

# Study of atmospheric depositions around the Porto waste incinerator

How Scanning Electron Microscopy helps to dissipate public  
concern

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Magali Riou, Tauw France



Although Industrial sector is not the main responsible of air pollution ...



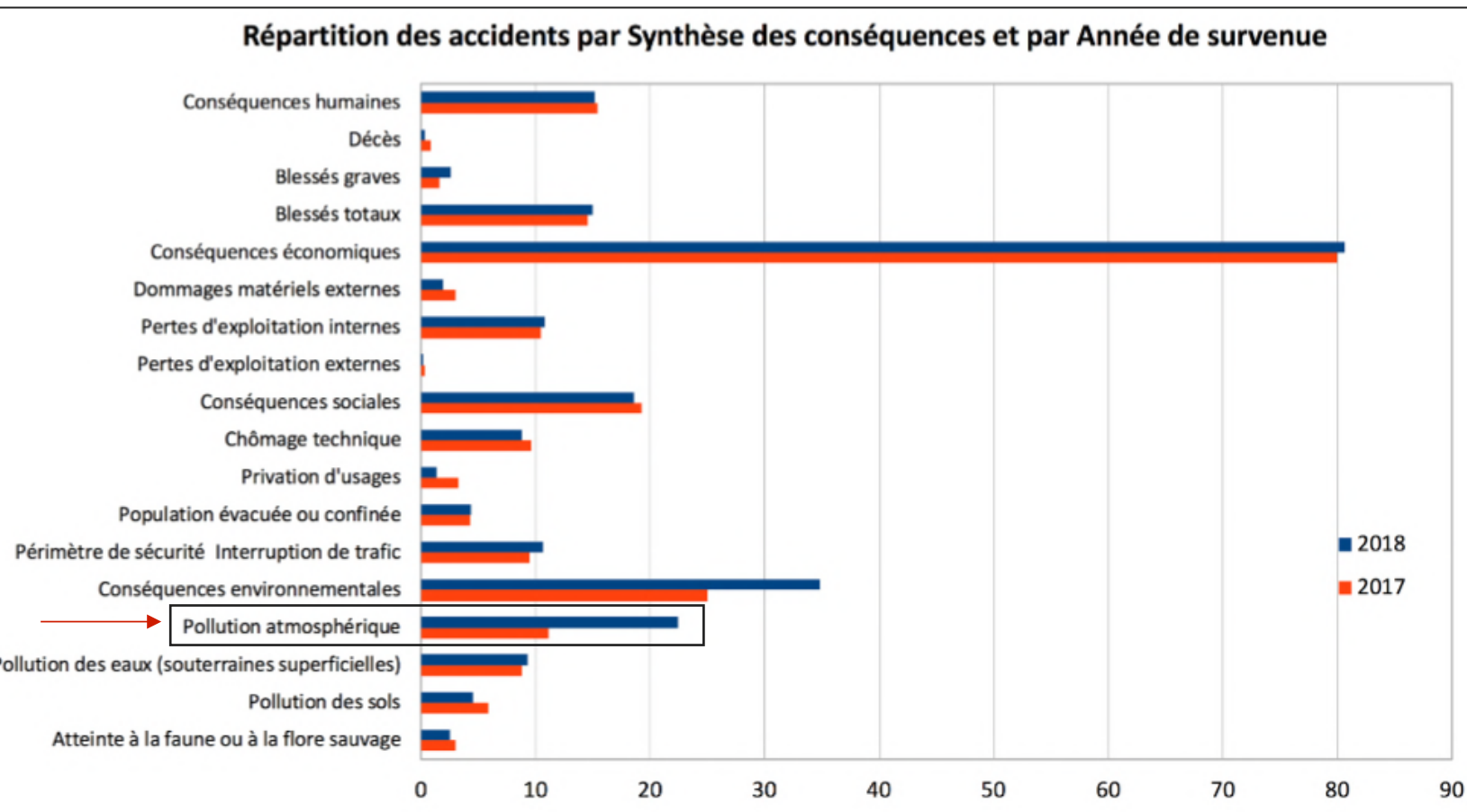
... it is responsible every year of accidents with serious and traumatic consequences for populations



# Introduction

## Technological accidents in 2018

*Inventaire 2018 des accidents technologiques, Bureau d'Analyse des Risques et Pollutions Industrielles, ISSN : 2118 8858*



- **Increase of accident number:** 827 in 2016, 978 in 2017 and 1 112 2018
- Human, environmental and economic consequences
- **Air pollution** >> soil and water pollution
- 2 times more of air pollution in 2018 than in 2017



