Representativeness of an Air Pollution Measurement

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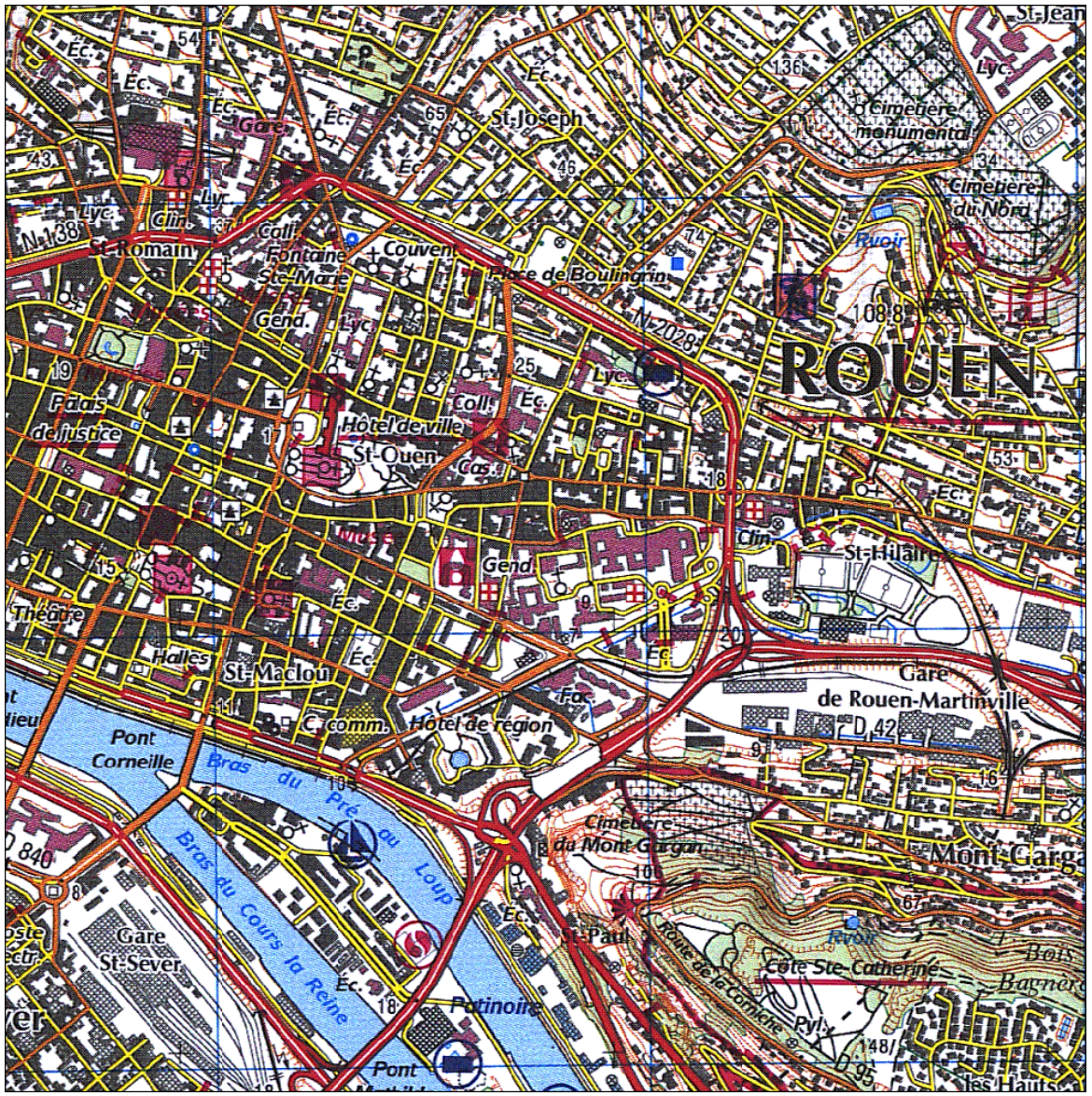
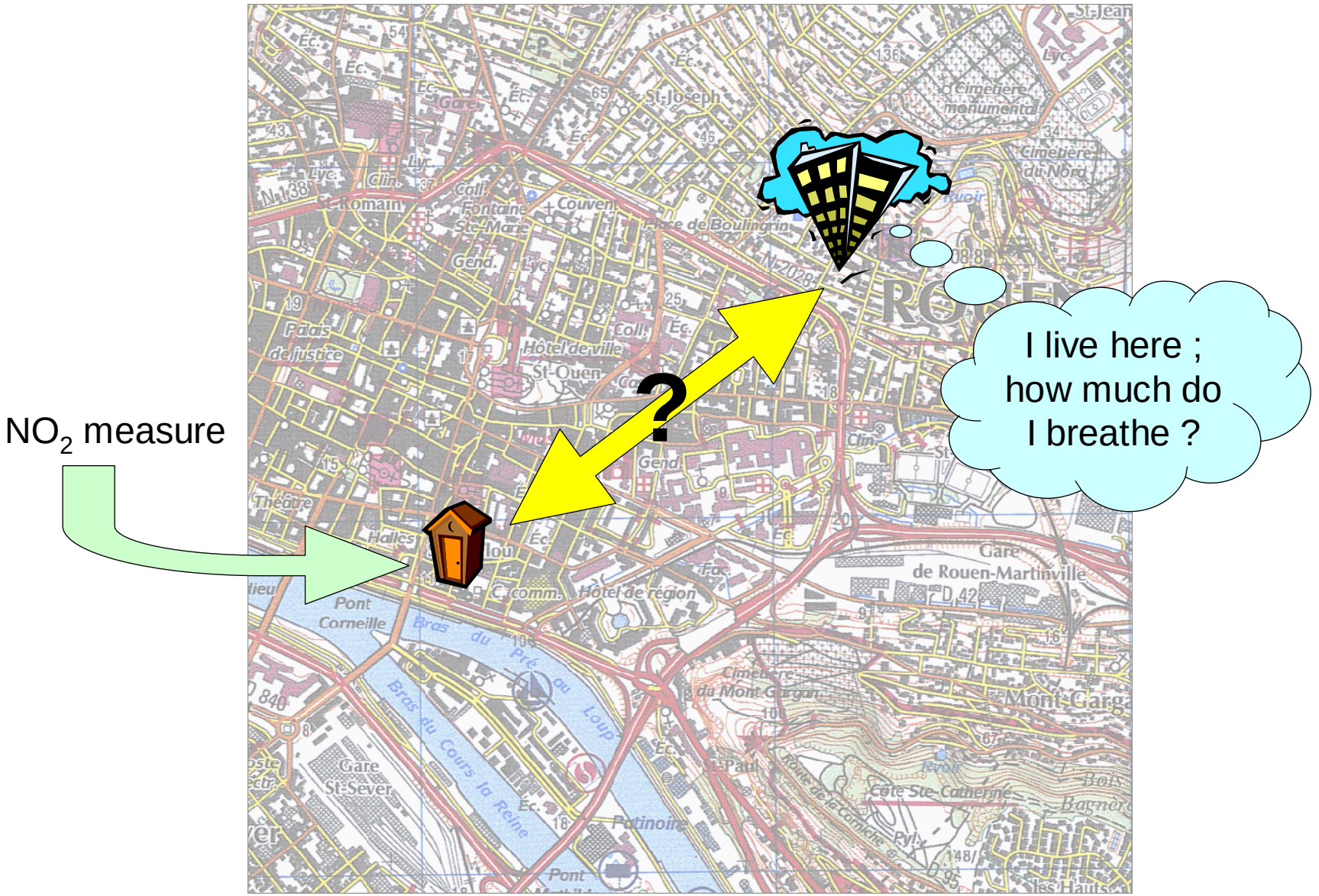
Concept

