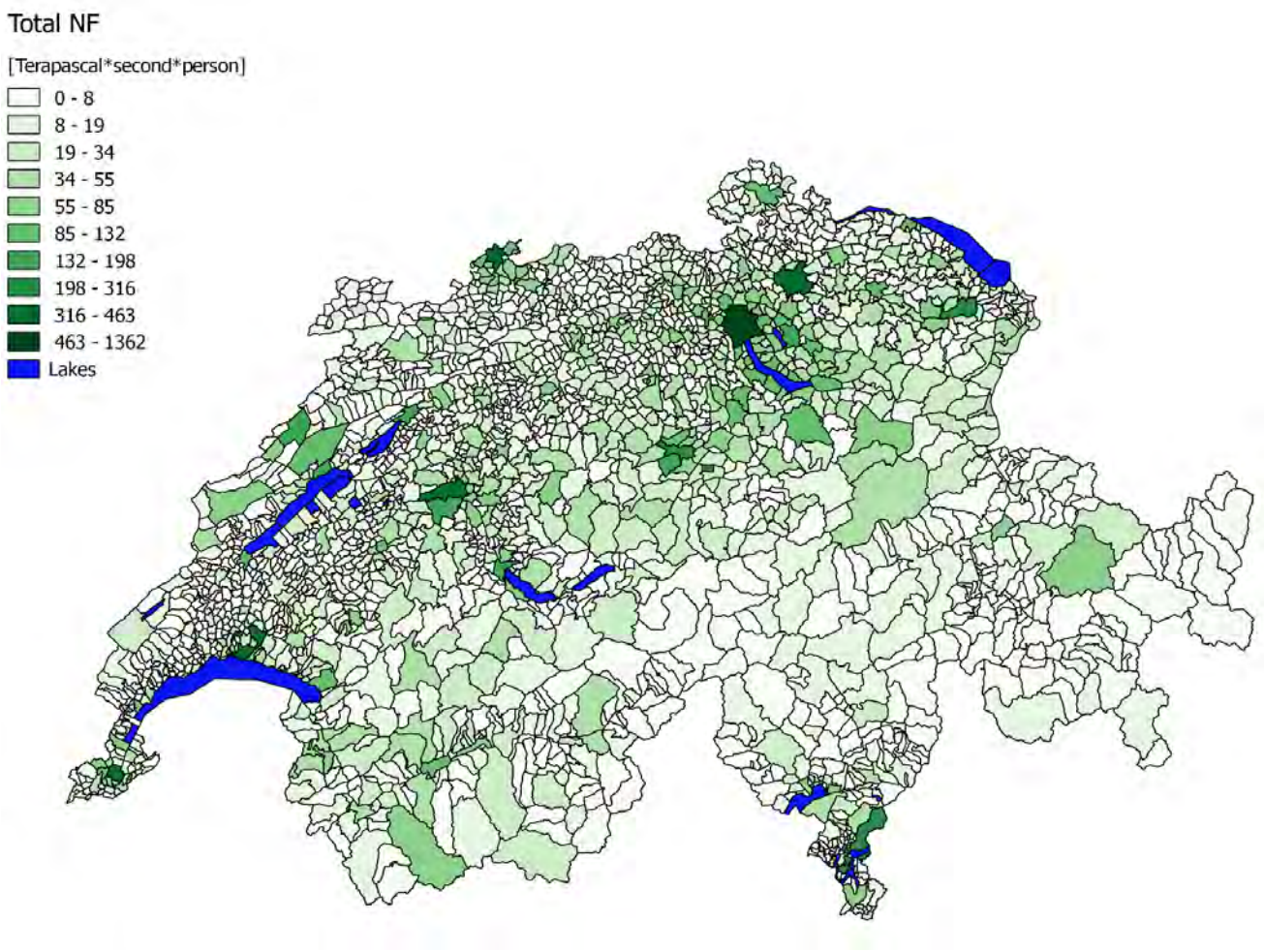
- Large-scale traffic simulation by the IVT
- Based on empirical data of the Swiss government
- Draws the actual traffic situation closely
- Provides data on:
  - What kind of vehicle (car, trolley bus, regular bus, tram, regtrain, urban train)
  - When
  - Where
  - How long