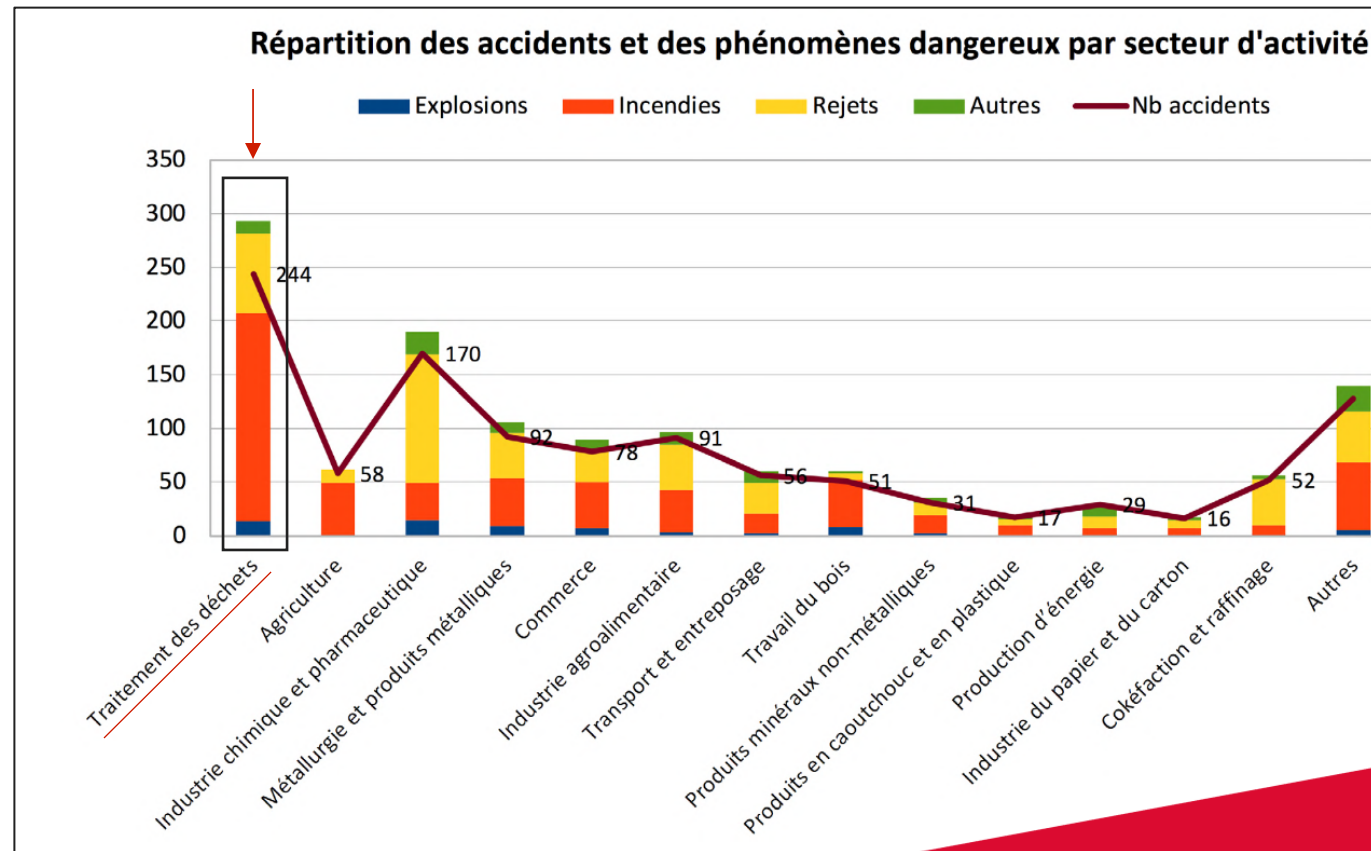
# Introduction

## Technological accidents in 2018

*Inventaire 2018 des accidents technologiques, Bureau d'Analyse des Risques et Pollutions Industrielles, ISSN : 2118 8858*

- **Waste treatment** is the activity with the most number of accidents in France (~ 250)
  - More than chemical industry
- Mainly due to pollutant releases and fires

➔ This observations have impacted our work in Tauw





# Introduction

Sustainable Solutions for a Better Environment

## Tauw activities in atmospheric pollutions



Tauw Group is an international firm of consulting engineers, present in 6 countries in Europa.

We work on diverse environmental projects: soil and groundwater remediation, environmental, water treatment, preservation of ecosystems ...

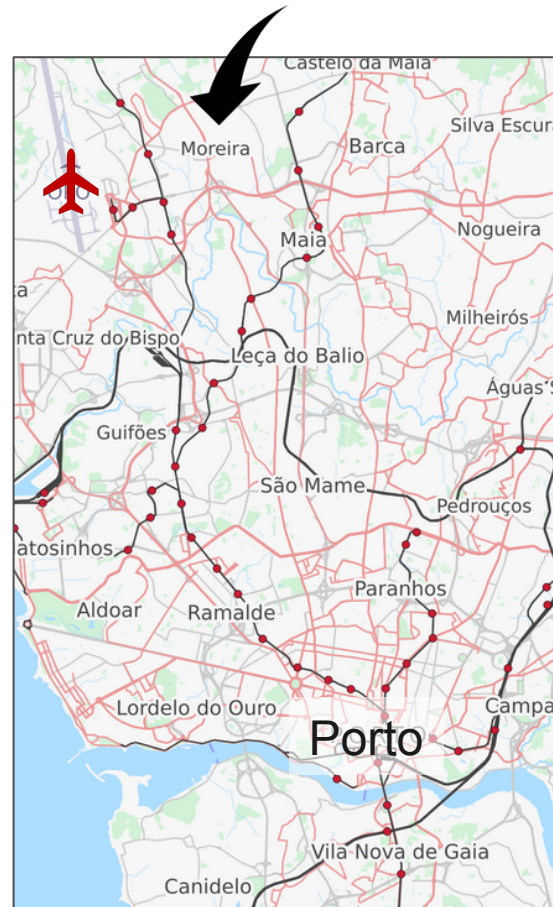
Increase of studies on **air quality, impact of atmospheric releases** from waste treatment or other process, environmental **investigations**. À compléter