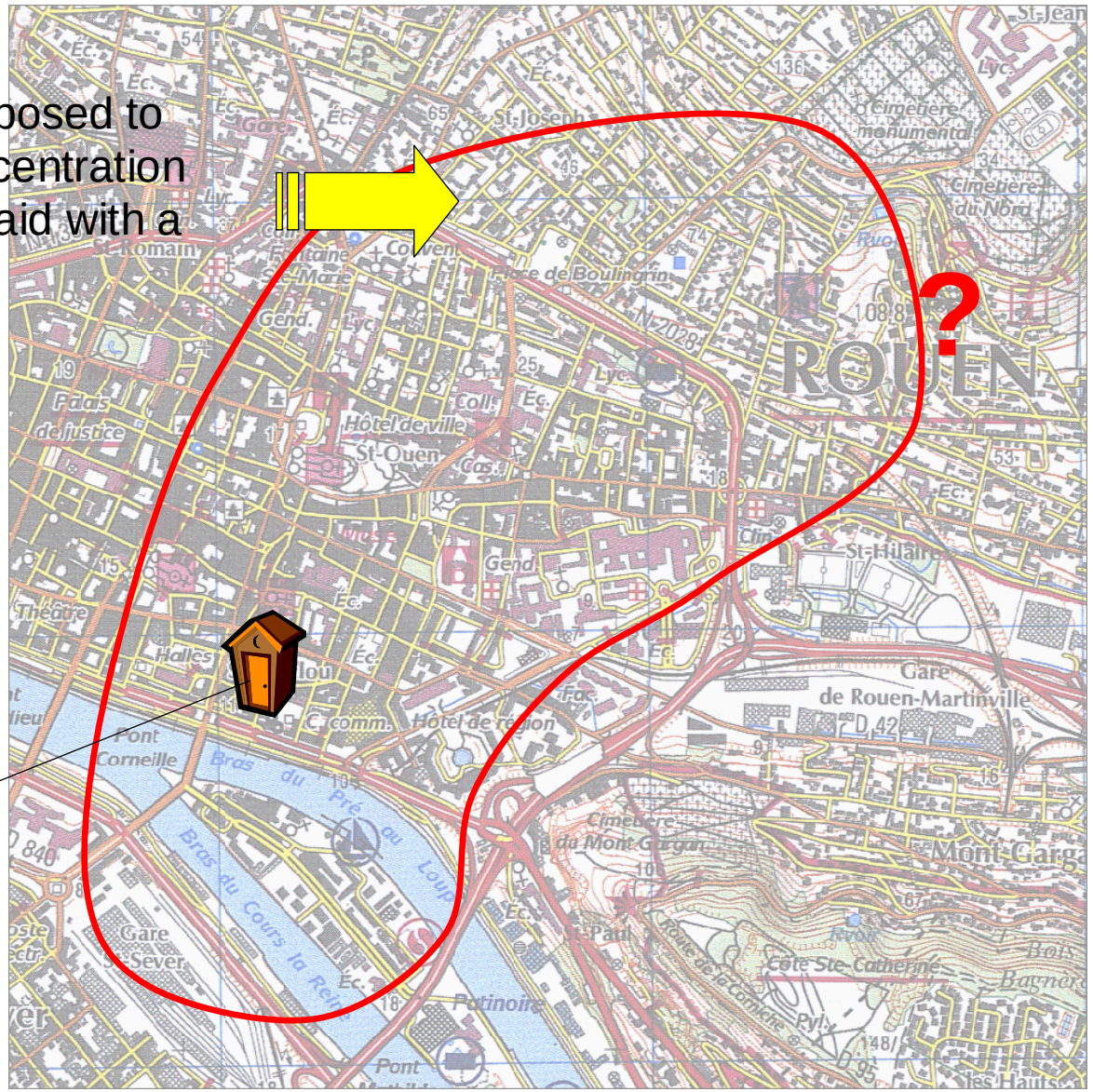

ROUEN
St-Joseph
St-Romain
Couvent
Fontaine Ste-Marie
Place de Boulingrin
Cimetière monumental
Cimetière du Nord
Palais de justice
Hôtel de ville
St-Ouen
St-Hilaire
Théâtre
Halles
St-Maclou
C. comm.
Hôtel de région
Gare de Rouen-Martinville
Pont Corneille
