IMPACT OF LAND USE AND TRAFFIC PATTERNS ON AIR POLLUTION IN A SWEDISH MEDIUM-SIZED CITY

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INTRODUCTION

- Atmospheric pollution: increase of morbidity and mortality rates;
- Highest exposures according different time-activity scenarios (residence, study or work);

OBJECTIVE

- Develop a LUR model in the city of Gothenburg, based on measurements of NO_2.
- Map levels of NO_2 in Gothenburg through LUR model and GIS.
- Verify if it's relevant/possible to use LUR-modelling in Gothenburg: Definition of “goods and bads” of LUR compared to ordinary dispersion modelling.

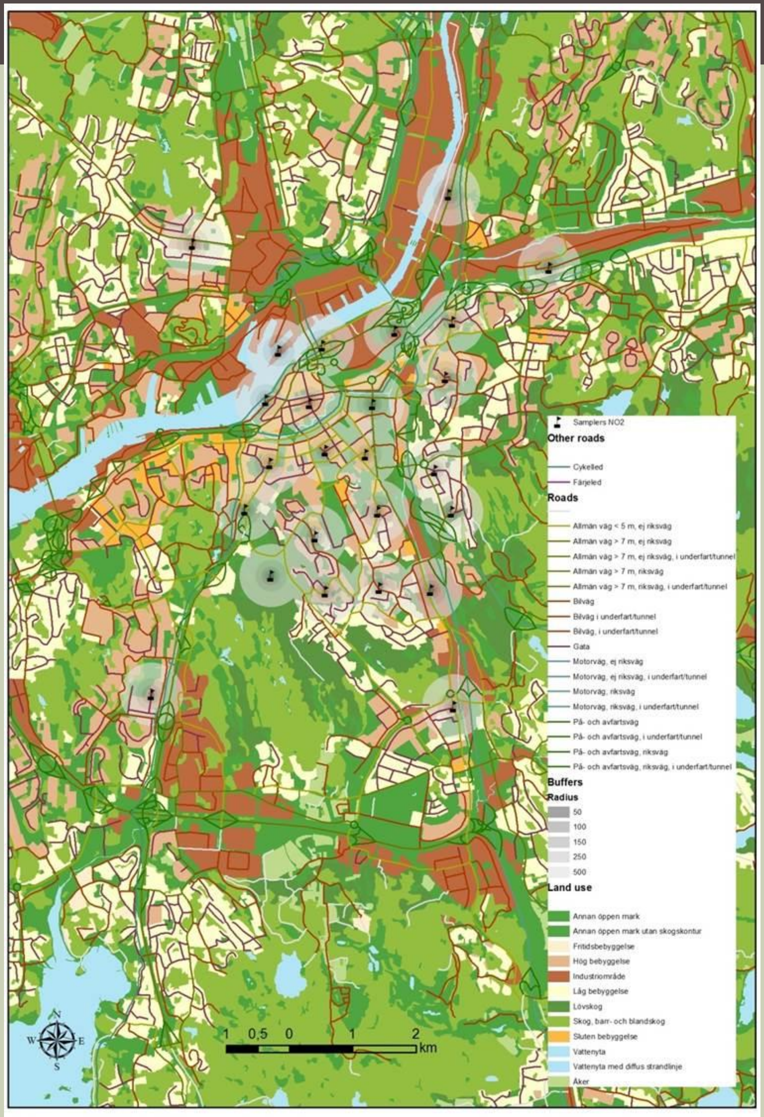
METHODS

- Measures of NO_2 from GÖTE-2001 campaign;
  - 25 Passive samplers
  - Period: 7th to the 20th May/2001
- Predominant land use;
  - building patterns: low, high, enclosed;
  - type of use: industrial, recreational, forests, arable areas, open areas, etc.;
- Type of roads
  - Highway, local road, underpass, cycle road;
- All independent variables were estimated by GIS in buffers 50; 100; 150 250 and 500 m-radiuses around sampler's sites;
- Demographic data: number of inhabitants to the closest NO_2 measurement point, average and sum of inhabitants in a buffer 500 m-radius.
- Traffic data for the year 2001

LAND USE REGRESSION (LUR)

- LUR estimates air pollution based on characteristics related to concentration and dispersion of pollutants
  - Land use
  - Demographic profile
  - Road type
  - Traffic volume
  - Elevation
- Buffers 50, 100, 150, 250 and 500 m

