Dioxins emitted from a municipal solid waste incinerator and risk for non-Hodgkin's lymphomas and soft-tissue sarcomas.

An ecoepidemiology case-study in Besançon, France.

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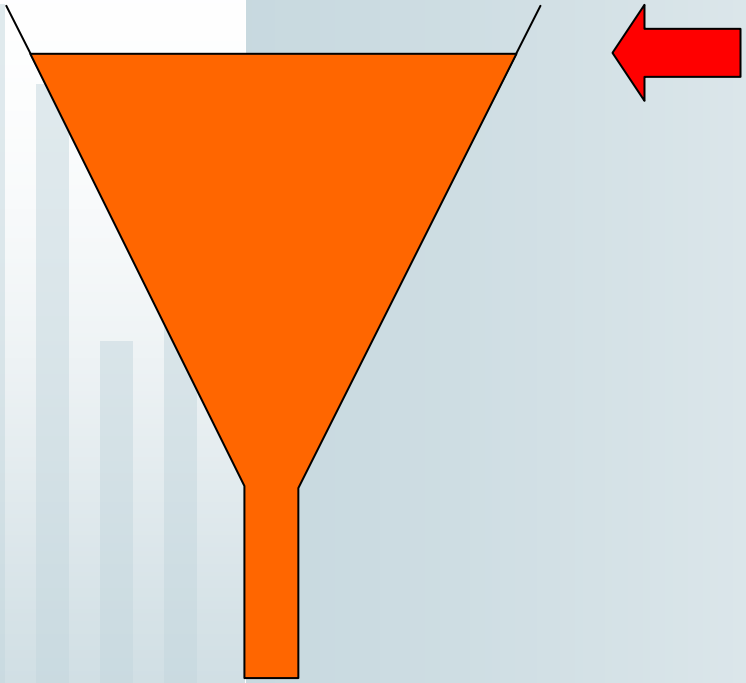
The municipal solid waste incinerator of Besançon, France

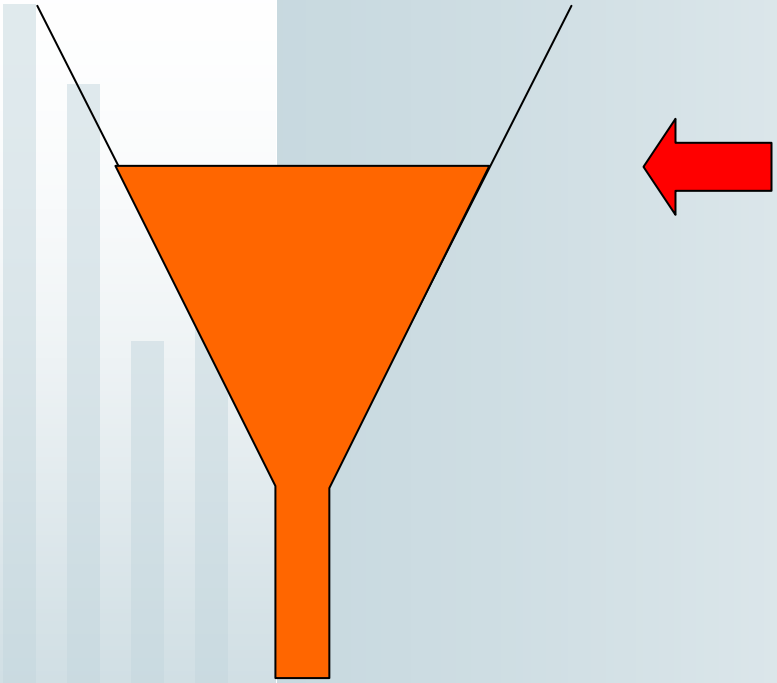
- Began operation in 1971.
- Located in an urbanized area.
- Capacity: 7.2 metric tons/hour.
- Stack: 40 m high.
- Processing: 67,000 tons of waste (1998).
- Emissions (1997):
  - dioxin: 16.3 ng I-TEQ / m^3,
  - dust: 315.6 mg / Nm^3,
  - hydrogen chlorine: 803.5 mg / Nm^3,
  - exhaust gases not maintained at temperatures ≥ 850°C for the legal time (> 2 s).