Bras du Pré au Loup
Bras du Cours la Reine
Cimetière du Mont-Gargan
Mont-Garg
St-Paul
Côte Ste-Catherine
Gare St-Sever
Patinoire
Pont

Concept



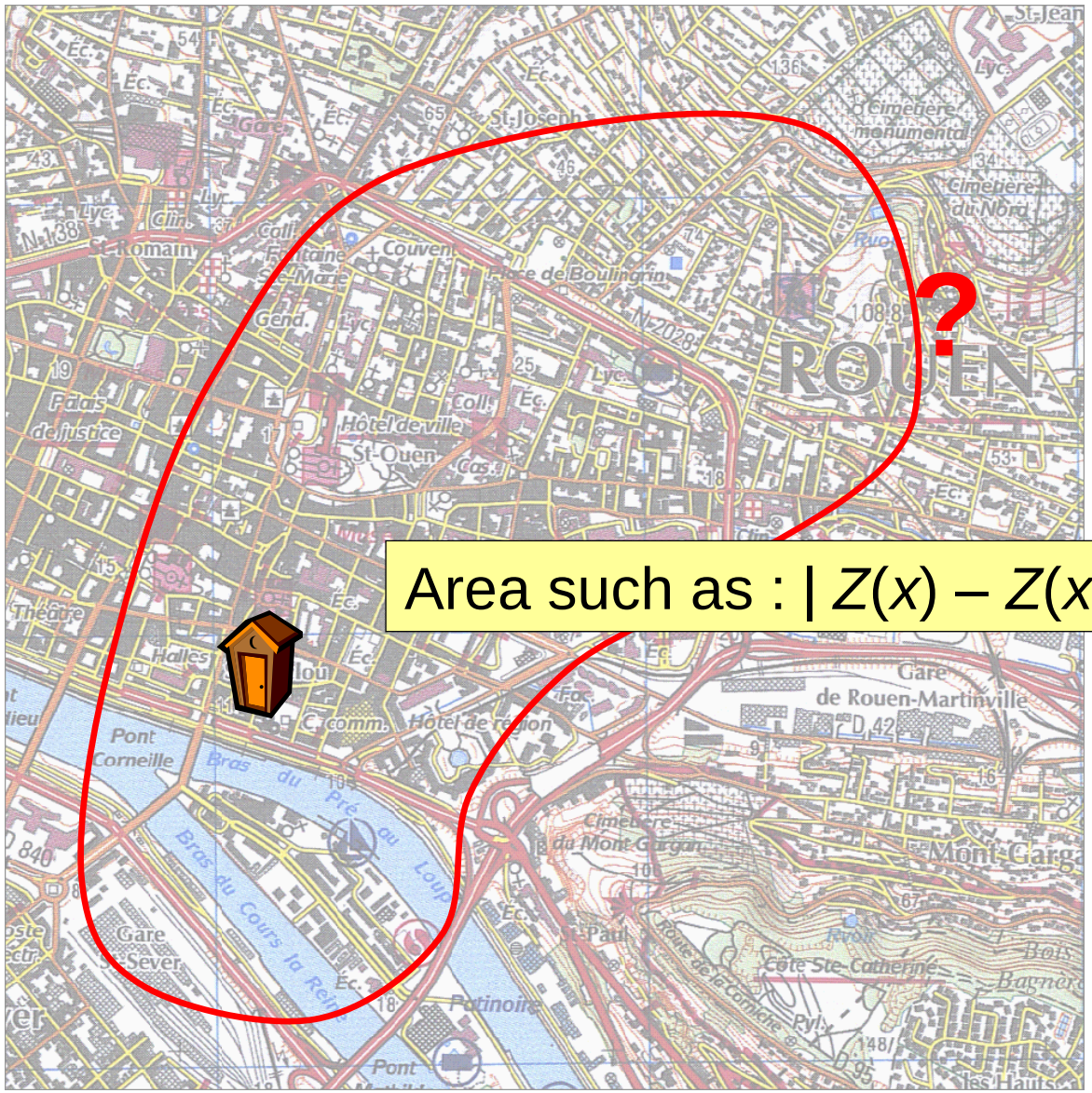
Concept

Where am I exposed to a pollution concentration nearby $Z(x_0)$, said with a little mistake ?