VARIABLES AND BUFFERS

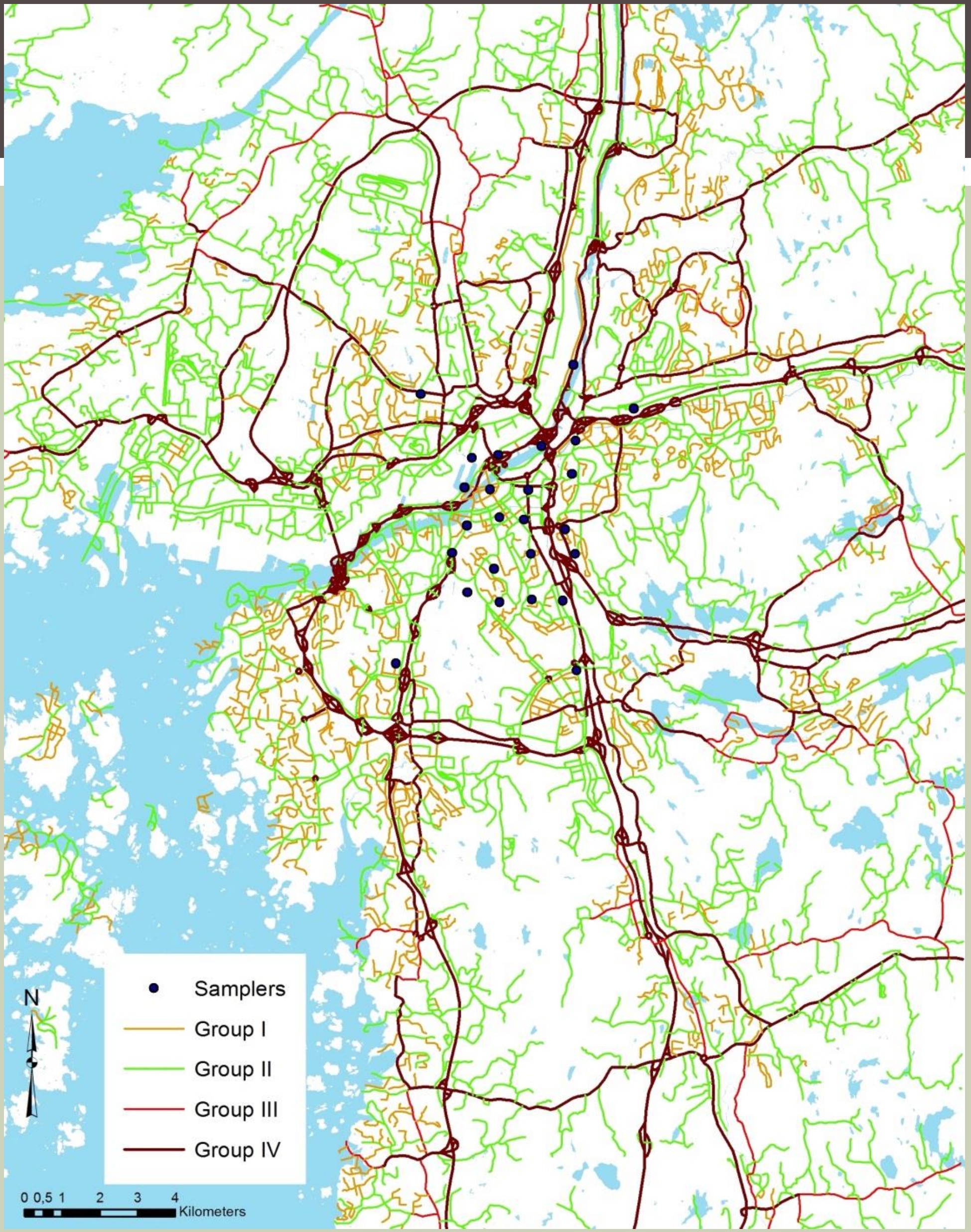


METHODS

- Statistics
  - Test the association between every independent variables and NO_2 using univariate linear regression (α=5%). The variables with p-value ≤ 0.2 in univariate analysis will be selected to multivariate analysis;
    - Collinearity of the variables was calculated by Pearson correlation test and selected most robust variables (lower p-value);
  - The final model was obtained by multivariate linear regression;
  - Final formula were applied in a map of regular points of in Gothenburg to estimate NO_2 using Kriging.