A funnel-shaped approach



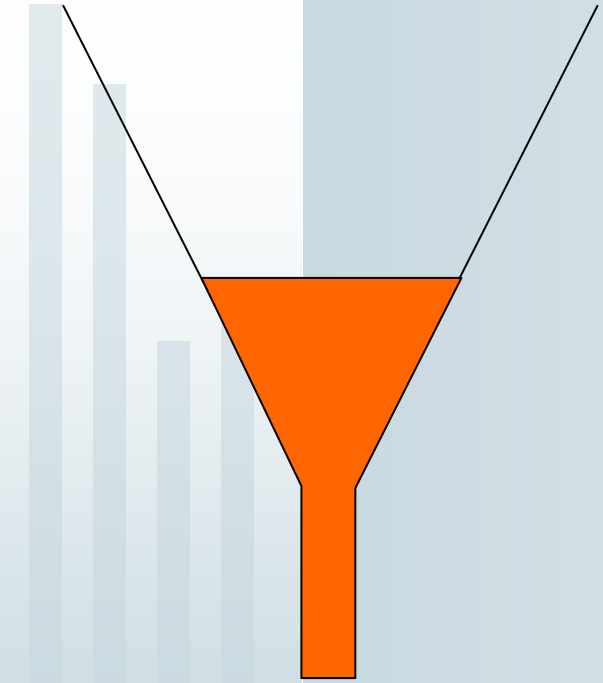
Macro-spatial step

A funnel-shaped approach



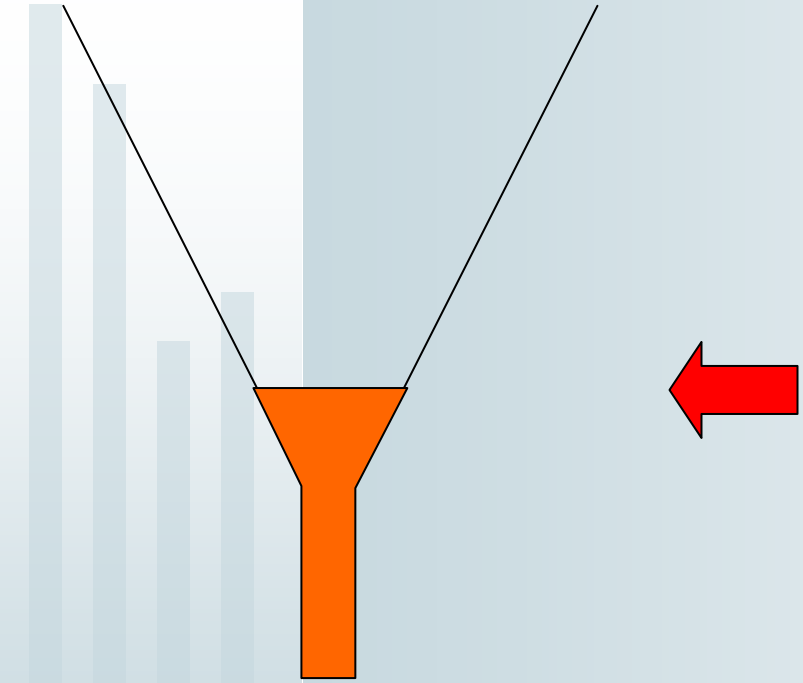
Micro-spatial step

A funnel-shaped approach



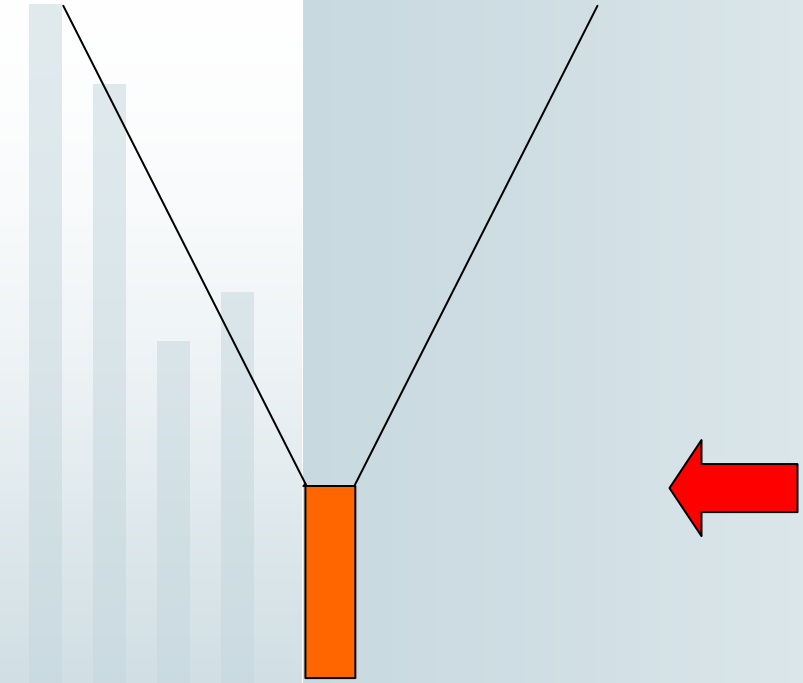
Validation of a diffusion model

A funnel-shaped approach



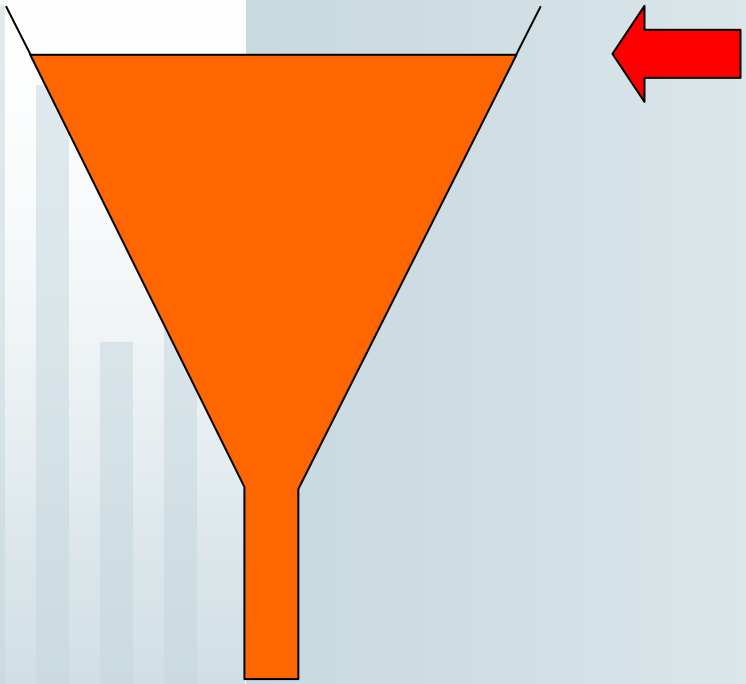
Dioxin measurements
in locally produced food

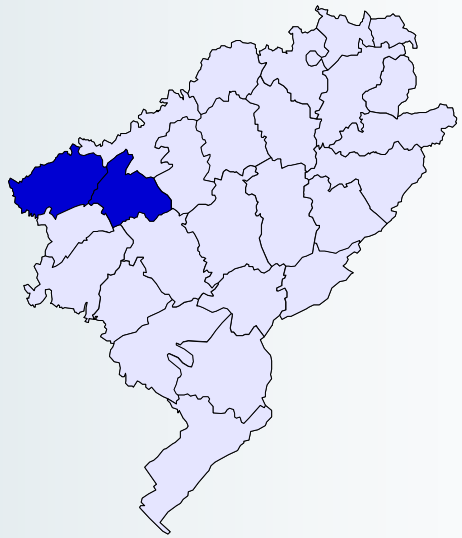
A funnel-shaped approach



Case-control study
with dioxin blood levels

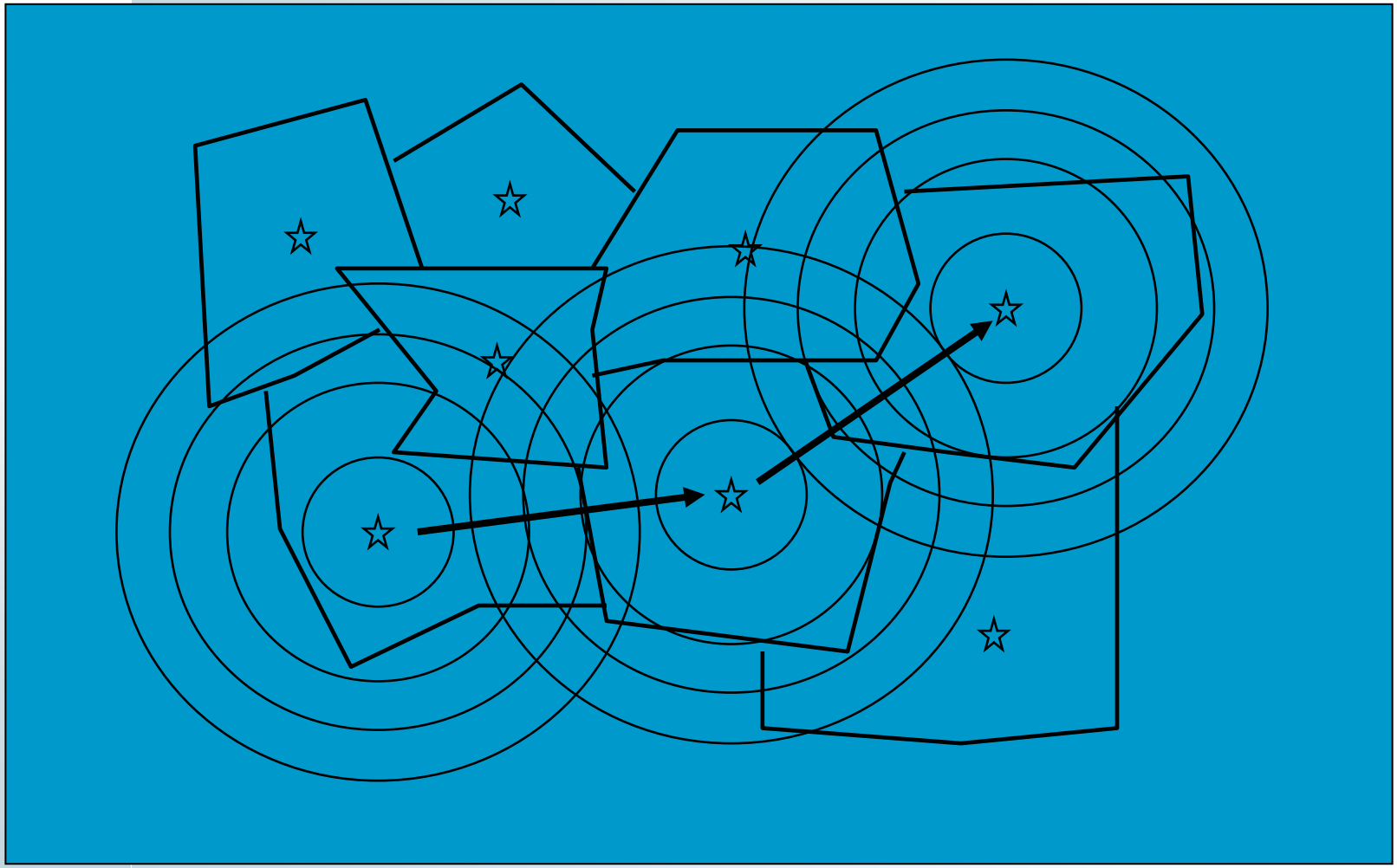
Macro-spatial step





Viel JF, Arveux P, Baverel J , Cahn JY. Soft–tissue sarcoma and non-Hodgkin's lymphoma clusters around a municipal solid waste incinerator with high dioxin emission levels. ***Am J Epidemiol*** *2000;152:13-19.*

Spatial scan test



Spatial scan test

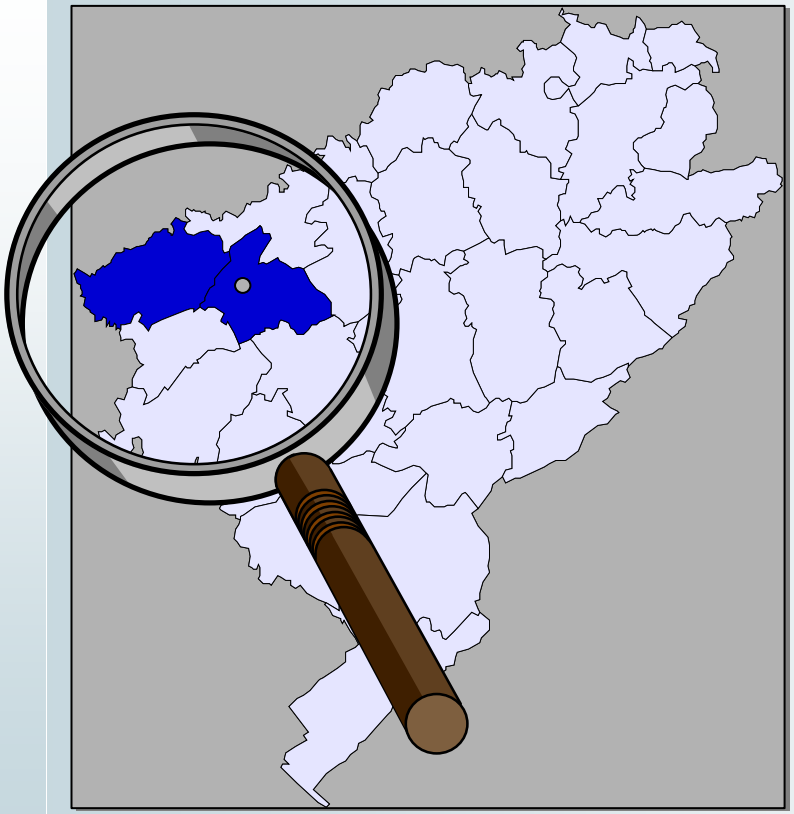
- For each location and size of the scanning window, the null hypothesis is that the risk of cancer is the same in all windows (complete spatial randomness), whereas the alternative hypothesis is that there is an elevated rate within compared with outside the window.
- The window which attains the maximum likelihood is identified as the most likely cluster.
- To find the distribution of the test statistic under the null hypothesis, Monte Carlo simulations (29 999) are carried out.