Measure = $Z(x_0)$

Formalization



Formalization

$$| Z(x) - Z(x_0) | \leq \delta$$

- Z(x) : unknown measure
- Geostatistics :

$$\{ Z(x_i) \}_{1 \leq i \leq n} \quad \Rightarrow \quad Z(x) = Z^*(x) + \varepsilon(x)$$

- We get so :

$$| \varepsilon(x) | \leq \delta - | Z^*(x) - Z(x_0) |$$

where $\varepsilon(x)$ is still an unknown quantity, but with an estimated variance $\sigma^2(x)$ (kriging variance)

- Bienaymé-Tchebychev inequality applied to $\varepsilon(x)$:

$$\mathbf{P}(|\varepsilon(x)| > k.\sigma(x)) \leq 1/k^2$$

Formalization

$| Z(x) - Z(x_0) | \leq \delta$

- Assumption : Z is gaussian

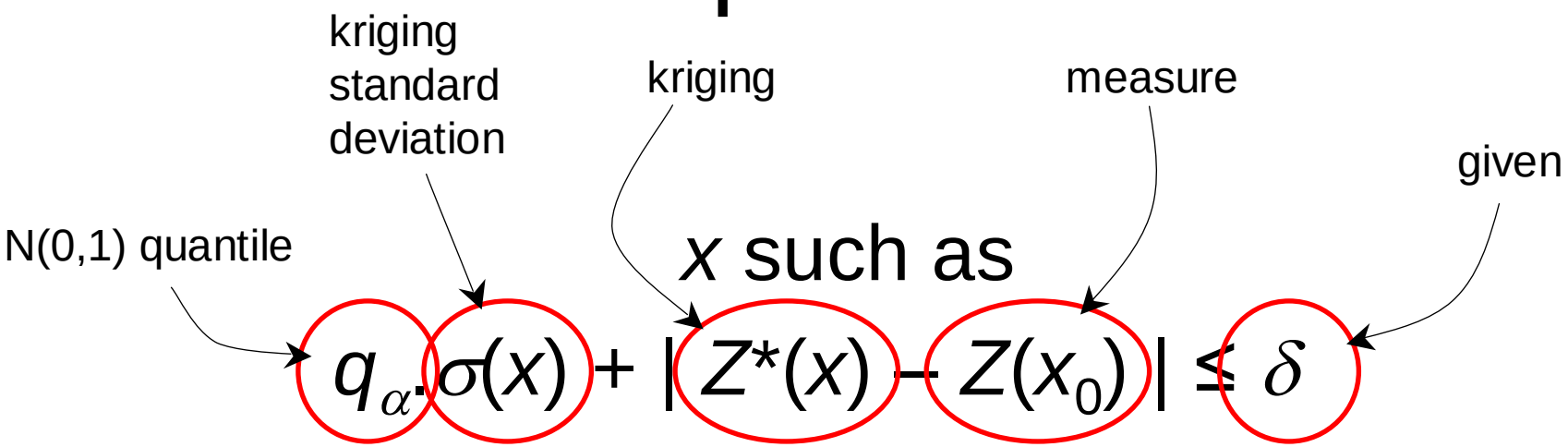
$$\Rightarrow \quad \mathbf{P}(|\varepsilon(x)| \leq q_\alpha . \sigma(x)) > 2.\alpha - 1$$

where q_α is normal quantile

- That is to say (with α=0.975 for example) :