METHODS

- The roads were grouped in 4 main groups based on their sizes
  - Roads type I: *gata*;
  - Roads type II: *bilvag, bilvag i underfart/tunnel, allmän väg < 5 m, ej riksväg and allmän väg <5 m, ej riksväg i underfart/tunnel;*
  - Roads type III: *allmän väg 5-7 m, ej riksväg and allmän väg 5-7 m i underfart/tunnel;*
  - Roads type IV: *Allmän väg > 7 m riksväg, Allmän väg > 7 m, riksväg i underfart/tunnel, motorväg-riksväg, motorväg-riksväg i underfart/tunnel; på-och avfartsväg, på- och avfartsväg i underfart/tunnel, på- och avfartsväg-riksväg, på-och avfartsväg-riksväg i underfart/tunnel.*



RESULTS

- The variables Industrial land use, enclosed buildings, traffic and roads type IV were associated with the increasing of NO2 concentration.
- Elevation, recreational buildings, high buildings and local roads were associated with **decreasing** of NO_2 concentration

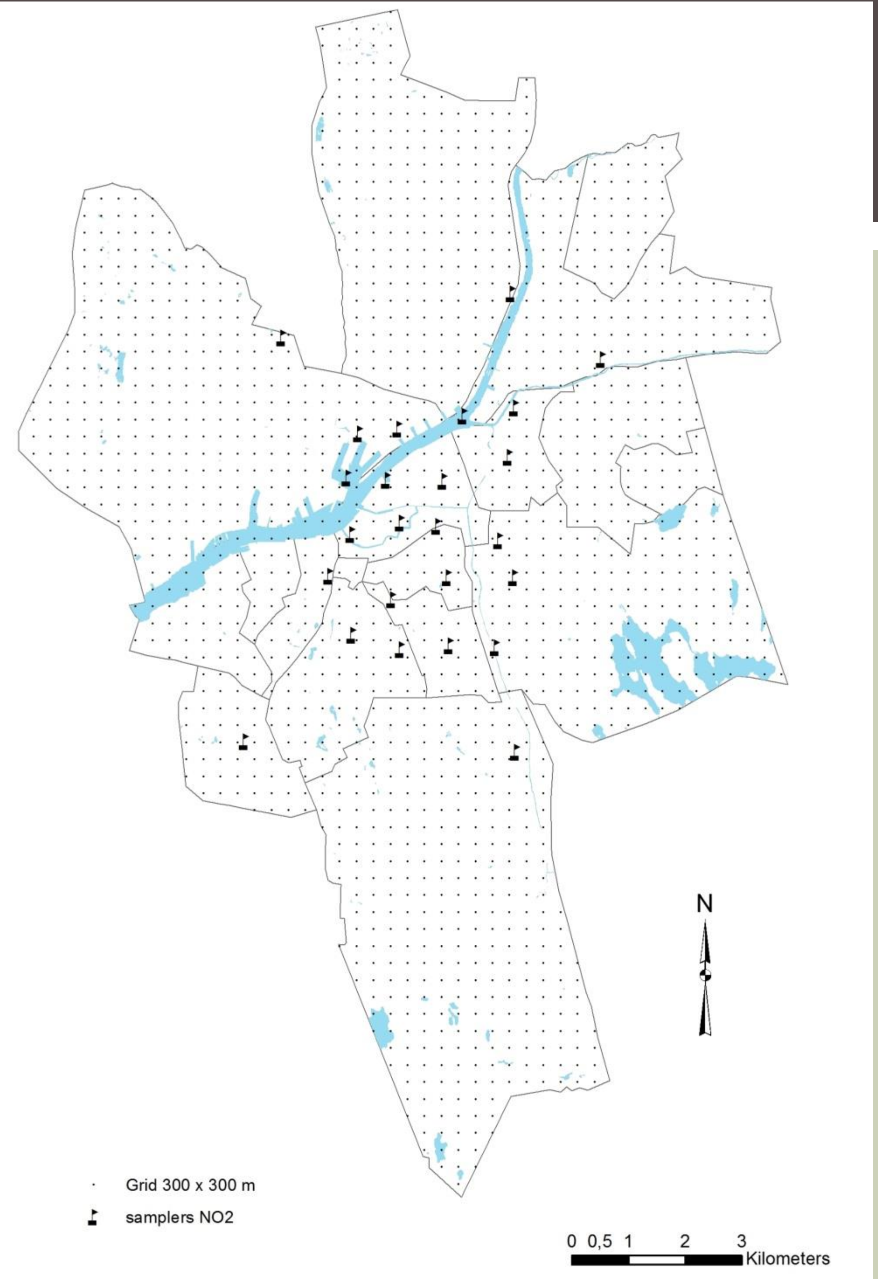
Variables	Buffer	r	r²	β	p
Elevation	-	0.677	0.459	-0.197	<0.001
Deciduous forest*	500	0.63	0.397	-53.345	0.001
Sum of traffic	150	0.62	0.384	0.00002	0.001
High building	500	0.566	0.32	-30.600	0.003