# Introduction

## Moreira da Maia city (Portugal)



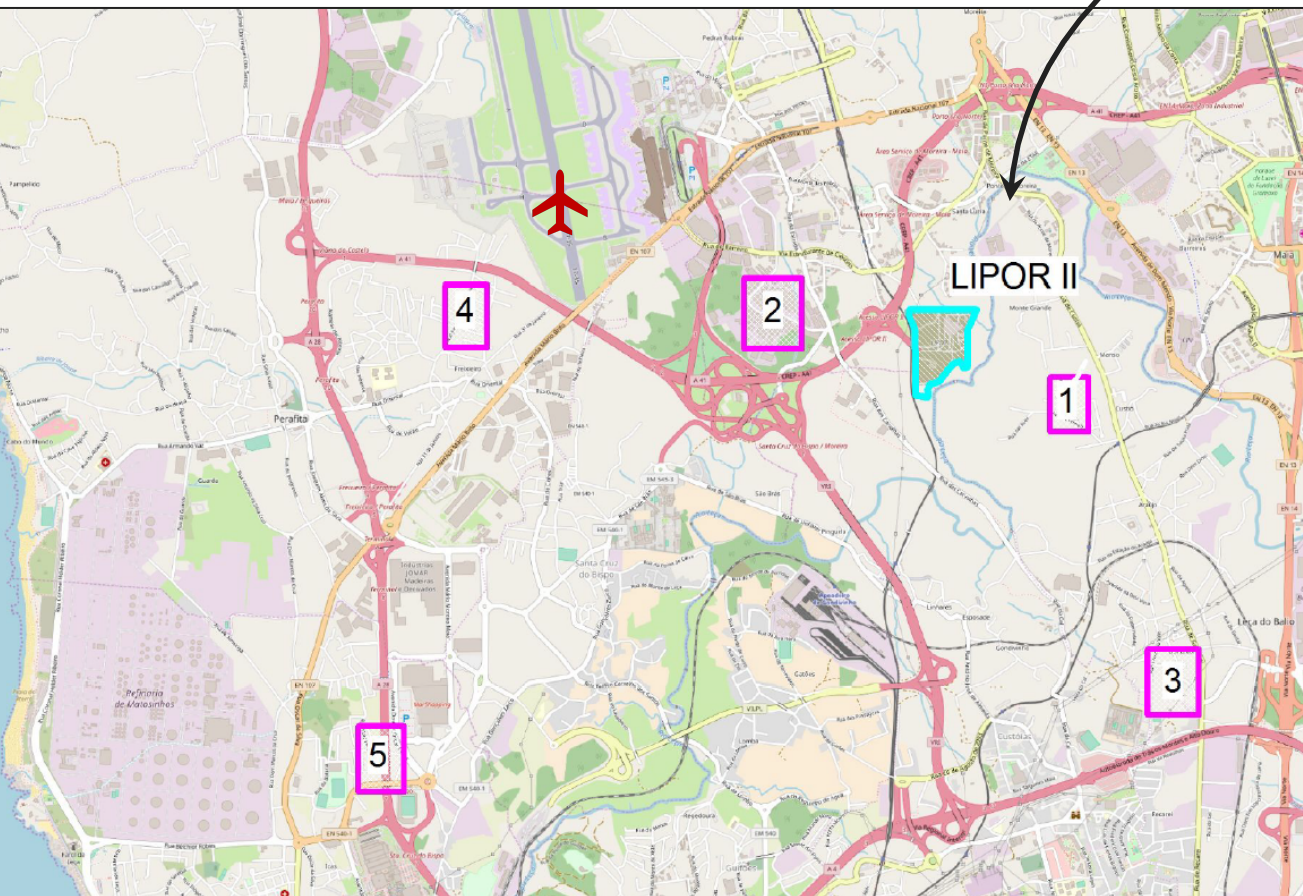
*Moreira da Maia*

- 13 000 hab. in 2011
- Located at North-East of Porto closed to the aeroport



# Introduction

## LIPOR II





# Introduction

## Atmospheric depositions

- Atmospheric depositions were observed on **facades of houses** in 5 areas in Moreira da Maia.
- Atmospheric deposition characteristics :
  - dried,
  - seems to be deposited **from droplets**,
  - brown,
  - a size between 3 and 10 mm,
  - no specific direction,
  - variable density (max : 30/m<sup>2</sup>)





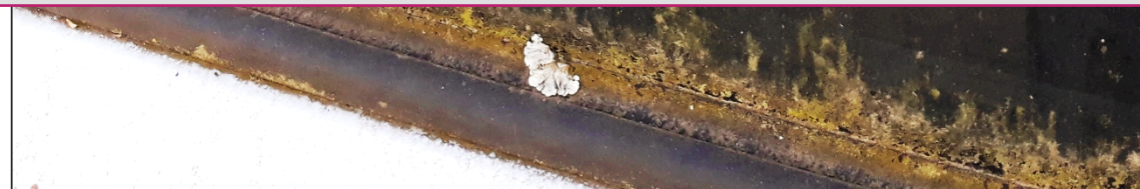
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  - no specific direction,
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➡ Is it from atmospheric emissions of LIPOR II? Where is the pollution source ?  
Is it toxic ? Which substances are present ? What is the chemical composition ?





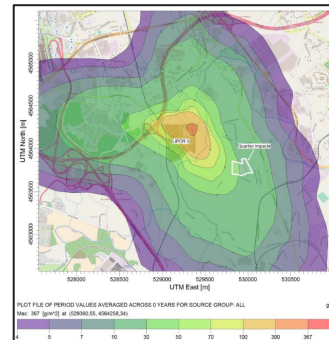
# Method

## 1. Population surveys



- Frequency of the depositions,
- Meteorological conditions,

## 3. Localisation of the pollution source (models)



- Is LIPOR II the pollution source ?
- What are the other potential sources ?