A priori reasoning

- **If, for STS and NHL:**
  - a significant cluster that includes the Besançon area is highlighted by the focused test,
  - a significant space-time interaction involving the recent years is found around the facility,
  - no other cluster is noticeable in the remaining area,
  - sub-analyses across gender are consistent,
- **but not for Hodgkin's disease.**
- **Then:**

  the study will support a relation between plant location and cancer incidence possibly mediated by dioxin emission.

Over-incidence



: Besançon, Audeux
: MSWI

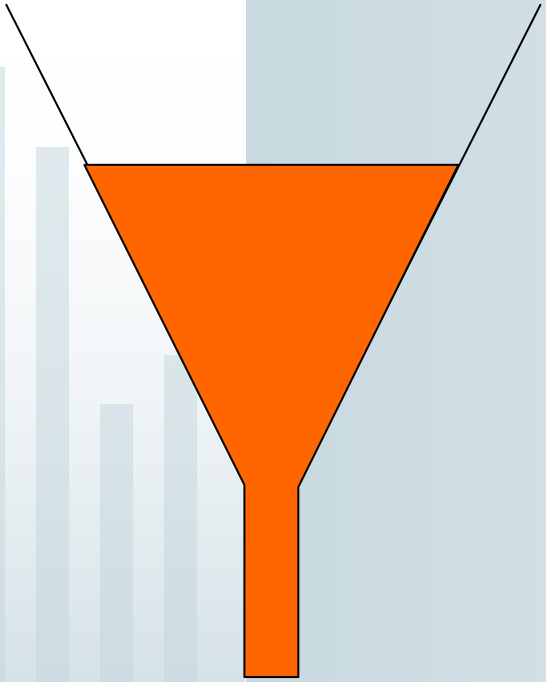
SIR NHL: 1.3 (1.1-1.4)
SIR STS: 1.4 (1.1-1.9)

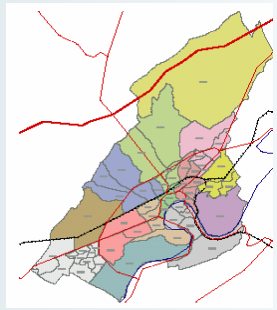
No cluster highlighted for Hodgkin's disease

Conclusion

- On the whole, the consistency of our findings for STS and NHL is remarkable. It is reinforced by the fact that no specific cluster was found for the control cancer category.
- These findings, together with the consistent results across gender, make us suspect an environmental pathway involving dioxin.
- However, caution should be exercised before these clusters are ascribed to dioxin released by the MSW incinerator.

Micro-spatial step





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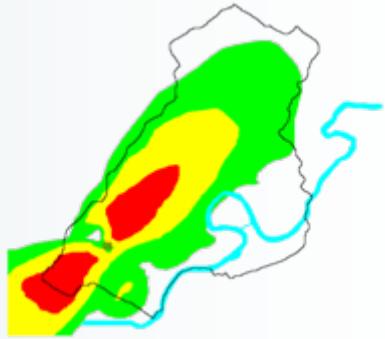
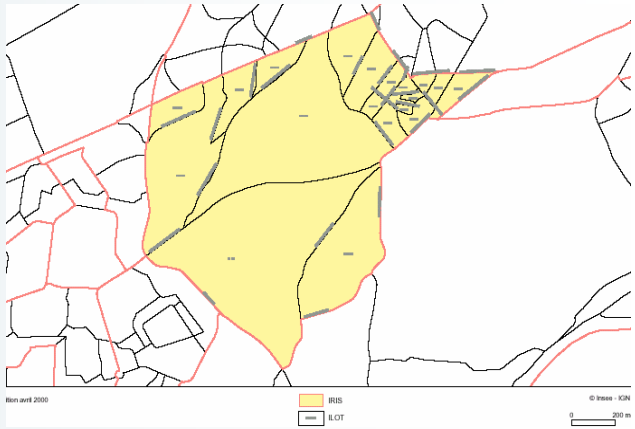


• *Floret N, Mauny F, Challier B, Arveux P, Cahn JY, Viel JF. Dioxin emissions from a solid waste incinerator and risk of non-Hodgkin lymphoma.* ***Epidemiology*** *2003;14:392-398.*

• *Floret N, Mauny F, Challier B, Cahn JY, Tourneux F, Viel JF. Dioxin emissions and soft-tissue sarcoma: results of a population-based case-control study.* ***Rev Epidem Santé Publique*** *2004;52:213-220.*

Micro-spatial step (2)

- Block:
  - the smallest level of geographic resolution,
  - typically a quadrangle bounded by four streets,
  - 705 blocks, averaging 161 inhabitants,
  - one age category is ascribed to each inhabitant (0-19, 20-39, 40-59, 60-74 and 75+ years), because of French privacy laws.

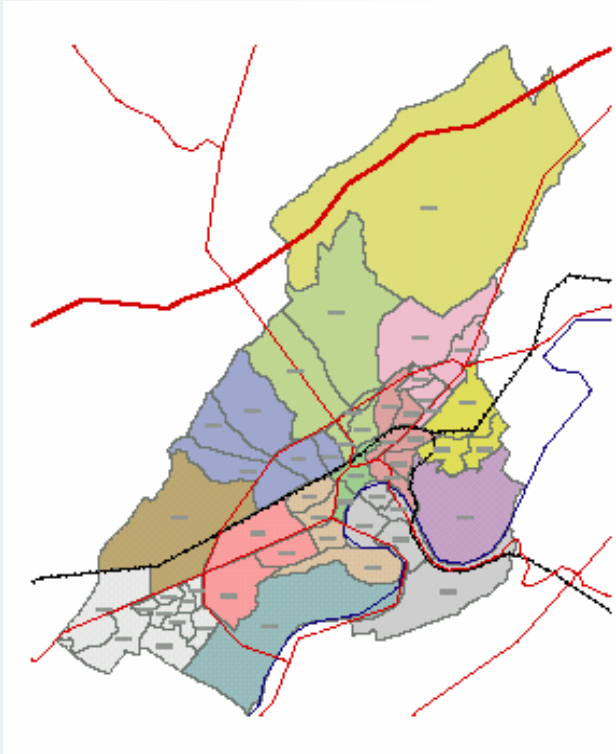


Micro-spatial step (3)

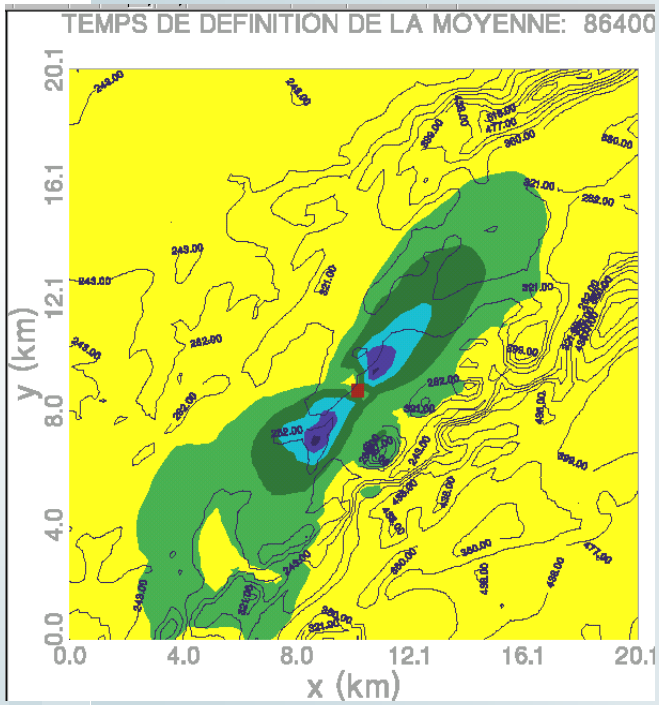
- Block group:
  - the 705 blocks of the study area

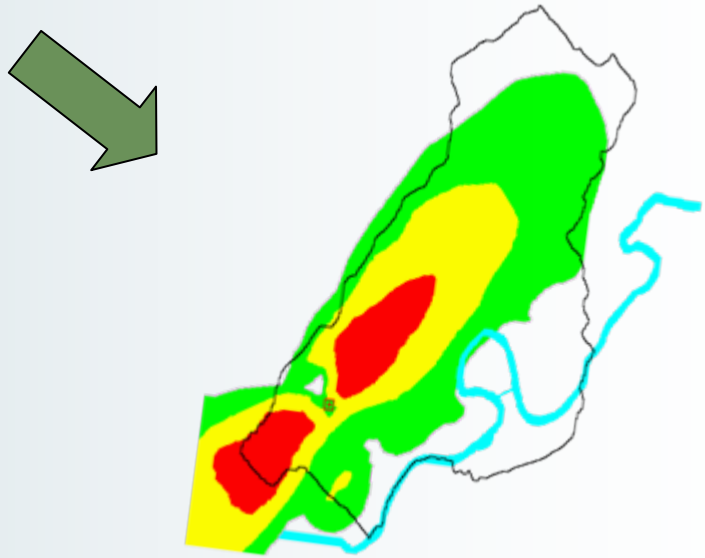
    are combined in 52 groups,
  - at this level many socio-economic status

    measures are available:
    - educational,
    - occupational,
    - household-based indicators,
    - etc.