Deciduous forest*	250	0.544	0.296	-134.710	0.005
Deciduous forest*	150	0.504	0.254	-275.263	0.01
Sum of traffic*	100	0.496	0.246	0.00003	0.011
High building*	250	0.481	0.232	-72.497	0.015
Average of traffic*	50	0.47	0.221	0.00079	0.018
Sum of traffic*	50	0.466	0.217	0.00007	0.019
High building*	150	0.453	0.205	-181.897	0.023
Deciduous forest	100	0.447	0.2	-483.949	0.025
Average of traffic*	150	0.444	0.197	0.0006	0.026
Industrial use	500	0.445	0.198	17.392	0.026
Roads type 4	100	0,431	0,186	0,024	0.031
High building*	100	0.431	0.186	-369.833	0.031
High building*	50	0.405	0.164	-1.215.930	0.045
Sum of traffic	250	0.4	0.16	0.000003	0.048
Roads type 4*	150	0,388	0,150	0,012	0.056
Deciduous forest*	50	0.379	0.144	-1.536.954	0.062
Enclosed building	500	0.365	0.133	21.066	0.073
Industrial use*	250	0.36	0.129	46.005	0.077
Enclosed building*	250	0.321	0.103	59.879	0.118
Roads type 1	250	0.319	0.102	-0.005	0.12
Roads type 1*	500	0.306	0.094	-0.002	0.136
Recreational building	500	0.297	0.088	-438.056	0.149
Industrial use*	150	0.293	0.086	84.453	0.156
Average of traffic*	100	0.283	0.08	0.0004	0.17
Enclosed building*	100	0.265	0.07	150.434	0.2