## Chemical composition

Concentrations en µg/dépôt			
Composés	No CAS	Dépôt PT1-sec	LQ
composé oxygéné (acide)	NA	1.0	0.2
hydrocarbure aliphatique	NA	<LQ	0.2
composé oxygéné (acide)	NA	0.5	0.2
hydrocarbure aliphatique	NA	<LQ	0.2
composé oxygéné (aldéhyde)	NA	0.6	0.2
hydrocarbure aliphatique	NA	2.4	0.2
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hydrocarbure	NA	<LQ	0.2
hydrocarbure aliphatique	NA	0.2	0.2
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hydrocarbure aliphatique	NA	7.6	0.2
composé oxygéné	NA	1.0	0.2

- Is it organic ?
- Is it metals ?
- minerals ...?
- Which activities could produce it ?

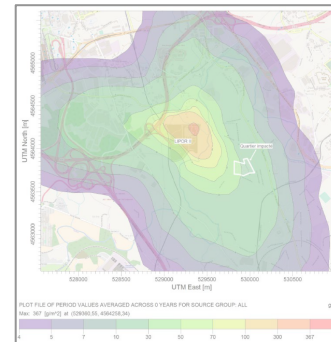
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hydrocarbure aliphatique	NA	0.2	0.2
composé oxygéné (aldéhyde)	NA	0.5	0.2
hydrocarbure aliphatique	NA	5.8	0.2
composé oxygéné (aldéhyde)	NA	1.1	0.2
hydrocarbure aliphatique	NA	0.6	0.2
composé oxygéné (aldéhyde)	NA	1.6	0.2
hydrocarbure	NA	0.3	0.2
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# Results

## Population surveys



Tauw

### Diário de apuramentos de precipitação atmosférica - depósitos

\*Completado por:

Nome(s) e apelido(s):

Endereço:

período de monitoramento: de 20/09/2018 a 23/11/2018

*Para que seja possível identificar as causas dos incômodos, favor preencher o formulário de monitoramento anexo. O documento deve ser preenchido de maneira precisa, tanto o incômodo identificado, bem como o período em que ocorre. O monitoramento diário ajuda a ilustrar a extensão do incômodo. Esses formulários fornecerão informações específicas e factuais. A presença de incômodo deve ser indubitável e apenas os incidentes identificados como anômalos devem ser registrados.*

\* indicar os nomes e apelidos de todas as pessoas que realizaram o registo de incômodos.

**Completar o formulário no mínimo 1 vez por semana, a fim de identificar o mais precisamente possível a data que o depósito de partículas aparece.**

Para a descrição da presença de precipitações / depósitos (poeira, pó, gota, partícula...), preencha os campos abaixo e descreva com precisão onde estes são encontradas (na roupa estendida do lado de fora da casa, na mobília de jardim, vidros de janelas/ portas, etc ...)

1- Preencha o formulário a cada vez que o(a) senhor(a) notar a presença de novos depósitos em uma superfície e especifique o tipo de superfície (janelas / terraço/ varanda / roupa de cama estendida do lado de fora ...)

2- Preencha também o formulário toda vez que o(a) senhor(a) limpar a superfície na qual os depósitos apareceram

3- Se o(a) senhor(a) estiver ausente por um período de mais de dois dias, por favor especifique o período durante o qual não foi possível acompanhar a aparição dos depósitos

*Para nos ajudar a visualizar melhor os depósitos, é recomendável tirar uma fotografia datada de cada evento. As fotografias serão recuperadas no momento da reunião dos formulários (um email vos será comunicado para nos transmiti-las). É muito importante indicar nos comentários se a foto foi tirada durante a manifestação do evento.*

Collect of samples





# Results

## Population surveys



Figure 2.1 Illustration des dépôts (« quartier impacté » – à gauche porte palière – à droite portail métallique)



Figure 2.2 Illustration des dépôts (« quartier impacté »)

Deposits observed up to  
4,5km away

Variable orientation



**MAIN hypothesis : “Is LIPOR II responsible of the atmospheric emissions?”**

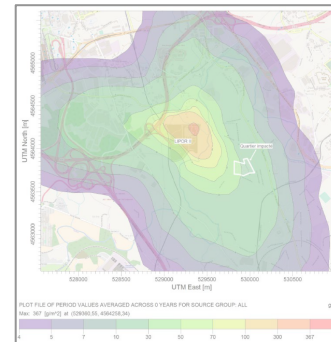
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- Is it organic ?
- Is it metals ?
- minerals ...?
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# Results

What is the chemical composition of the atmospheric depositions?

GC, IC and ICP analysis

➔ The first analysis didn't identify any toxic compound.

- It is organic

~ 50 % of organic compounds  
mainly aliphatic hydrocarbures >C20 (80%)

~ 24 % of  $NH_4^+$   
~ 9,5 % of  $SO_4^{2-}$

Proteins ?  
Mineral salts ?