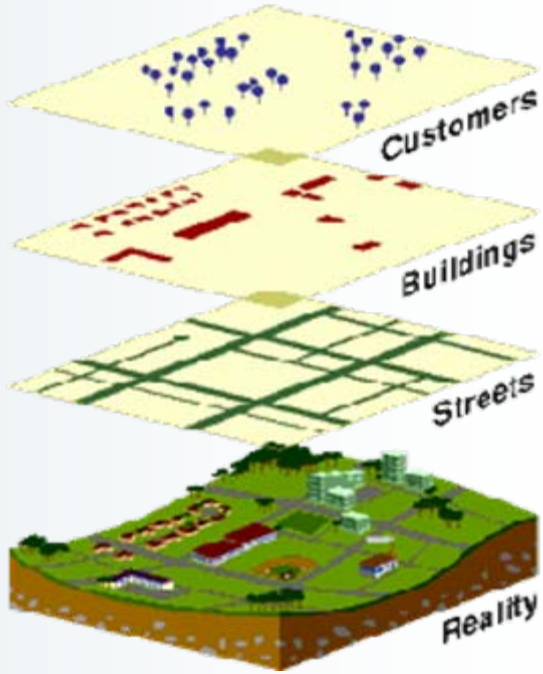
Atmospheric diffusion model





Population and methods

- Geographic information system:
  - location of residence (cases),
  - block of residence (controls),
  - block group (socio-economic variables),
  - modeled dioxin contours (exposure).
- Conditional logistic regression :
  - dependent variable: case/control status,
  - independent variable: dioxin exposure level.
- Multi-level analyses: individuals, block groups.



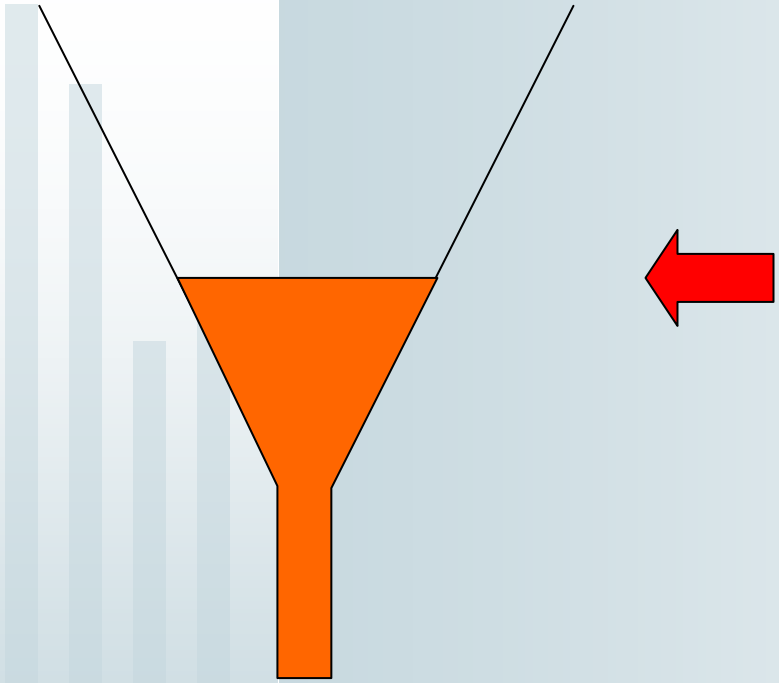
Association of NHL with dioxin exposure

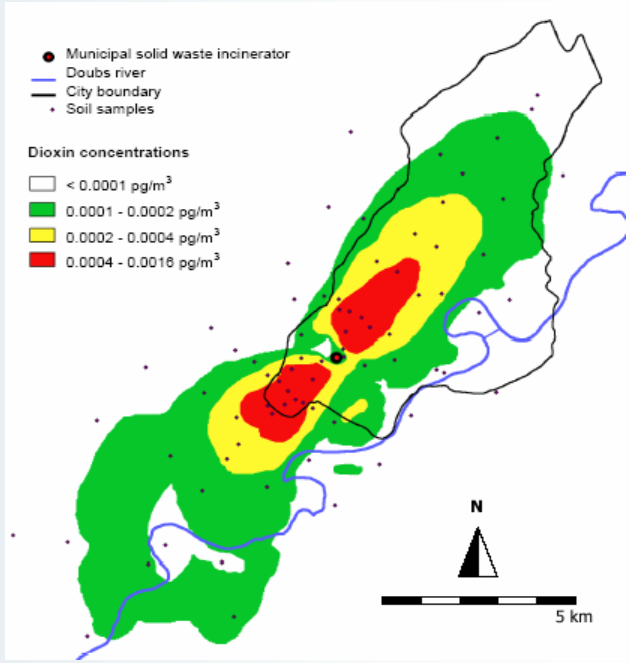
Dioxin exposure	Cases	Controls	OR (95% CI)
Very low	42	441	1.0
Low	91	952	1.0 (0.7-1.5)
Intermediate	58	681	0.9 (0.6-1.4)
High	**31**	**146**	**2.3 (1.4-3.8)**

Association of STS with dioxin exposure

Dioxin exposure	Cases	Controls	OR (95% CI)
Very low	5	74	1
Low	15	145	1.2 (0.4-3.4)
Intermediate	15	126	1.4 (0.5-4.1)
High	2	25	0.9 (0.2-5.1)

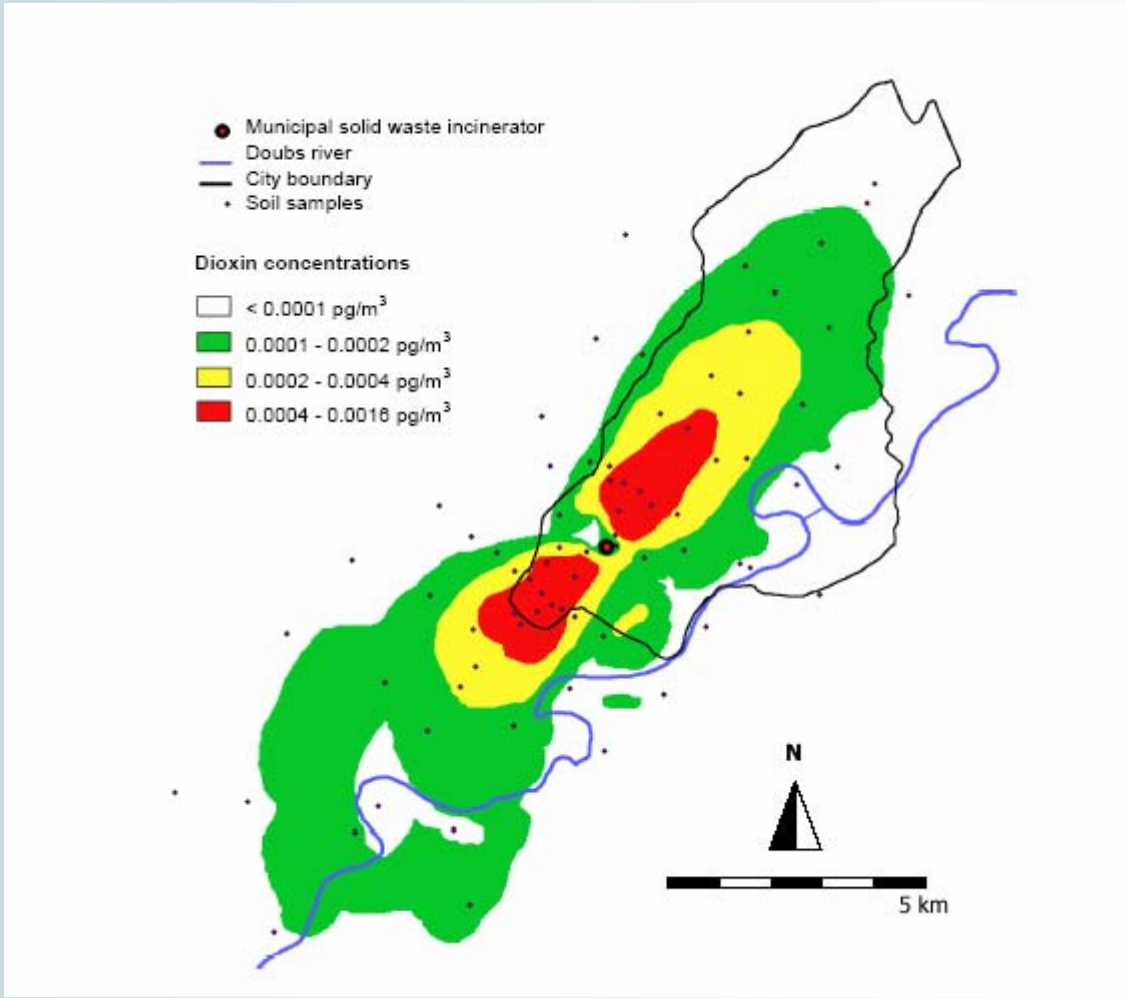
Validation of an atmospheric diffusion model for dioxin exposure assessment.