* excluded by collinearity

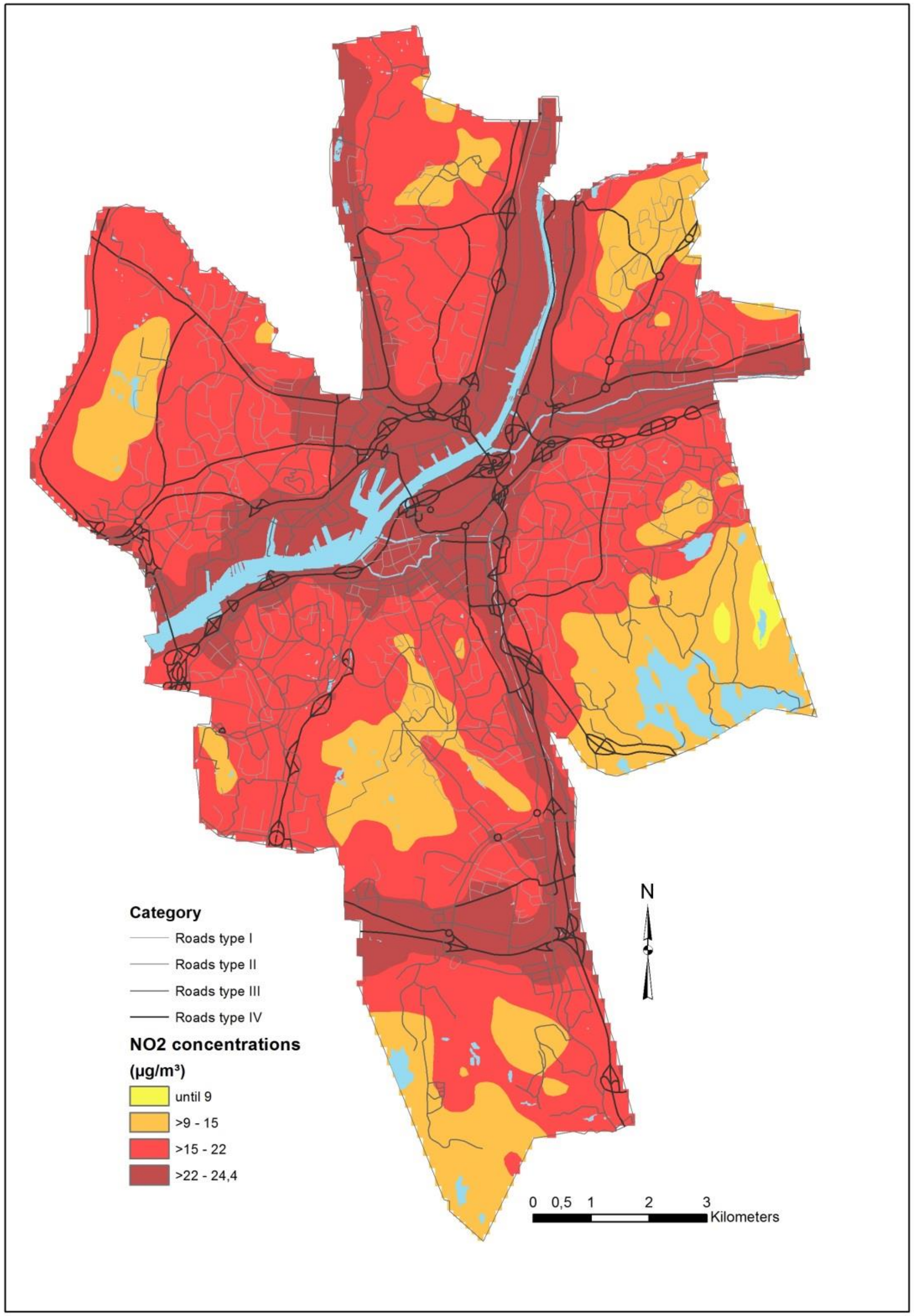
RESULTS

- The final model explained **59.4%** of the variance of NO_2;
- **Elevation** and **sum of traffic** within 150 m, from the sampler sites as predictor variable;

Variable	β	Std. Err.	z	p
Constant	*23.99528*	*3.117506*	*7,70*	*<0.001*
Elevation	*-0.14693*	*0.050859*	*-2.89*	*0.004*
Traffic within 150 m	*0.0000143*	*0.0000064*	*2.24*	*0.025*
r^2 = 0,594				



- The correlation between measured and predicted levels of NO_2 was $r = 0.77$ ($p < 0.001$).
- The average of NO_2 predicted by the LUR model was 19.1 µg/m³ (DP = 4.7 µg/m³).



STEP-WISE PROCEDURES

1. Add **meteorological data** if possible and verify if it alters the previous results;
2. Compare the result to a dispersion model;
3. Use the LUR model and update with data from measurements from **later years**;
4. Compare to the dispersion model from the same year;
5. Reflect over the results and the road forward - Do you want to refine the LUR model and proceed?