error is smallest than $2\sigma(x)$
with a probabilty greater than 95 %

Interpretation

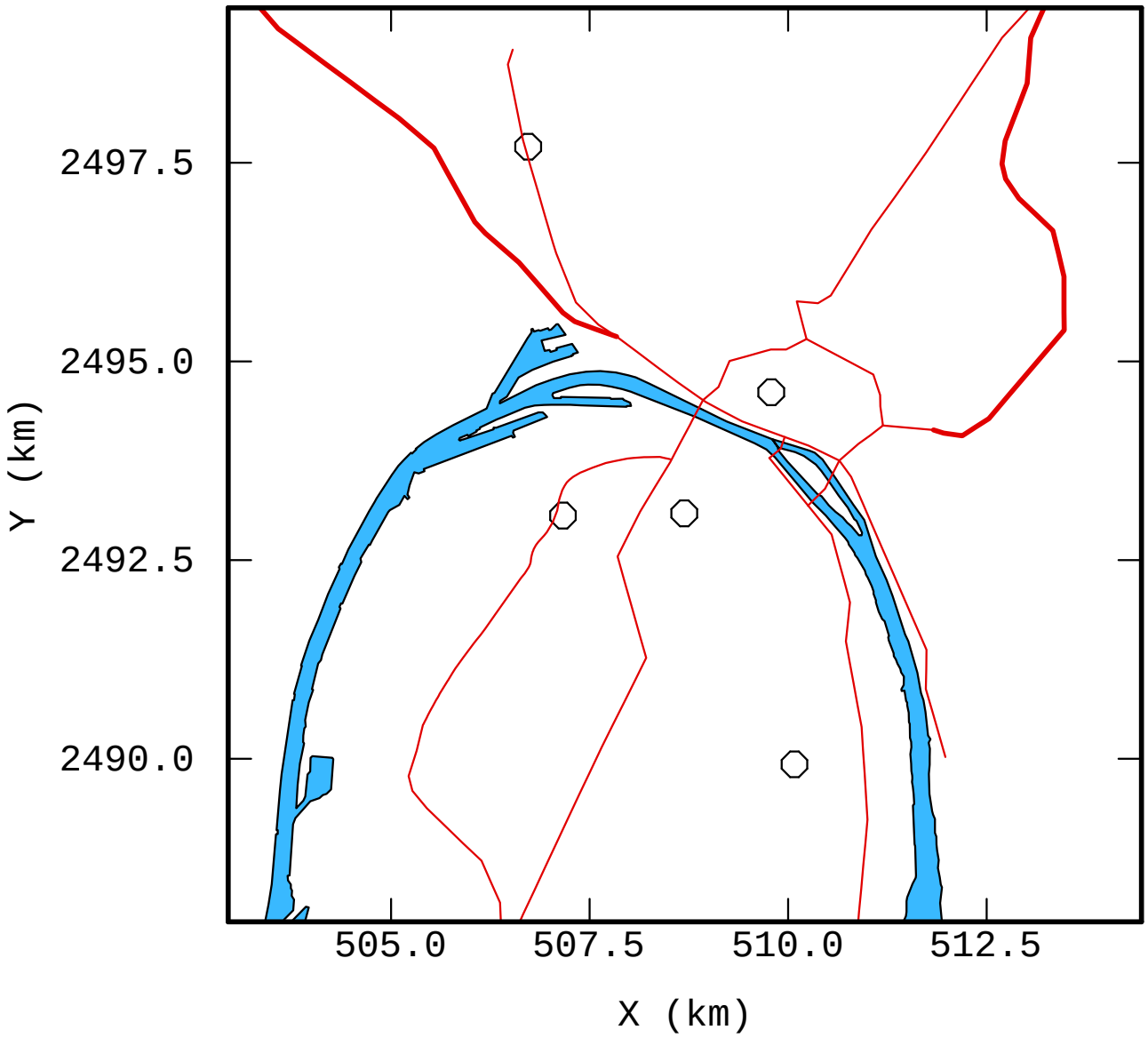


$$\Downarrow$$

$$\mathbf{P}\left(|Z(x) - Z(x_0)| \leq \delta \right) > 2.\alpha - 1$$

x is in the representativity area with 95% confidence

Application



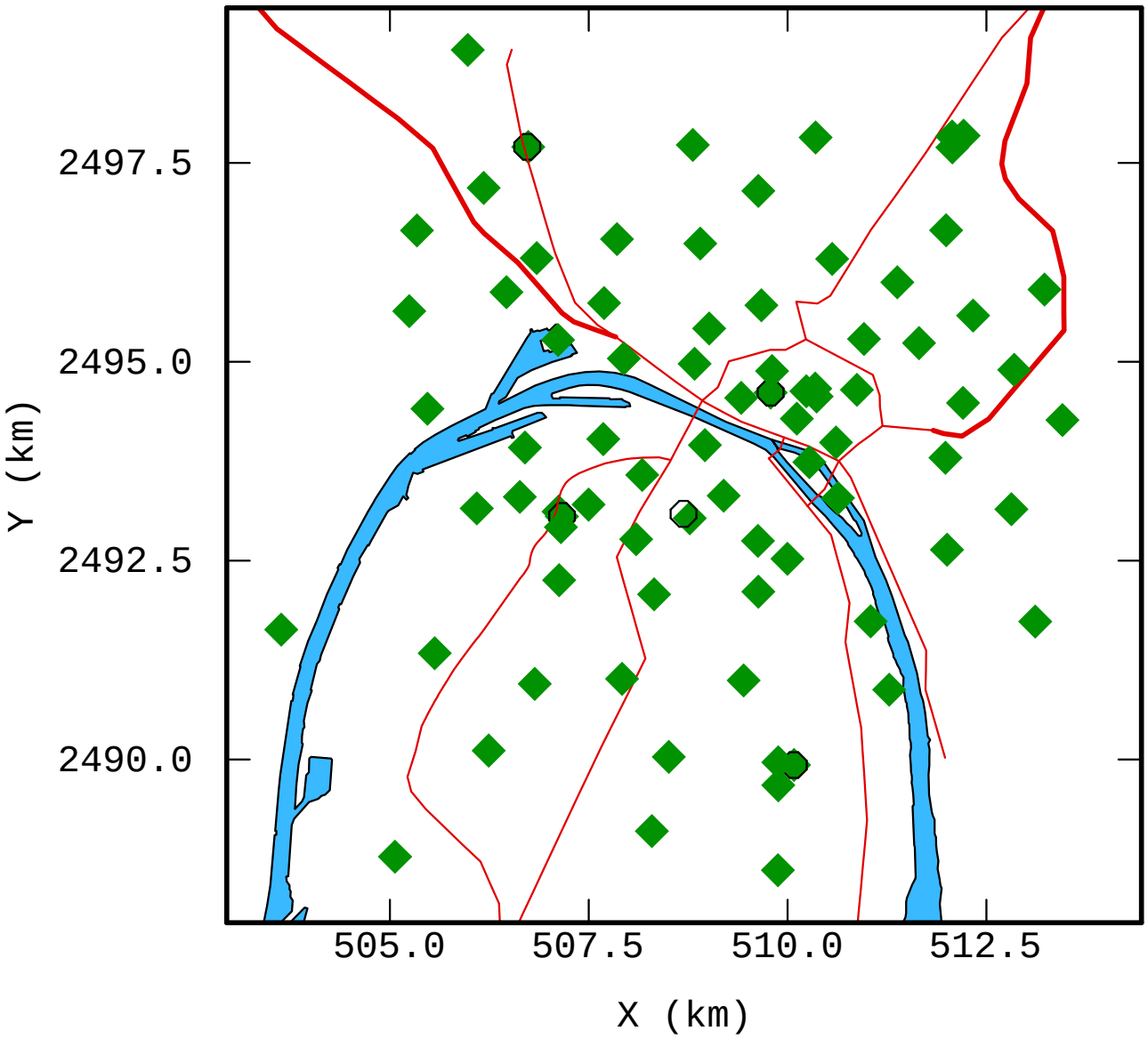
City of Rouen

~450 000 inhab.