http://icos.urenio.org/applications/matsim/, 16.05.2016

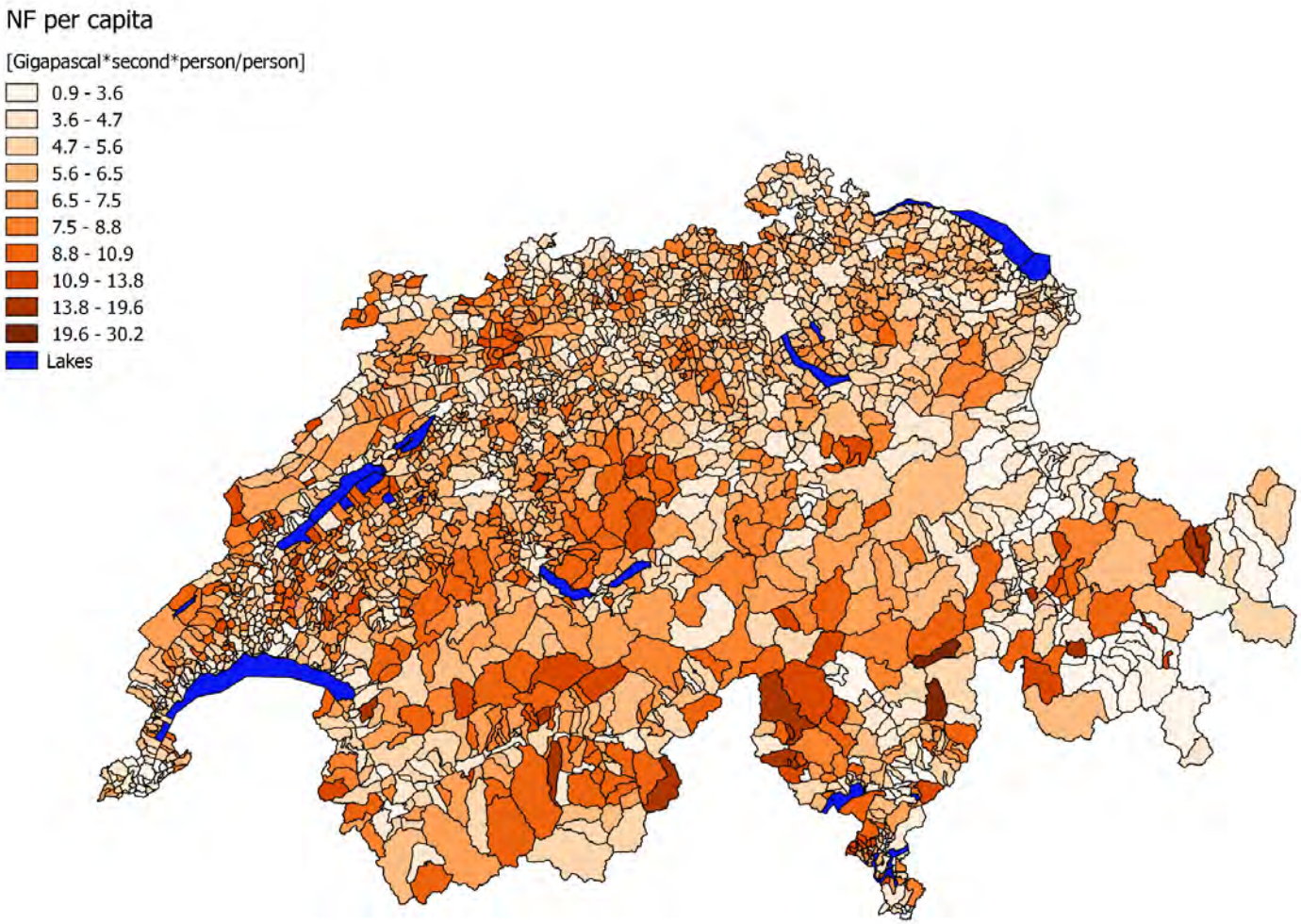
ESD ecological systems design

Results – Municipalities Total



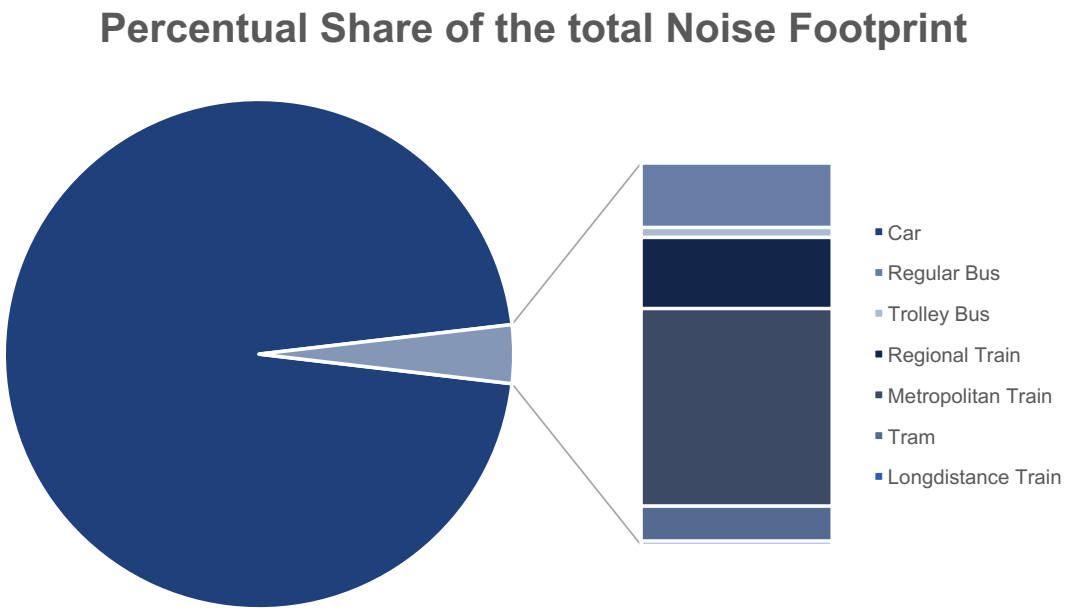
ESD ecological systems design

Results – Municipalities per person



ESD ecological systems design

Results Noise Footprint



Results Noise Footprints

- Total NF Switzerland = 9295 [DALY]
- NF Swiss citizens = 0.0015 [DALY/person]

- WHO estimates: 0.004 – 0.025 [DALY/person]

Results – Electrical mobility

- Rolling noise more relevant
- Propulsion noise reduced according to CNOSSOS
- Total Noise Footprint reduced by 44.75 %

Results Discussion

Results

- Rural villages have a higher NF per person
- Urban cities have a high total NF
- Public Transport connections reduce the NF
- Swiss Noise Footprint is under the European WHO estimates

Method

- Accuracy of the model can still be enhanced
- First approach to charge noise in future LCAs

Outlook

- Adapt the vehicle emissions to the actual vehicle fleets
- Calculate the uncertainty of the model with a sensitivity analysis
- Create the specific mobility profile for each agent with the MATSim data
  - Calculate the driven slope
  - Include acceleration and deceleration