Floret N, Viel J-F, Lucot E, Dudermel P-M, Cahn J-Y, Badot P-M, Mauny F. Dispersion modeling as a dioxin exposure indicator in the vicinity of a municipal solid waste incinerator: a validation study. ***Environ Sci Technol*** *2006;40:2149-2155.*

Validation of an atmospheric diffusion model for dioxin exposure assessment.



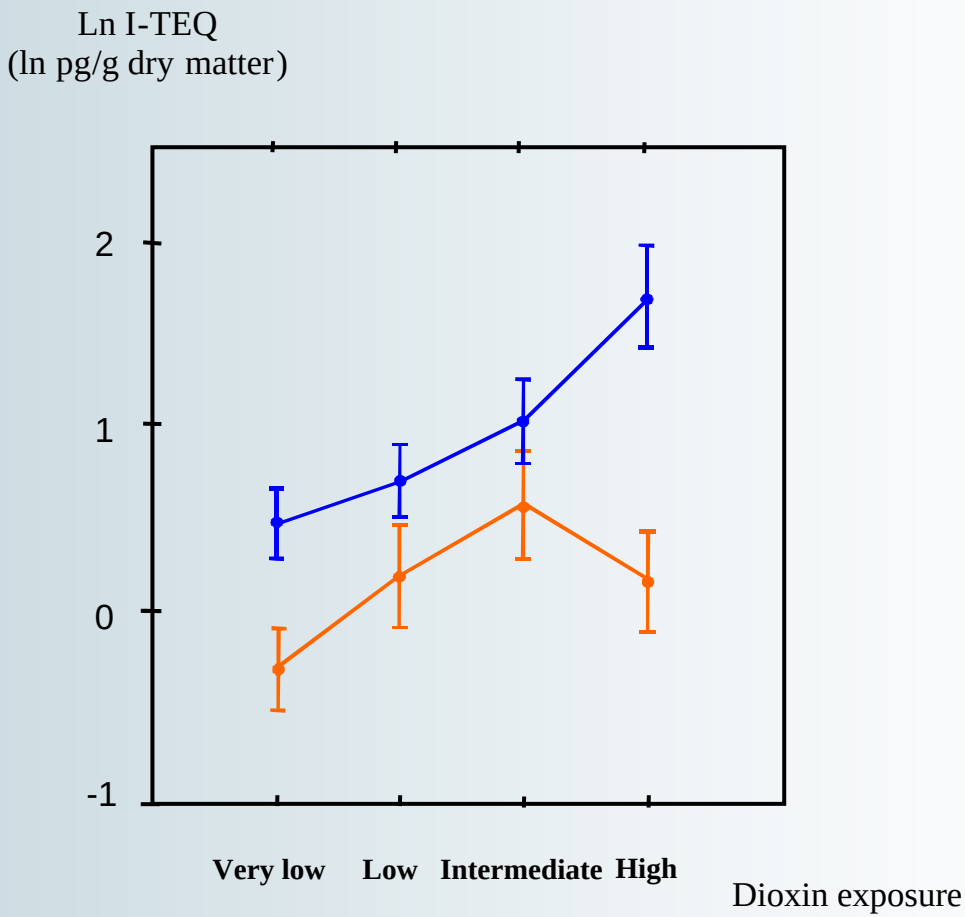
Dioxin soil concentrations

- Range = 0.25 - 28.06 pg WHO-TEQ/g dry matter.
- Means (standard deviations), per geographic-based exposure and topography complexity categories.

Geographic-based exposure	Very low	Low	Intermediate	High
Complex topography	1.09 (1.76)	2.44 (3.53)	1.91 (1.12)	1.37 (0.21)
Simple topography	1.81 (1.14)	1.99 (1.37)	3.53 (2.30)	11.25 (12.39)

pg WHO-TEQ/g dry matter.

Adjusted means of log-transformed dioxin concentration per dioxin exposure categories



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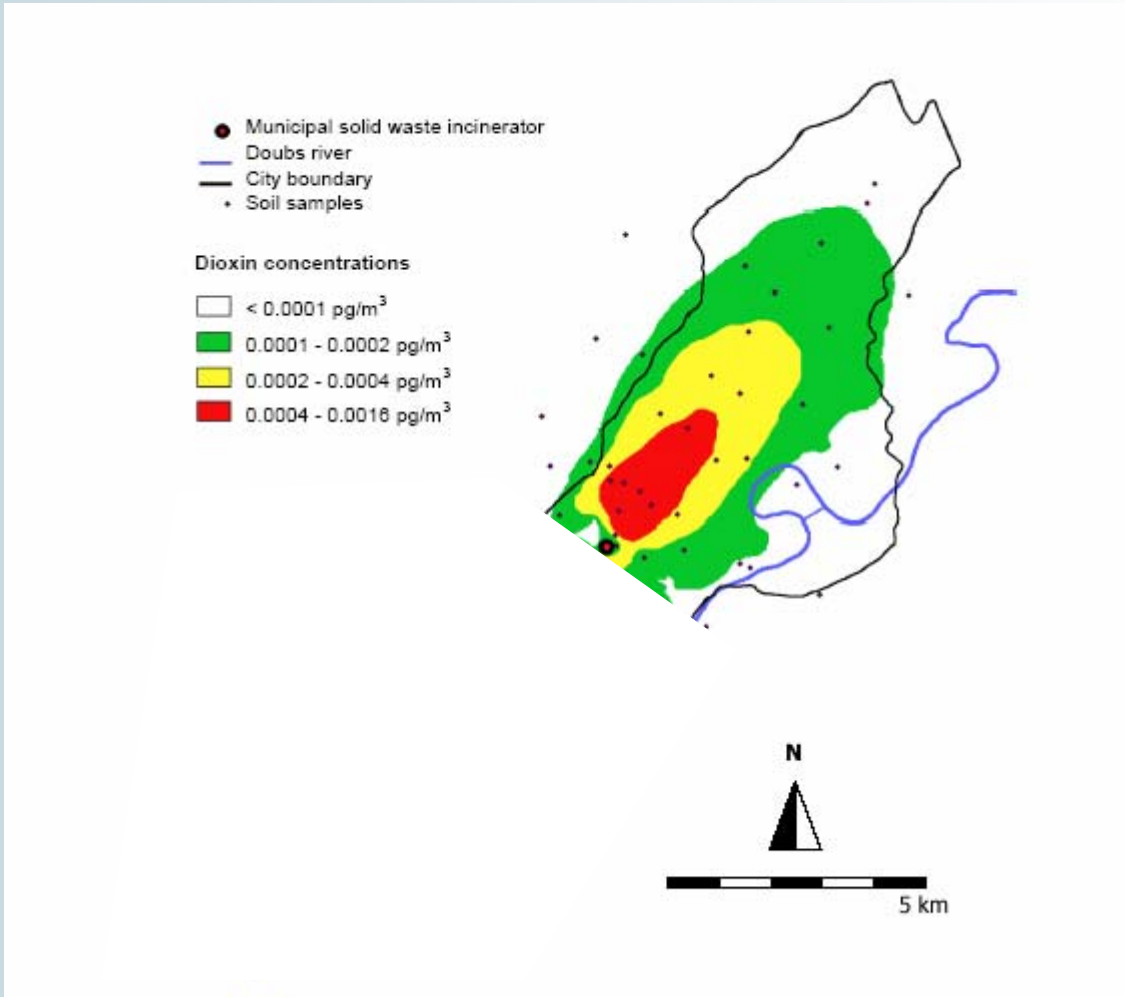
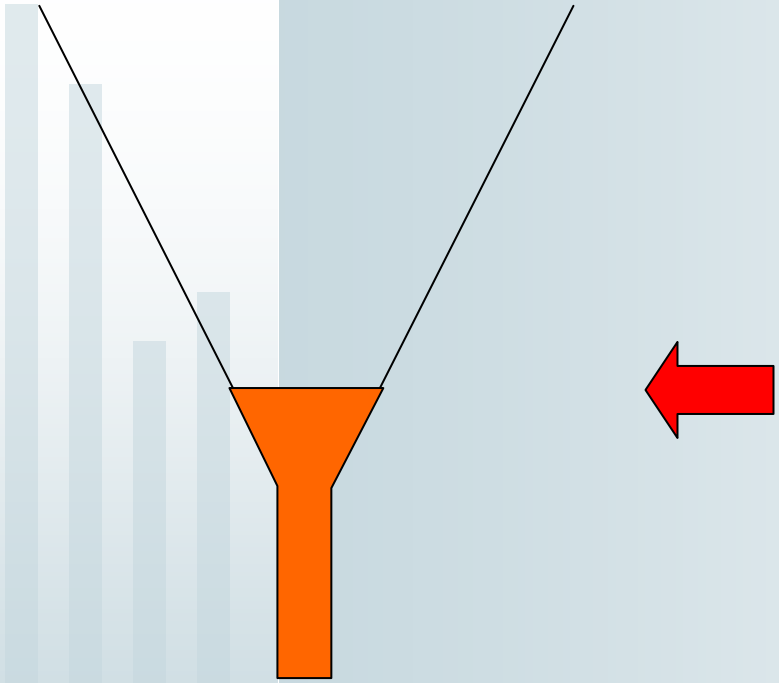
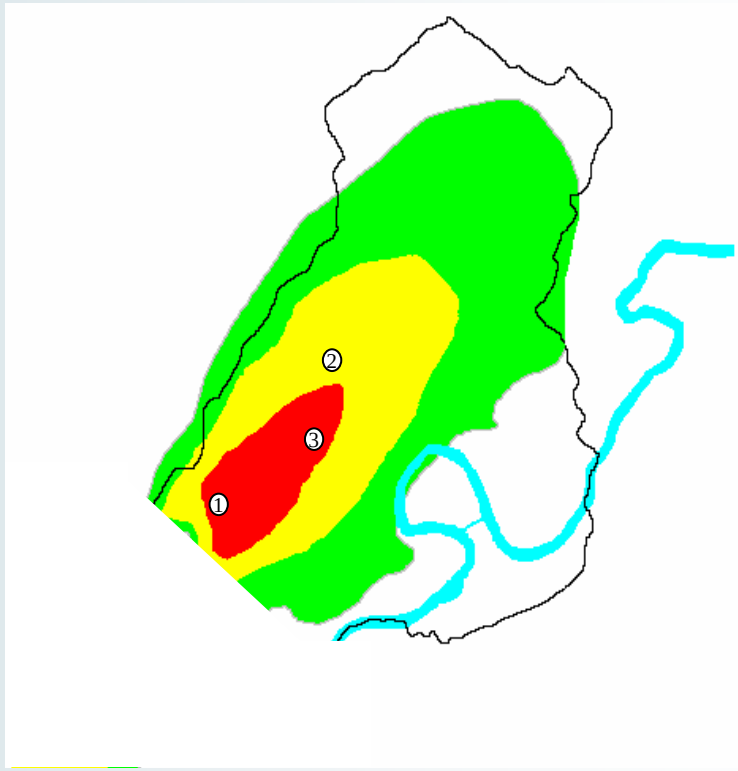