➔ No clear identification → Complex substances which are not volatile

Composés	unité	Dépôt PT1-sec	Proportion / famille
<b>Organiques</b>			
Hydrocarbures aliphatiques	µg/dépôt	27	80%
Composé oxygéné (aldéhydes)	µg/dépôt	3,8	11%
Composé oxygéné (acide)	µg/dépôt	1,5	4%
Composé oxygéné	µg/dépôt	1,5	4%
Somme des organiques		33,8	
LQ: Limite de quantification du laboratoire: 0,2 µg/dépôt			
<b>Métaux</b>			
Fer (Fe)	µg/dépôt	1,25	30%
Aluminium (Al)	µg/dépôt	1,19	29%
Zinc (Zn)	µg/dépôt	0,48	12%
Rubidium (Rb)	µg/dépôt	0,32	8%
(Titane) Ti	µg/dépôt	0,25	6%
Manganèse	µg/dépôt	0,21	5%
Baryum (Ba)	µg/dépôt	0,19	5%
Cuivre (Cu)	µg/dépôt	0,15	4%
Strontium (Sr)	µg/dépôt	0,08	2%
Plomb (Pb)	µg/dépôt	0,03	1%
Somme métaux détectés à l'analyse	µg/dépôt	4,15	
LQ: Limite de quantification du laboratoire: 0,03 µg/dépôt			
<b>Anions cations</b>			
Ammonium (NH4+)	µg/dépôt	16,3	55%
Sulfate (SO4-)	µg/dépôt	6,4	22%
Chlorure (Cl-)	µg/dépôt	4,6	16%
Nitrate (NO3-)	µg/dépôt	2,3	8%
Somme Anions et Ions détectés	µg/dépôt	29,6	
LQ: Limite de quantification du laboratoire: 0,5 µg/dépôt			

- Trace metals

~ more than 1 % of Al

~ more than 1 % of Fe



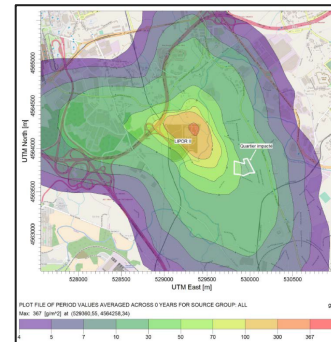
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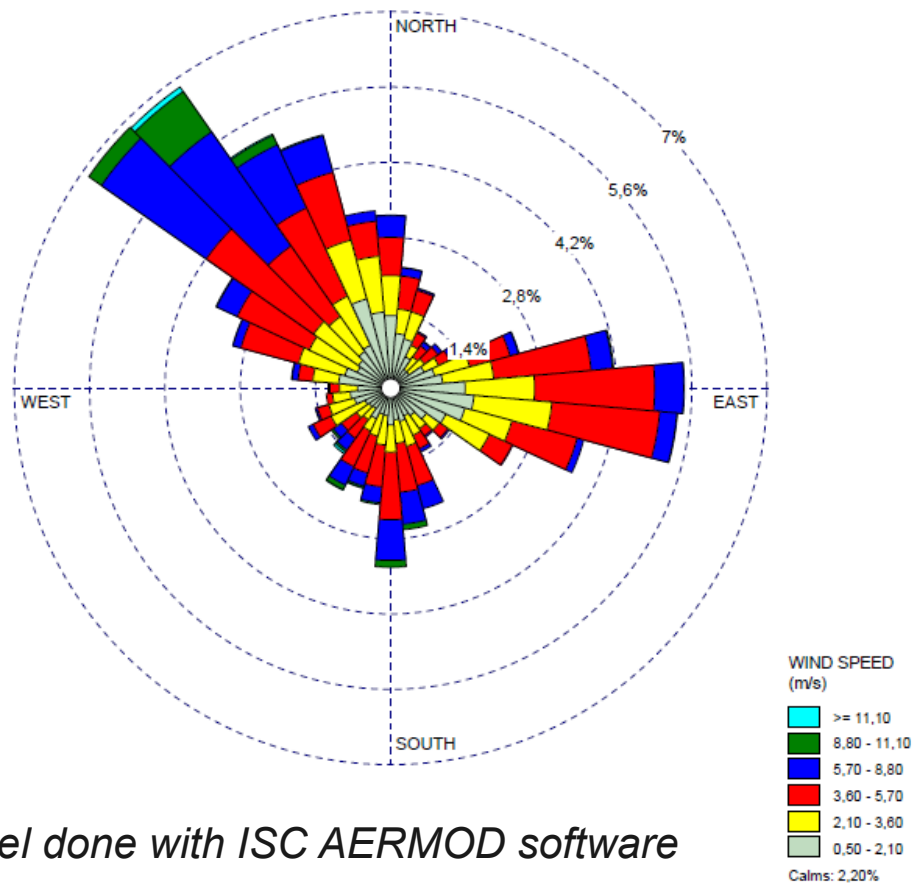
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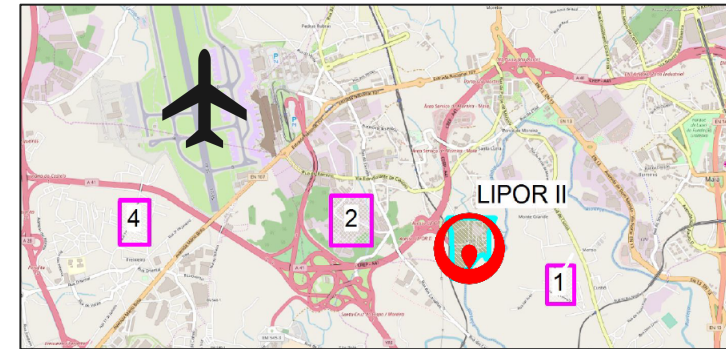
# Results

Is LIPOR II the pollution source ?