5 permanent NO_2 measure

Who is exposed to an exceedance of the limit value (annual mean = 40 µg/m^3) ?

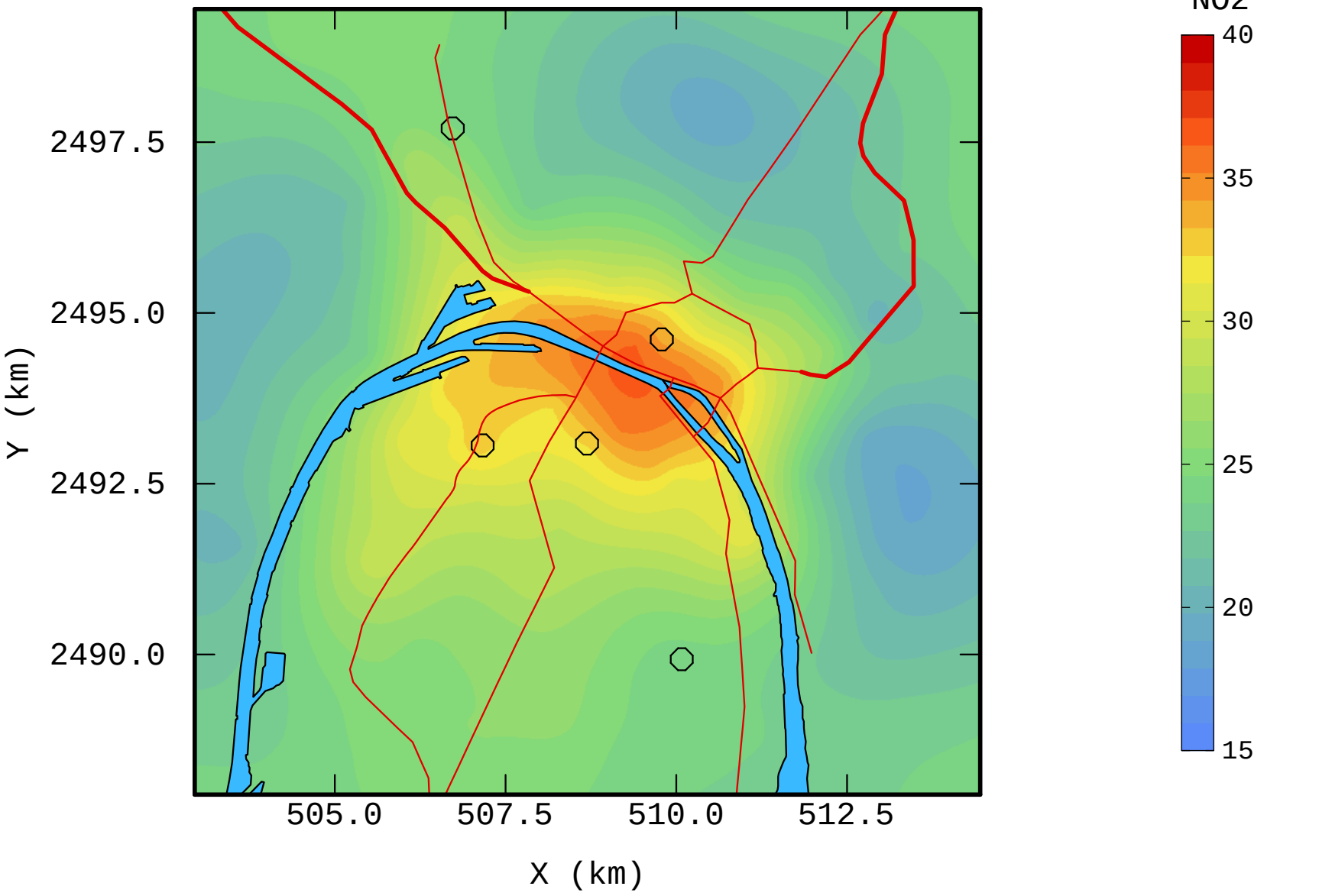
Application



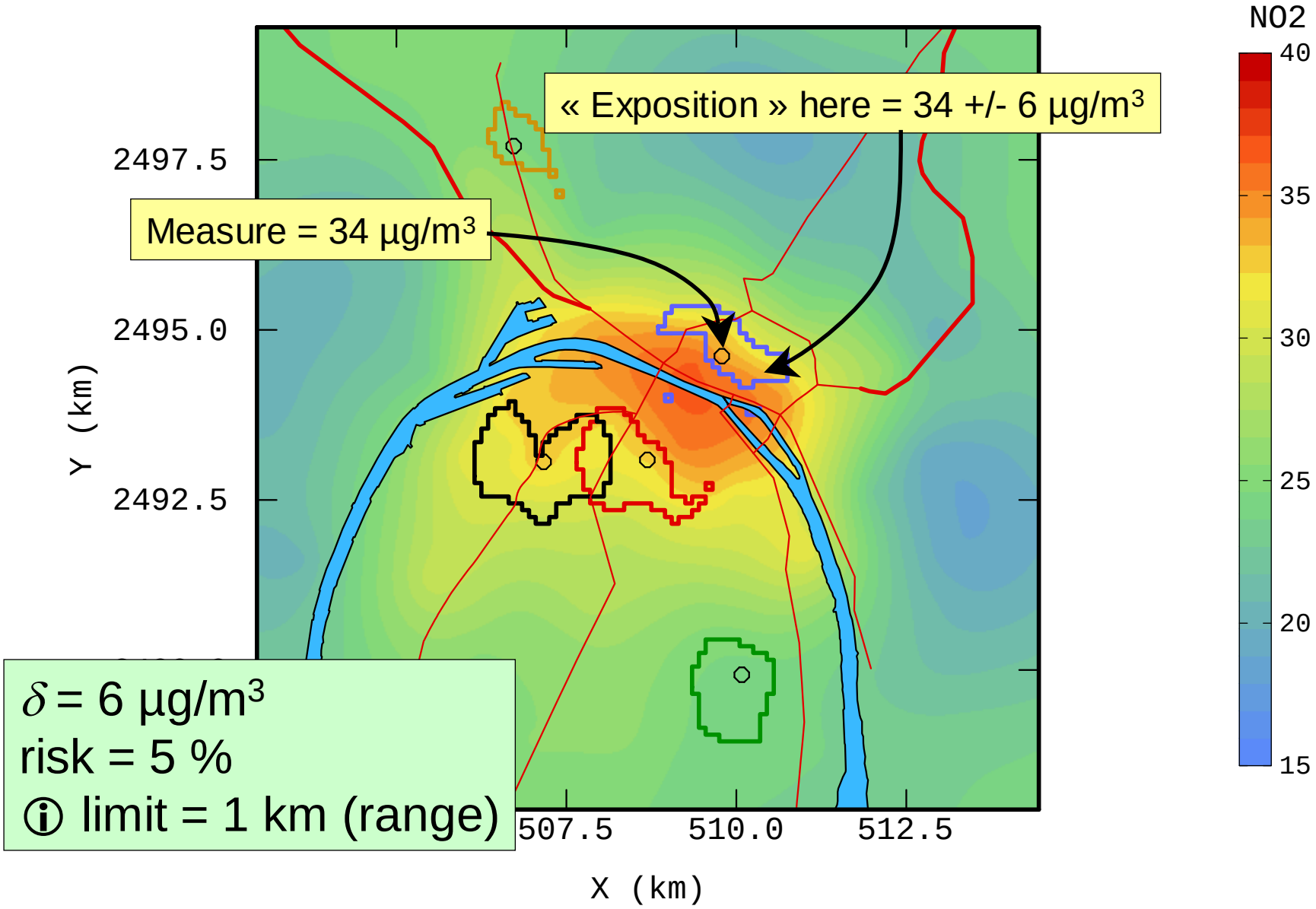
80 temporary NO_2 measure

$\Rightarrow$ Annual mean