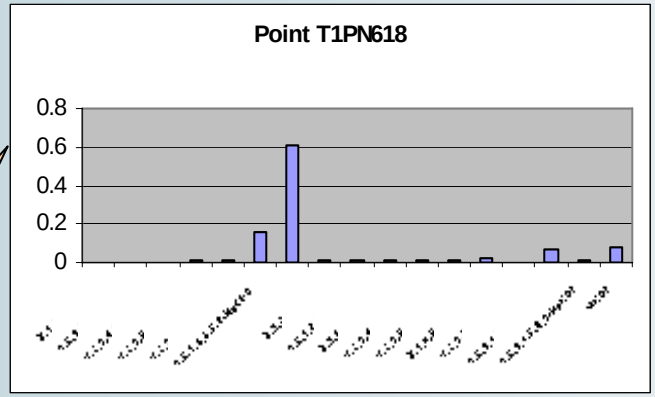
Dioxin measurements in locally produced eggs.

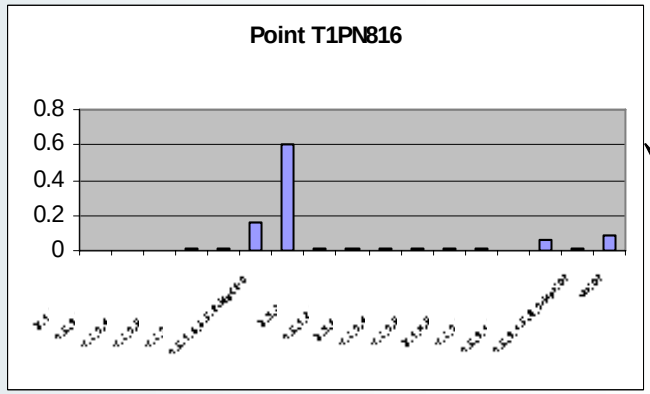




Publication in progress.