Model done with ISC AERMOD software

Tauw



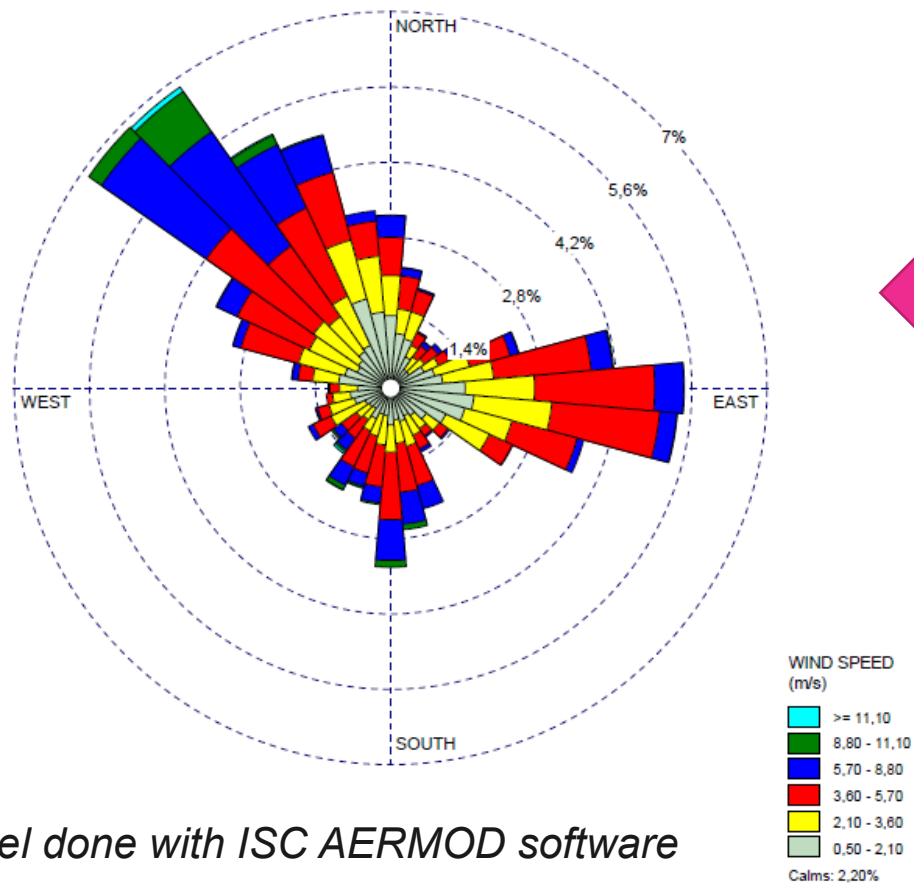
## Atmospheric transport and dispersion model

- Qualitative approach :
  - detected the most impacted periods
  - Selected the most probable sources



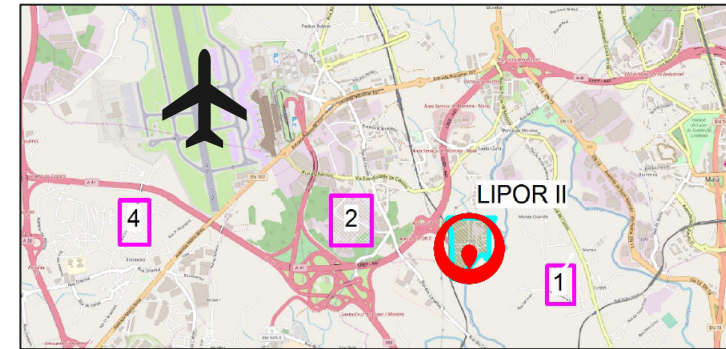
# Results

Is LIPOR II the pollution source ?



Model done with ISC AERMOD software

Tauw



- Aerodispersive simulation,
- Input: annual meteorologic data from aéroport station (2017),
- Input: topography, receptor localisation, particule size, flow of pollution ...