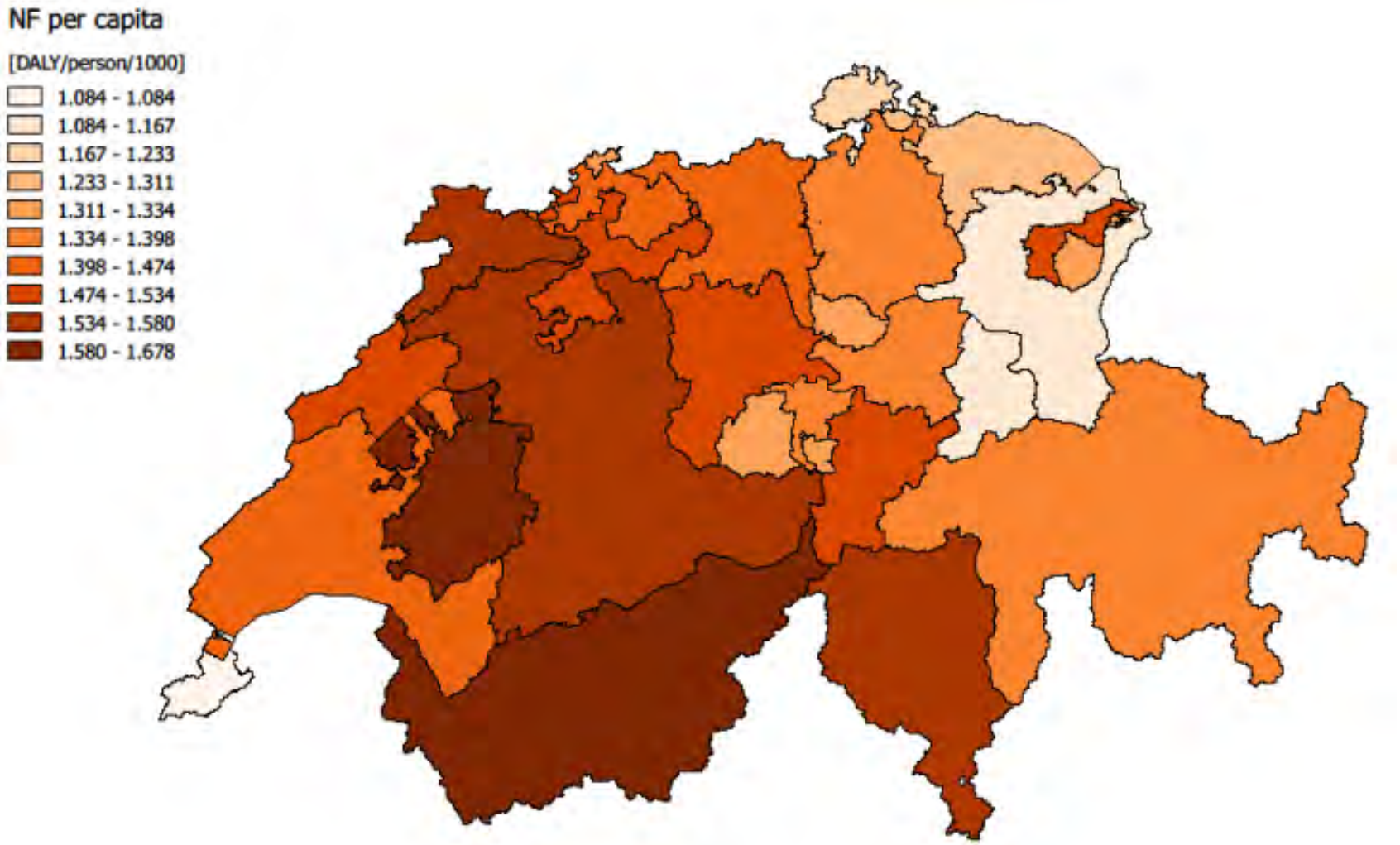
- Stefano Cucurachi
  s.cucurachi@cml.leidenuniv.nl
- Samuel Schiess
  samuel.schiess@epfl.ch
- Andreas Froemelt
  andreas.froemelt@ifu.baug.ethz.ch
- Stefanie Hellweg
  stefanie.hellweg@ifu.baug.ethz.ch