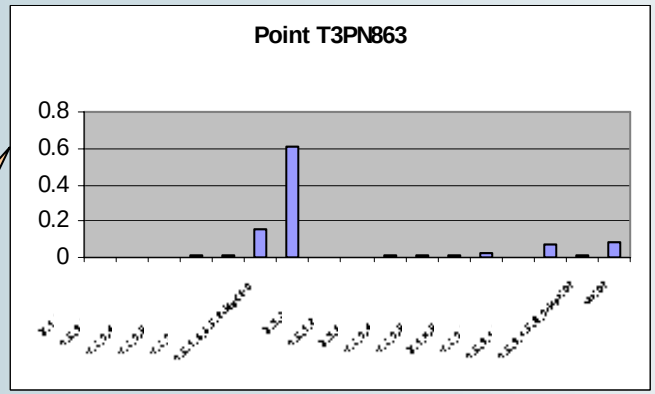
2,86 TEQ pg/g mg

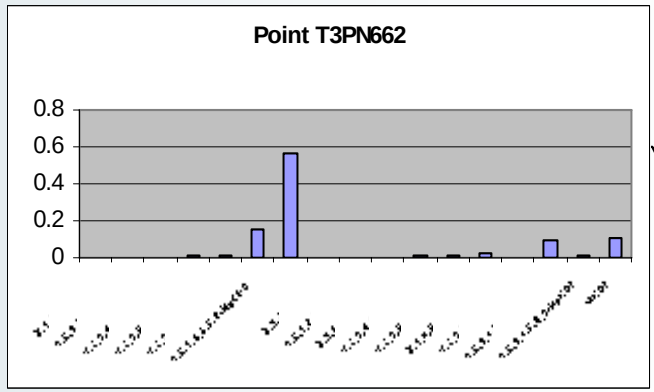




2,39 TEQ pg/g mg

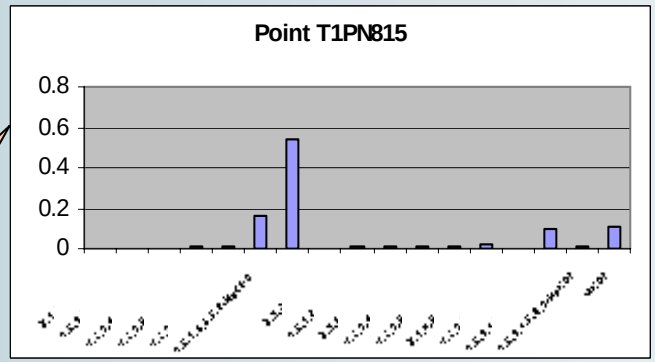
3,65 TEQ pg/g mg

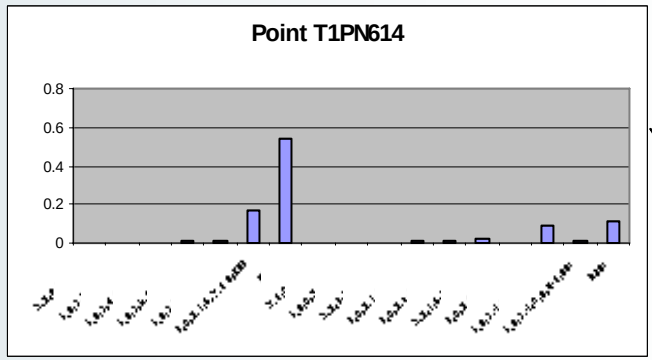




4,44 TEQ pg/g mg

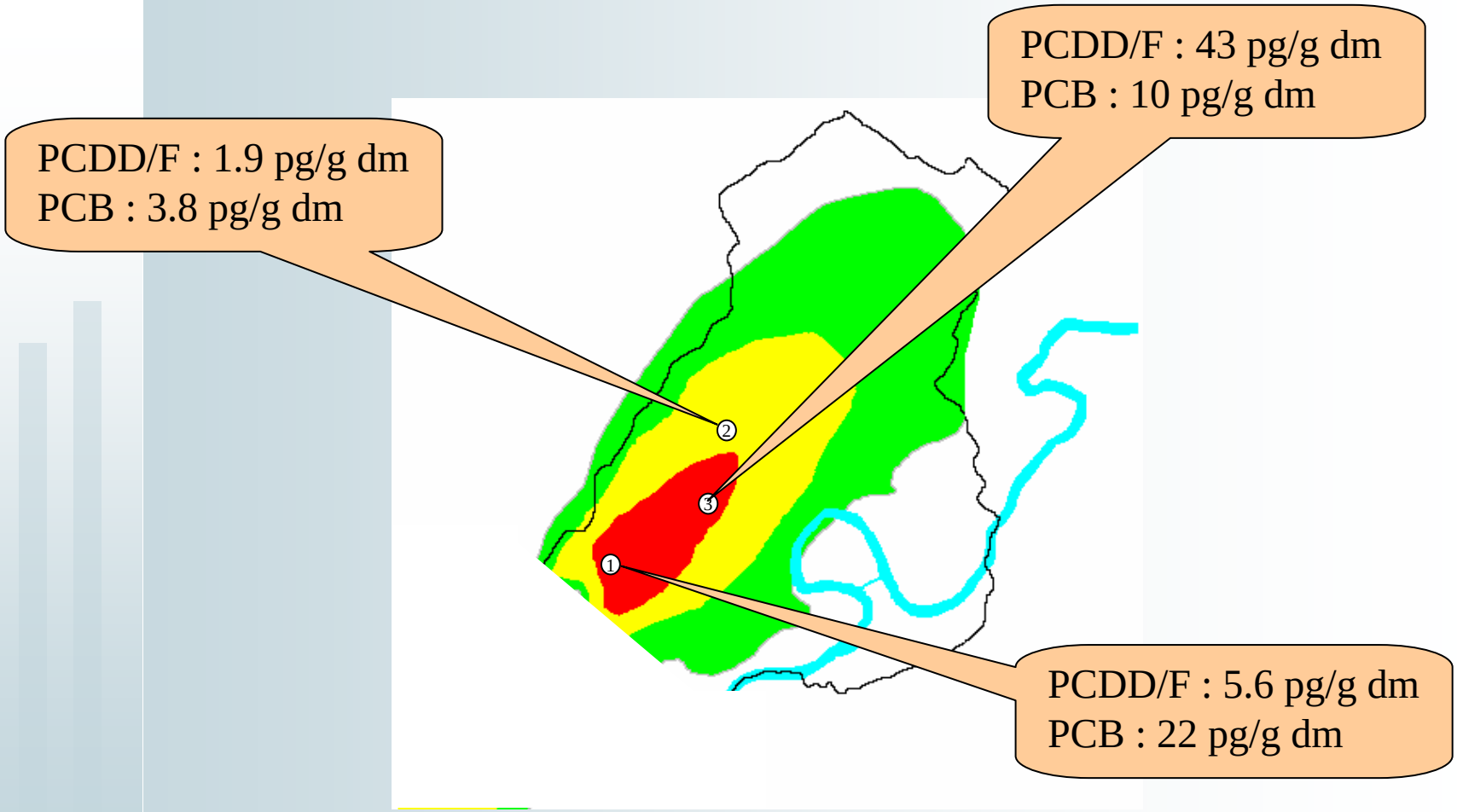
26,1 TEQ pg/g mg

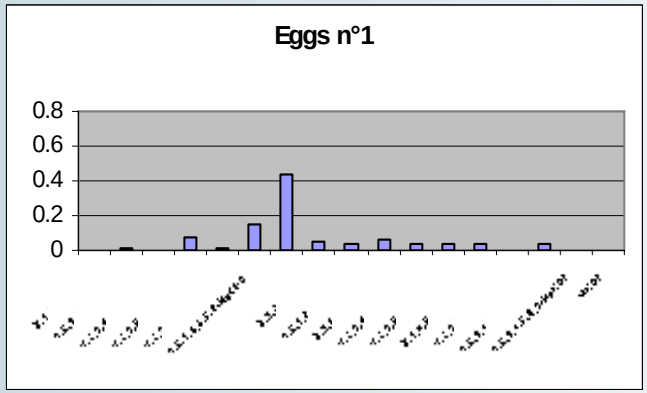




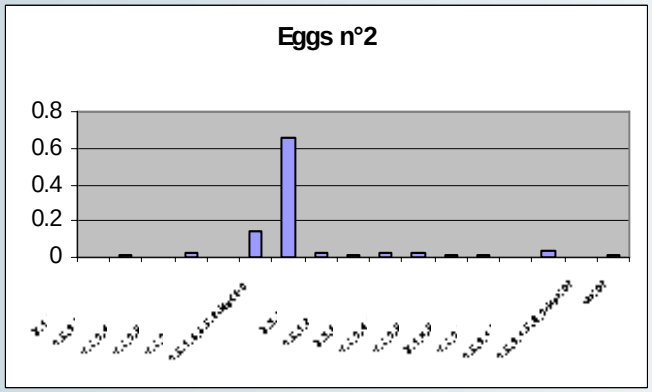
28,06 TEQ pg/g mg

PCDD/F and dioxin-like PCB concentrations in locally produced eggs.

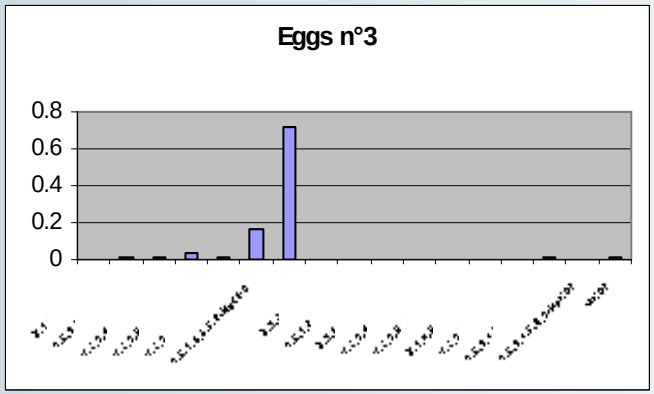




5,6 TEQ pg/g mg



1,9 TEQ pg/g mg



43 TEQ pg/g mg

Case-control study with dioxin and pesticide blood levels

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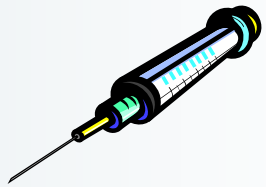
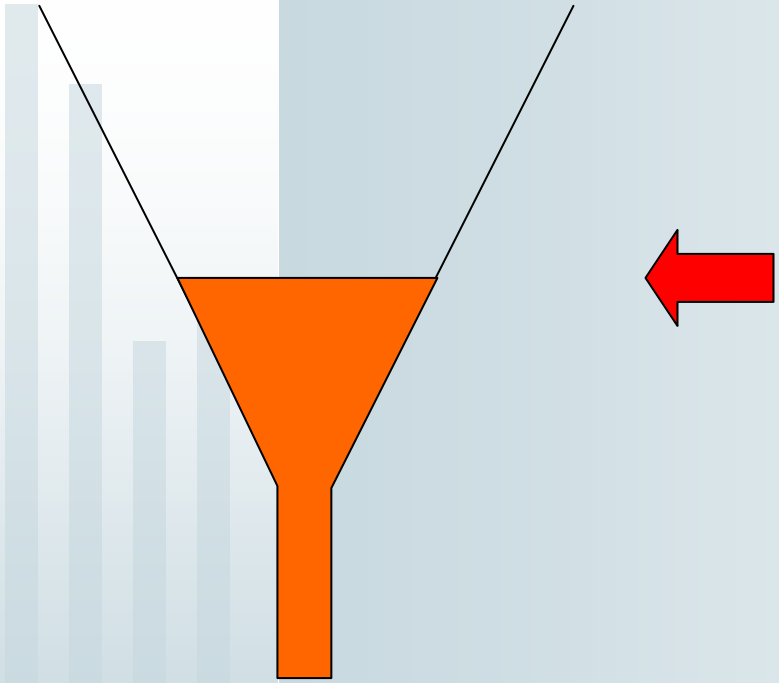


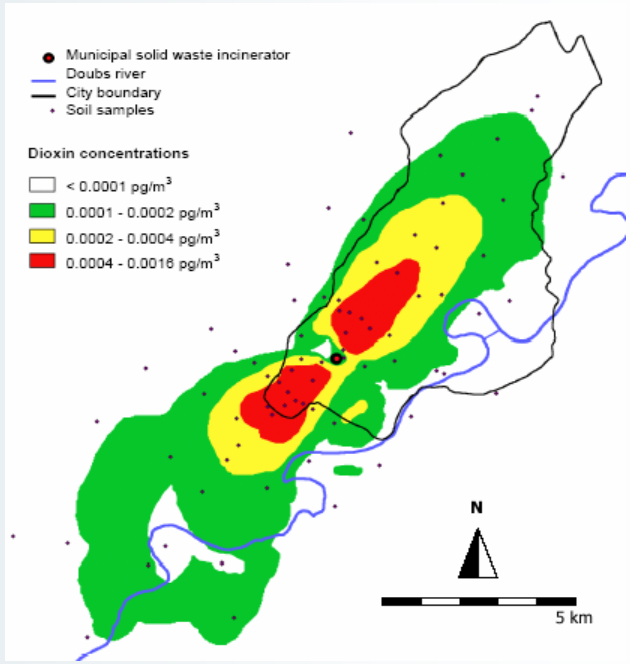
Causality ?

Results due in one year.

Thank you
for your kind attention

The MSWI as the single dominant point source of PCDD/Fs.