# Results

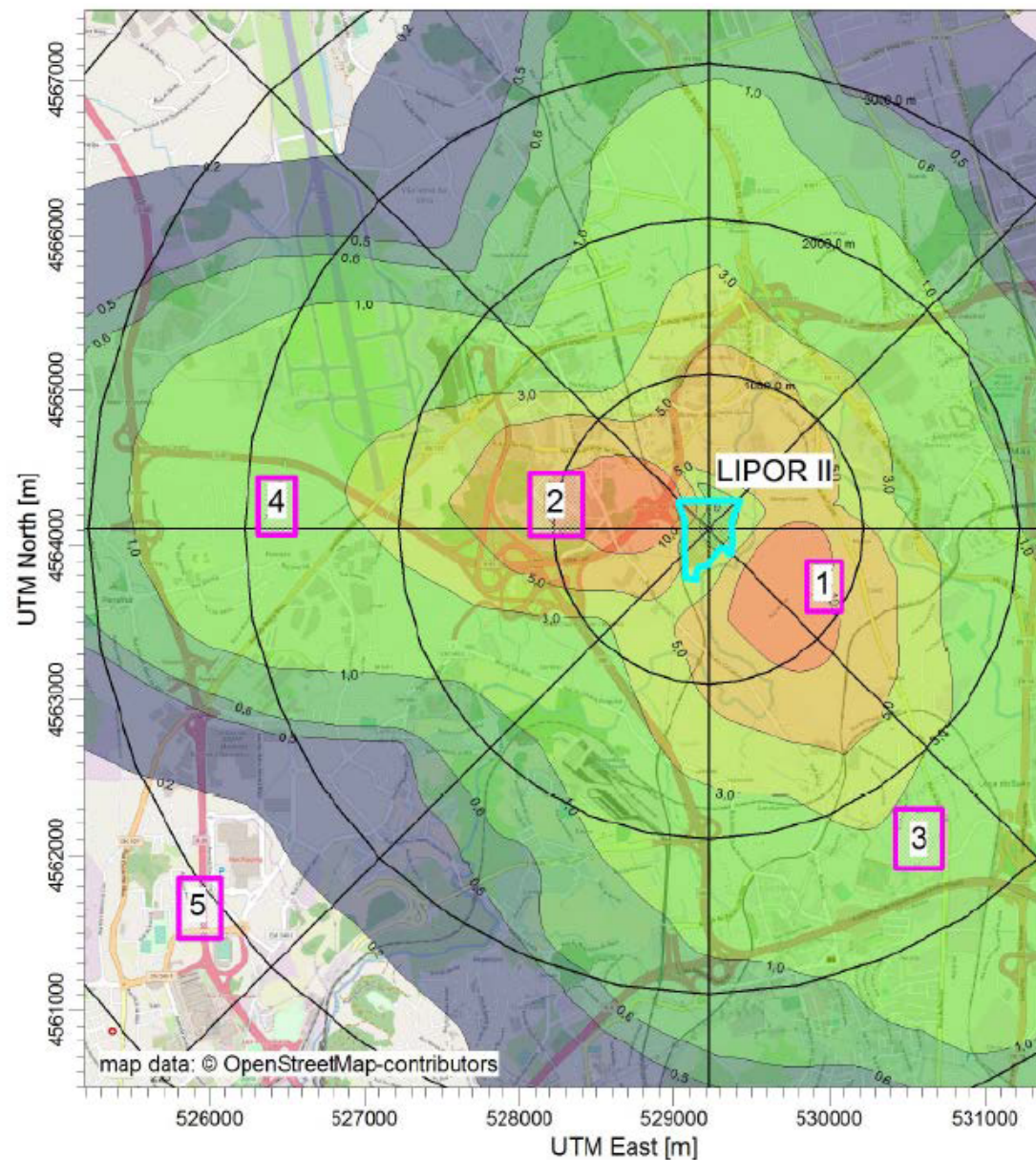
## Is LIPOR II the pollution source ?

- Differences between **observations** and **results** from the model:

Area	Observations	Model
1	Ponctual high concentrations	
2	Ponctual high concentrations	
3 and 4	At 3 km, only 2 small area	At 3 km, homogenous concentrations on a large area
5	Deposition	Negligible
North	No observation	High concentrations

- Several models were done for différents periods and particule size

Tauw



PLOT FILE OF PERIOD VALUES AVERAGED ACROSS 0 YEARS FOR SOURCE GROUP: FF1&2  
Max: 23,3 [g/m<sup>2</sup>] at (528870,73, 4564264,00)

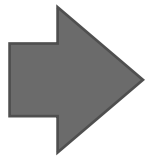
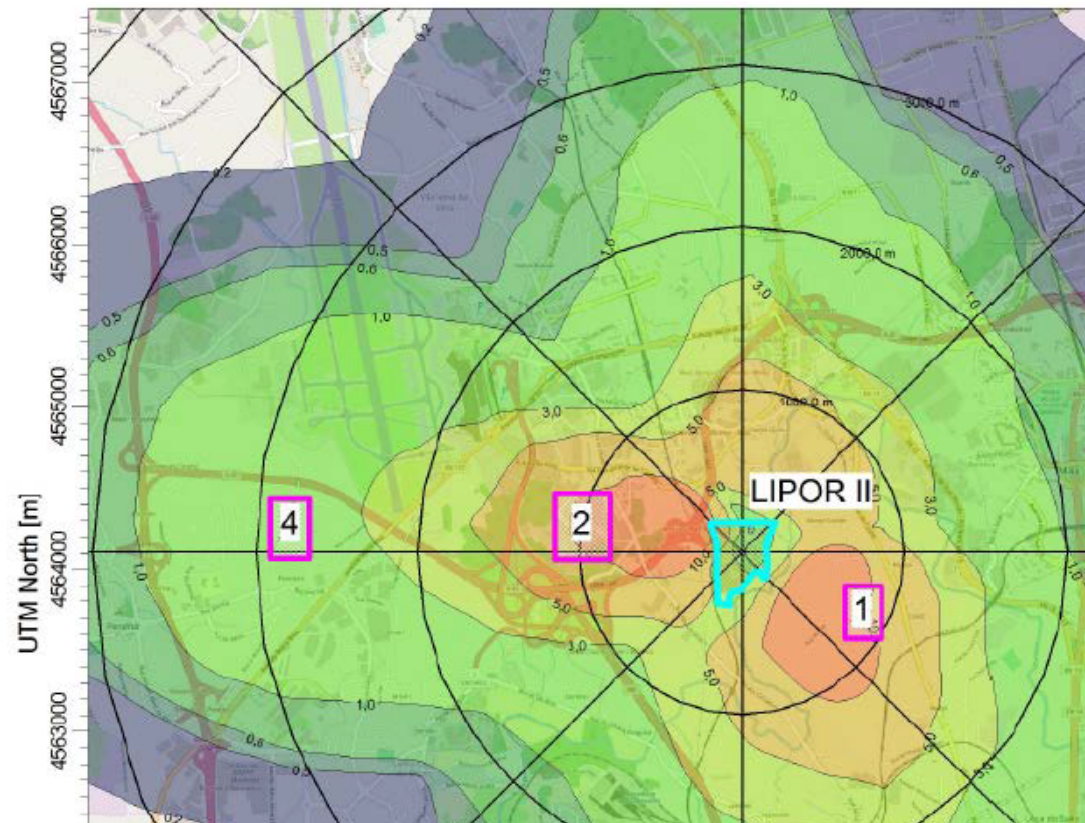