Application

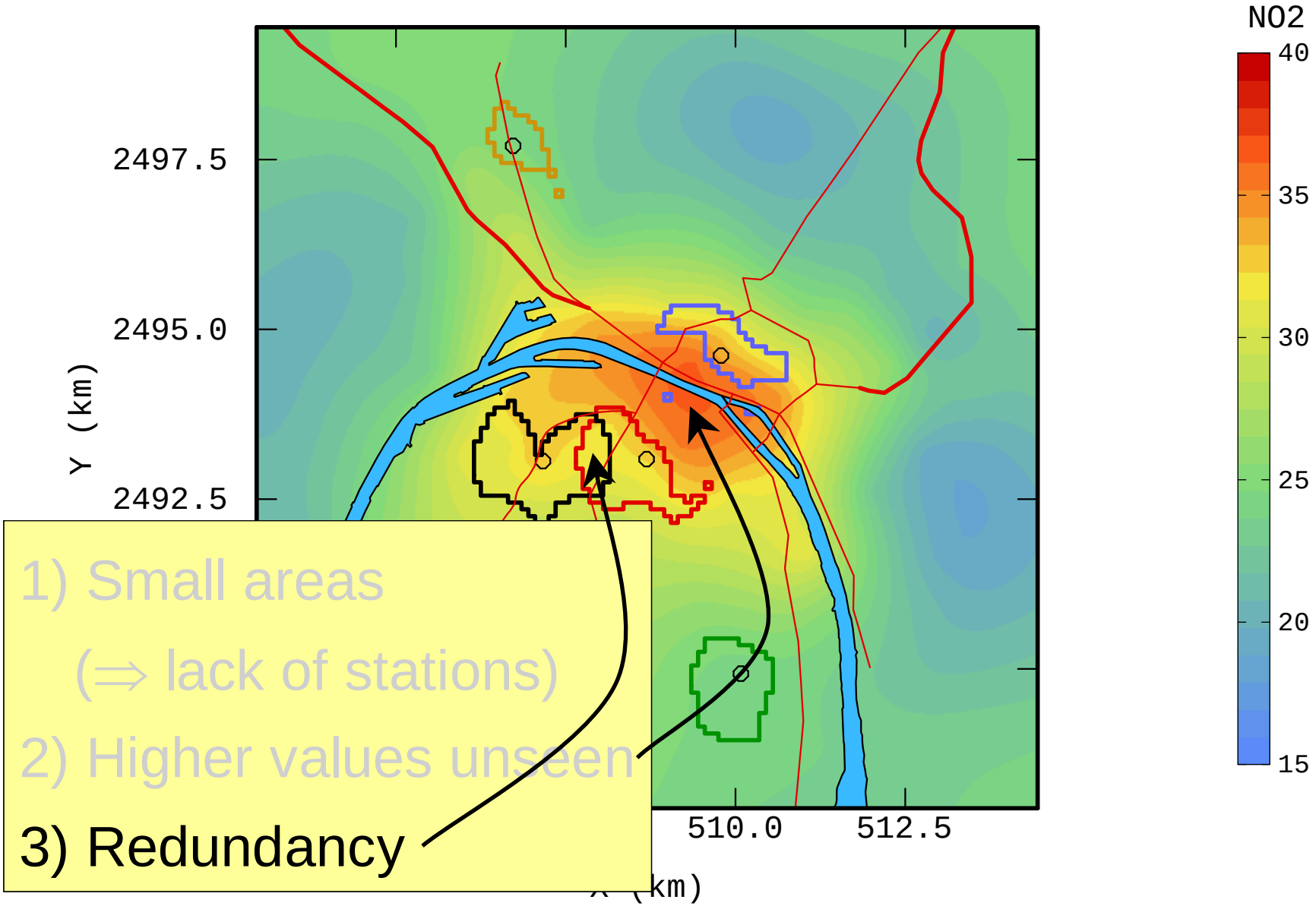


Results



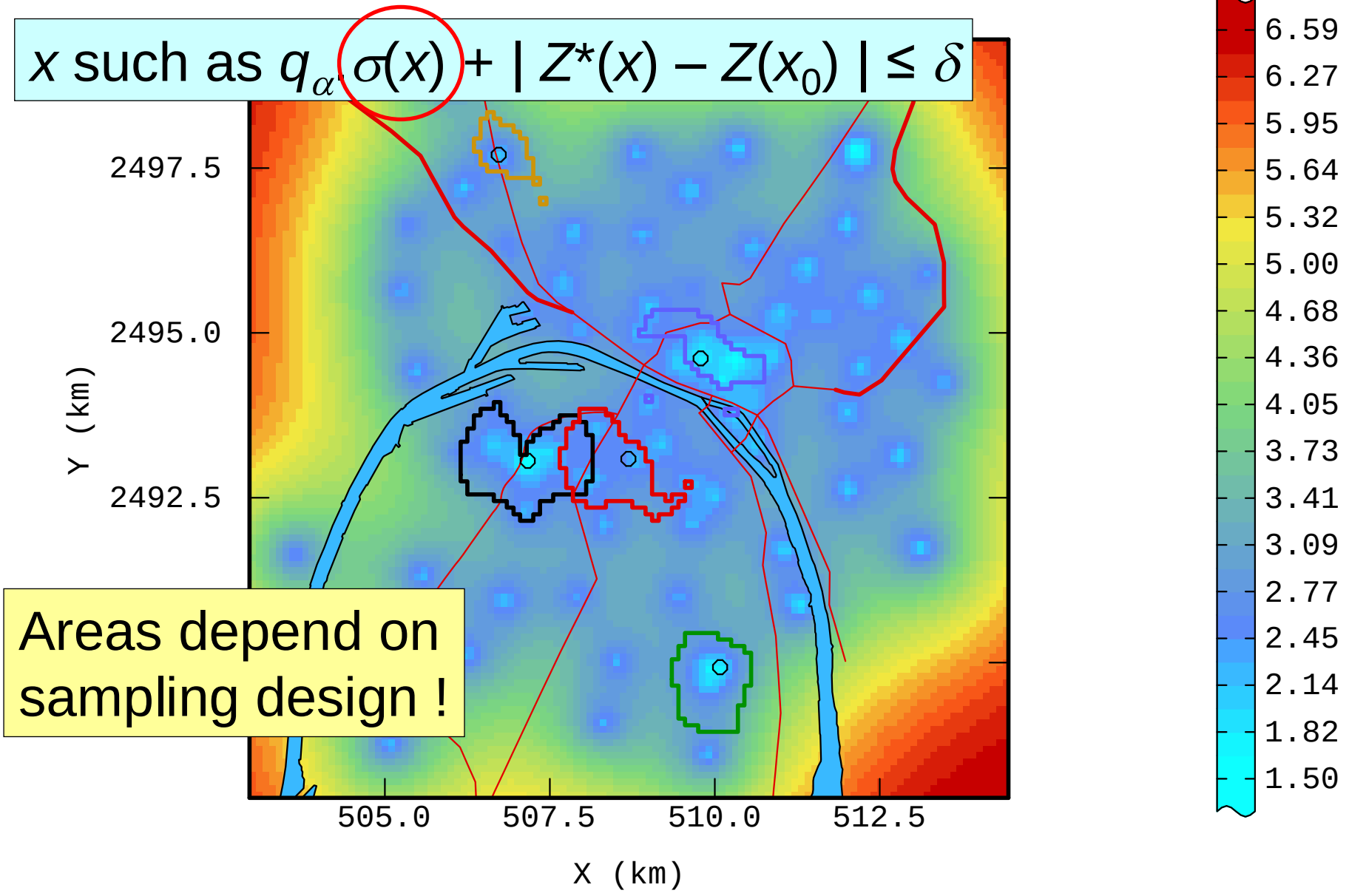
δ = 6 µg/m³
risk = 5 %
ⓘ limit = 1 km (range)

Interpretation



Discussion

x such as $q_\alpha \sigma(x) + | Z^*(x) - Z(x_0) | \leq \delta$



Areas depend on sampling design !

Conclusion

- Definition limited to areas of similar values
- Usefulness of ISATIS and Geostatistics to solve the problem
- Limit : representativeness is linked to the sampling design
- Using auxiliary variable leads to extended areas