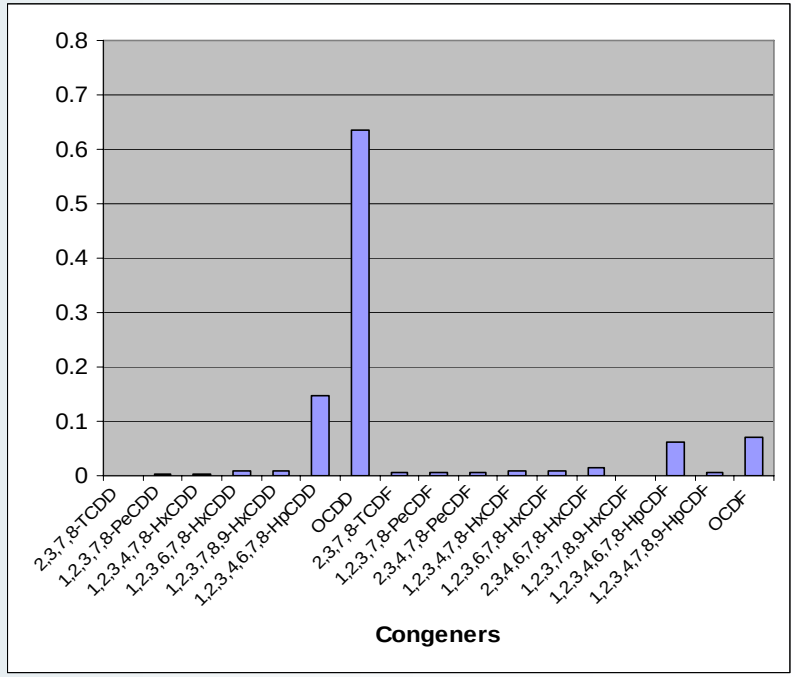
Floret N, Lucot E, Badot PM, Mauny F, Viel JF. A municipal solid waste incinerator as the single dominant point source of PCDD/Fs in an area of increased non-Hodgkin's lymphoma incidence. ***Chemosphere*** *2007;68:1419–1426.*

Background and aim

- Although the dispersion modeling of dioxin emissions from the MSWI was validated, there was still some local controversy regarding the source(s) of the PCDD/Fs deposited onto soils.
- The aim of this survey was therefore to examine the nature of the PCDD/F soil contamination in the surroundings of the MSWI, to characterize whether more than one potential emission source could explain the presence of the PCDD/Fs.

Material and methods

- The analysis of congener profiles allows an easy visual estimation of the possible incidence of individual sources.
- PCDD/F congener profiles were determined in 75 soil samples collected in the vicinity of the MSWI.
- They were compared according to the most environmentally impacted zones and to various spatial contrasts to evaluate possible similarities and/or discrepancies.



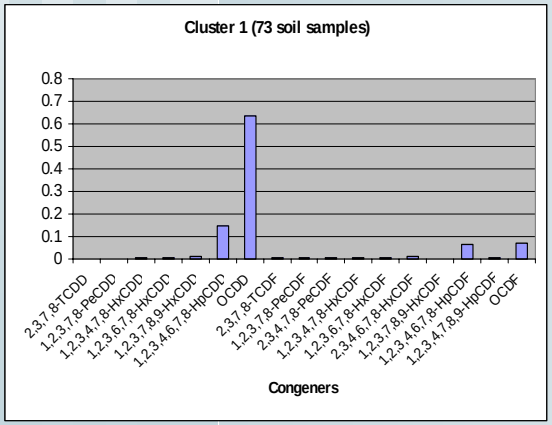
Material and methods (2)

- To identify the most environmentally impacted zones, two complementary cluster analyses were carried out:
  - an unsupervised neural network-based clustering technique,
  - a fuzzy k-means unsupervised classification procedure.
- Moreover, various spatial contrasts were considered:
  - topography (simple versus complex topography),
  - urbanization (inside versus outside the city boundary),
  - modelled dioxin exposure (the two most exposed areas under direct influence of the facility versus the two least exposed areas).

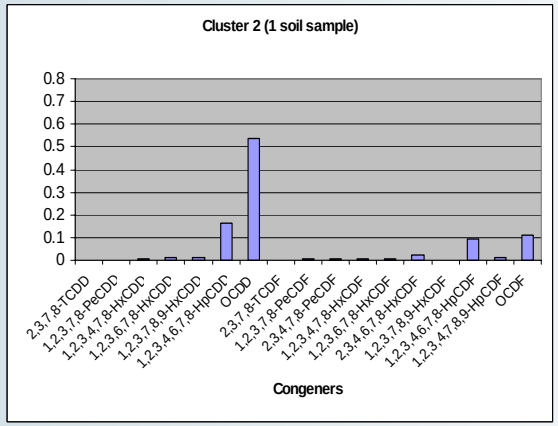
Results

- One main cluster, consisting of 73 soil samples, was identified.
- The remaining two samples, located in the most exposed zone in the north–east direction, were either aggregated in one single cluster or represented as many single-sample clusters.
- Although, they differed in their mean WHO–TEQ concentrations, reflecting the degree of pollution, their respective congener profiles were of the same pattern.

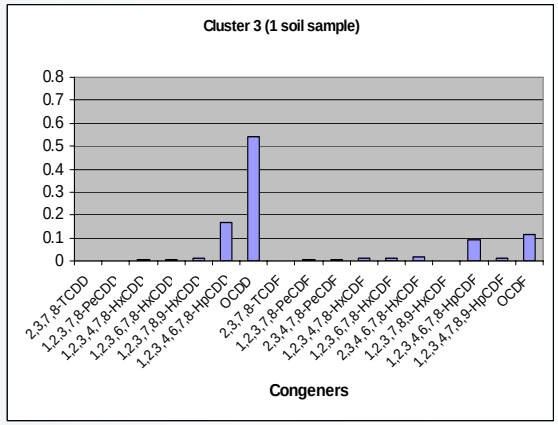
2.03 pg g^{-1} dm



26.10 pg g^{-1} dm

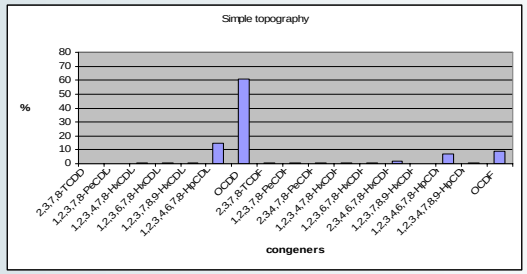


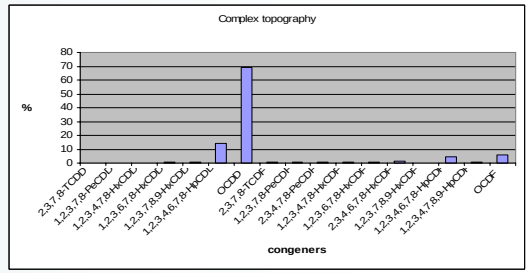
28.06 pg g^{-1} dm

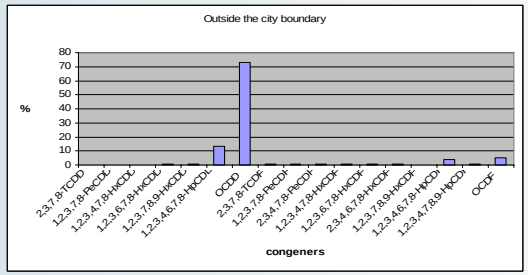


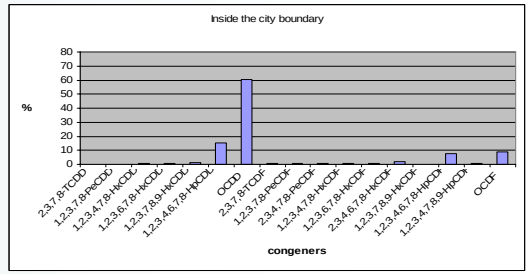
Results (2)

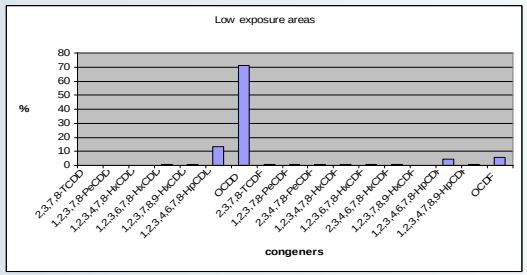
- No contrast was observed for congener distributions between:
  - simple and complex topographies,
  - outside and inside the city boundary,
  - the two least and the two most exposed areas,
- reflecting a common fingerprint.

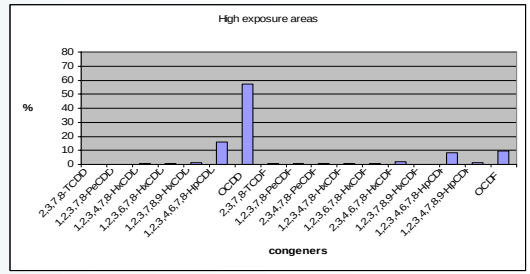












Conclusion

- The sampling site selection process, the high similarities in the congener profiles, and the absence of other polluting industries allow us to conclude that the presence of PCDD/Fs in the area under influence of the MSWI is not subject to other point sources of PCDD/Fs.
- Therefore, since the most polluting combustion chambers were recently shut down, and replaced by a new one with up-to-date pollution controls, slowly decreasing dioxin concentration in soils are to be expected in the study area.