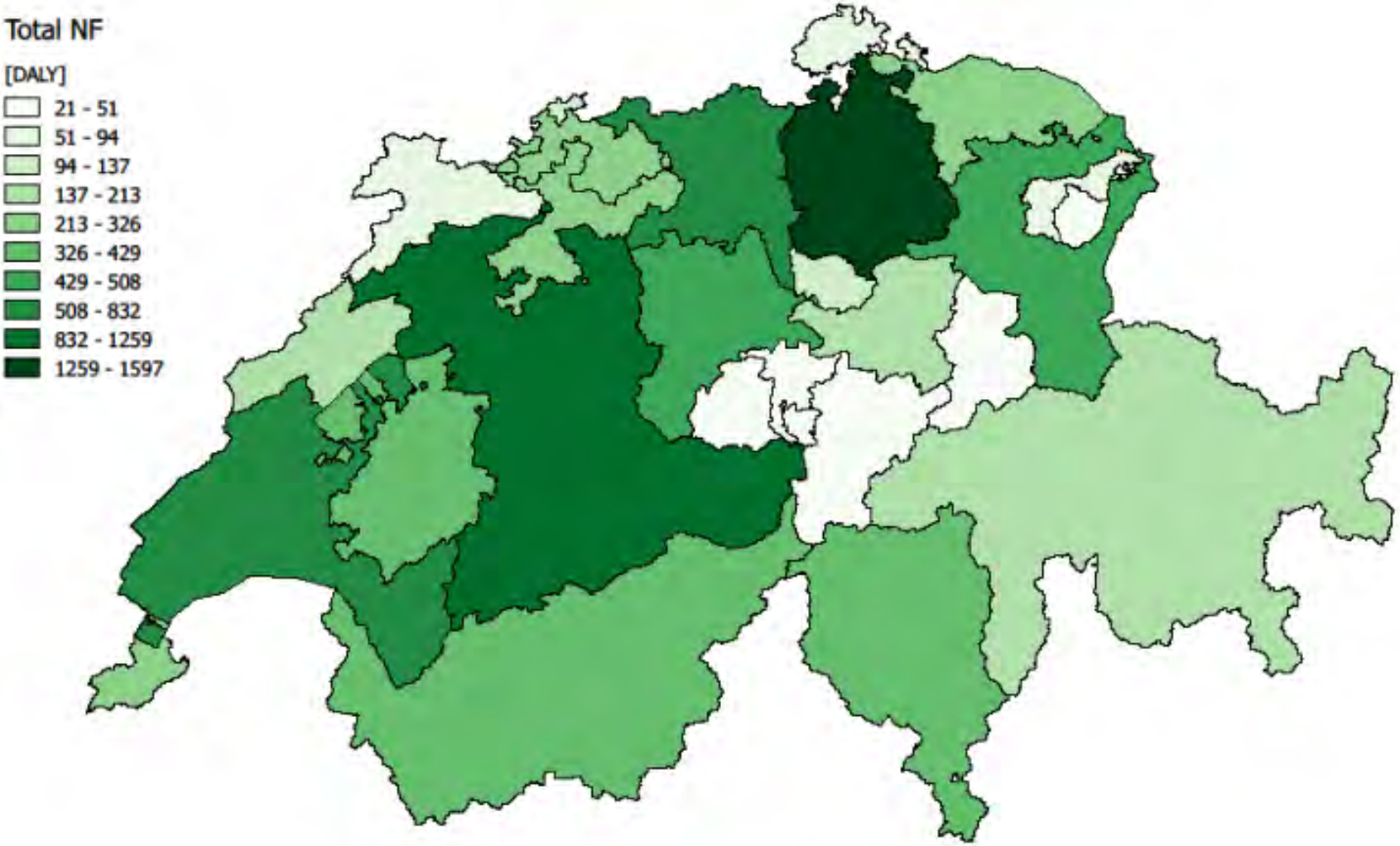
ESD
ecological systems design

Universiteit Leiden

Literature

- Cucurachi, S., A. Frömelt, and S. Hellweg. Noise Footprint from Personal Land-Based Mobility, unpublished
- Cucurachi, S. and R. Heijungs. 2014. Characterisation factors for life cycle impact assessment of sound emissions. Science of the Total Environment 468-469: 280-291
- Althaus, H.J., P. De Haan, and R.W. Scholz. 2009. Traffic noise in LCA: Part 1, Part 2. International Journal of Life Cycle Assessment 14(6)/14(7): 560-570/676-686
- CNOSSOS, Kephalopoulos, S., M. Paviotti, F.A. Ledee, and others. 2012
- Ecoinvent transport report No. 14 (Ecoinvent v2.0)


NF per capita
[DALY/person/1000]
1.084 - 1.084
1.084 - 1.167
1.167 - 1.233
1.233 - 1.311
1.311 - 1.334
1.334 - 1.398
1.398 - 1.474
1.474 - 1.534
1.534 - 1.580
1.580 - 1.678


Total NF
[DALY]
21 - 51
51 - 94
94 - 137
137 - 213
213 - 326
326 - 429
429 - 508
508 - 832
832 - 1259
1259 - 1597

Characterisation factors

$$CF_{ftl} = \frac{20}{\sqrt{Wamb}_{ftl}} \times Nf_{tl} \times 10^{\frac{\left(D_f - Aatt_{fl}\right)}{20}} \times 10^{\frac{\left(\alpha_f + \beta_t\right)}{20}}$$

Conversion factors

$$\vartheta_{i,s}^{EU} = \frac{X_{i,s}}{B_{i,s}}$$

$$X_{i,s} = \left(\frac{P_{i,s} \times \left(RR_{i,s} - 1 \right)}{1 + P_{i,s} \left(RR_{i,s} - 1 \right)} \right) \times \left(I_i \times DW_i \times D_i + N_i \times L_i \right).$$

$$B_{i,s} = \tau_{i,s} \times Pp \times T.$$

Sound power level

$$Lw_{ftls} = AR_{ftls} + BR_{ftls} \times \log\left(\frac{v_s}{v_{s,ref}}\right)$$