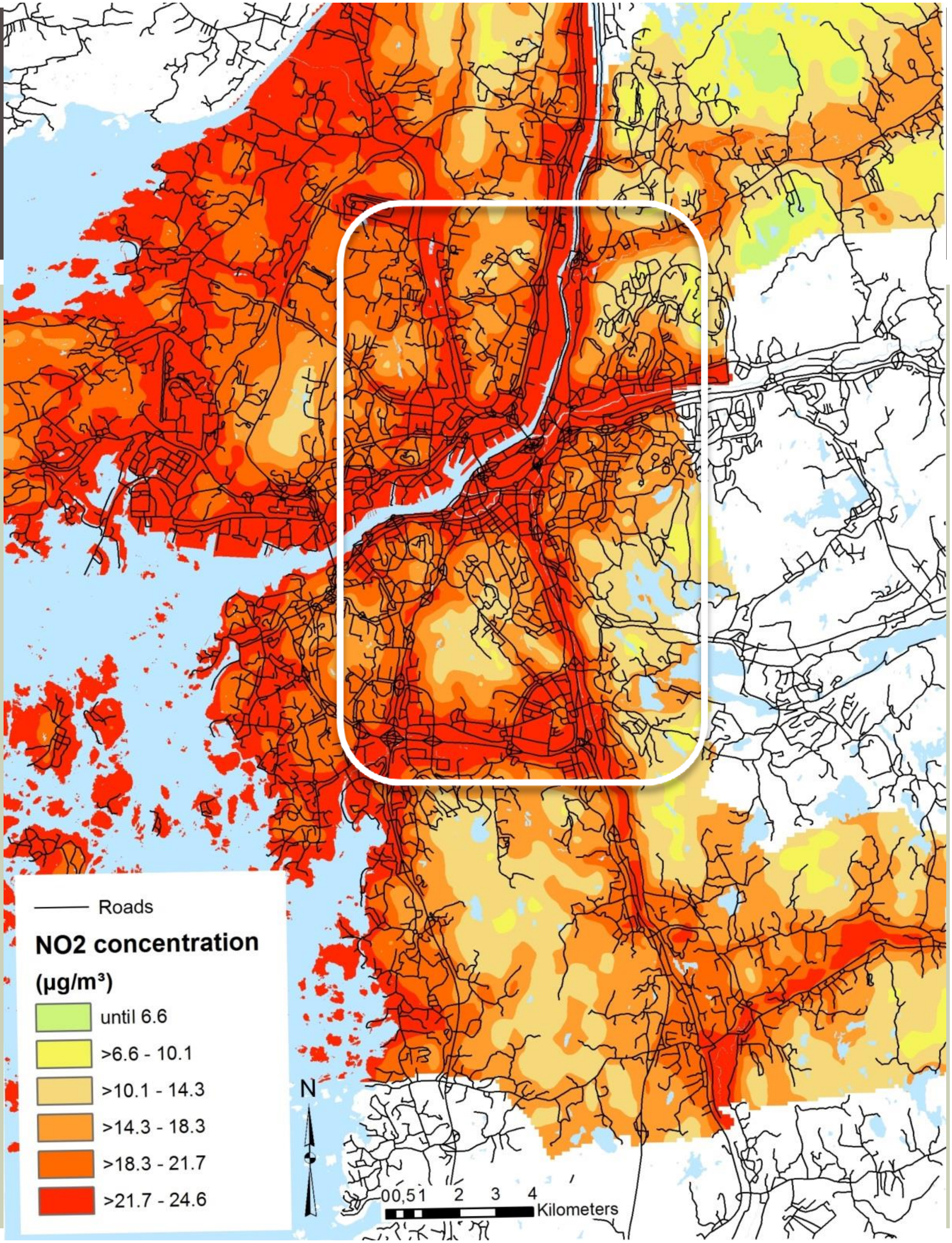
Limitations of the model

- Samplers were not located in all representative areas of Gothenburg;
- The **quality** of data available to compose the LUR model explain its **reliability**
- More precision of the LUR model when applied at the urban area;
- Less precision of the LUR model when extrapolated to another areas (i.e. rural areas and islands);

DISCUSSION

- Traffic as responsible to increasing of pollutant concentration;
- Policies to decreasing air pollution concentration
  - Identifying a specific source of pollution to support decision policy makers in designing effective regulation;
- Improve urban air quality;
  - Public health
  - Environment
- Final model can be applied in epidemiologic studies to access exposure to NO_2 (i.e. residence of subjects);
  - Personal measurements are expensive and logistically difficult.

- Map is less precise closer to the sea and to the islands



Previous Results (without traffic data)

- The final model explained 71.8% of the NO2 variance;
- Elevation, high buildings (hogbebyggelse) within 150 m, recreational buildings within 500 m (fritidsbebyggelse) and Highway >7m within 100 m (riskvag) from the sampler sites as predictor variables;

Variable	β	Std. Err.	z	p
Constant	*27.598976*	*1.319367*	*20.91*	*<0.001*
Elevation	*-0.1364372*	*0.028946*	*-4.71*	*<0.001*
High buildings ≤150 m	*-111.1918*	*25.88605*	*-4.30*	*<0.001*
Recreational buildings ≤ 500 m	*-323.2534*	*132.8706*	*-2.43*	*0,015*
Highway >7m ≤100 m	*4.599215*	*2.185044*	*2.10*	*0,035*
r^2 = 0,718