# Results

## Is LIPOR II the pollution source ?

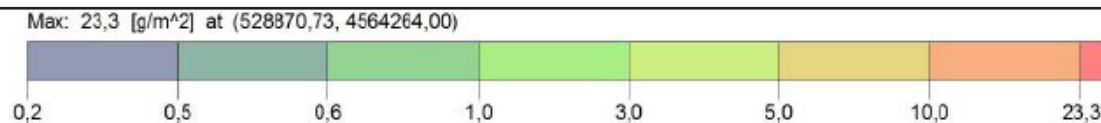
- Differences between **observations** and **results** from the model:

Area	Observations	Model
1	Ponctual high concentrations	
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3	At 3 km,	At 3 km, homogenous



LIPORII could be the source for the area 1 and 2  
But it is less probable for the area 3, 4 and 5

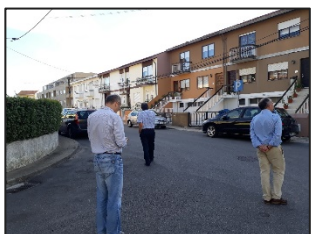
**It can not be stated that LIPOR II is the pollution source**





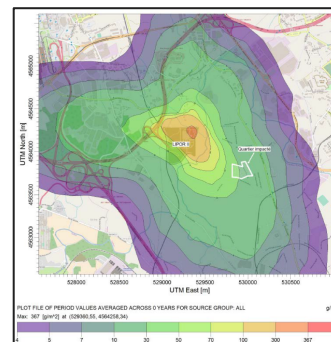
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- minerals ...?
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?

What's else?

# Method

## Presentation of the results in front of the pluridisciplinary team in Tauw

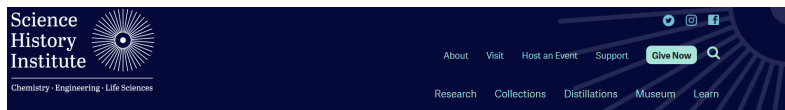
- **Research of a new approach, a new regard to formulate new hypothesis**
- After discussions, one hypothesis has emerged:  
→ « *atmospheric depositions could be from fecal matter of honeybees* »



# Method

## Presentation of the results in front of the pluridisciplinary team in Tauw

- Research of a new approach, a new regard to formulate new hypothesis
  - After discussions, one hypothesis has emerged:  
→ « *atmospheric depositions could be from fecal matter of honeybees* »
  - Already observed in the North of France ...
- ...and during the cold war (« Yellow rain »)!



### The Mystery of Yellow Rain

After the Vietnam War a mysterious yellow substance rained down from the skies of Southeast Asia. Was it a chemical weapon or something stranger?

By [Jacob Roberts](#) | April 13, 2018

Le ras-le-bol des habitants  
contre une pluie de taches  
jaunes

PAR EMMANUEL - 4 OCTOBRE 2017

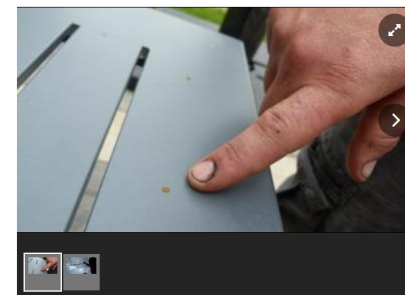


Oct 2017, à Masny dans le nord  
(avosruches.com)

### Les déjections d'abeilles enveniment les relations entre voisins à Toutencourt

Bien qu'une grande partie des ruches de la Miellerie de l'Halluette ont été démantées, des habitants se plaignent encore de déjections d'abeilles les empêchant de profiter de leur jardin.

Mis en ligne le 15/06/2018 à 16:49 par Benjamin Merleau



Jun 2017, à Toutencourt dans le nord  
(www.courrier-picard.fr)



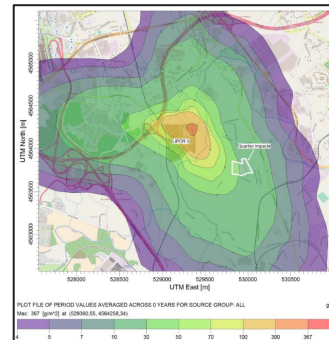
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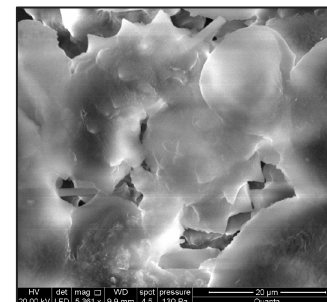
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hydrocarbure aliphatique	NA	1.9	0.2
hydrocarbure aliphatique	NA	7.6	0.2
composé oxygéné	NA	1.0	0.2

- Is it organic ?
- Is it metals ?
- minerals ...?
- Which activities could produce it ?

## 4. Ecological analysis



- MEB observations
- Chemical analysis

# Results

## Microscopic observations

MEB FEI Quanta2000

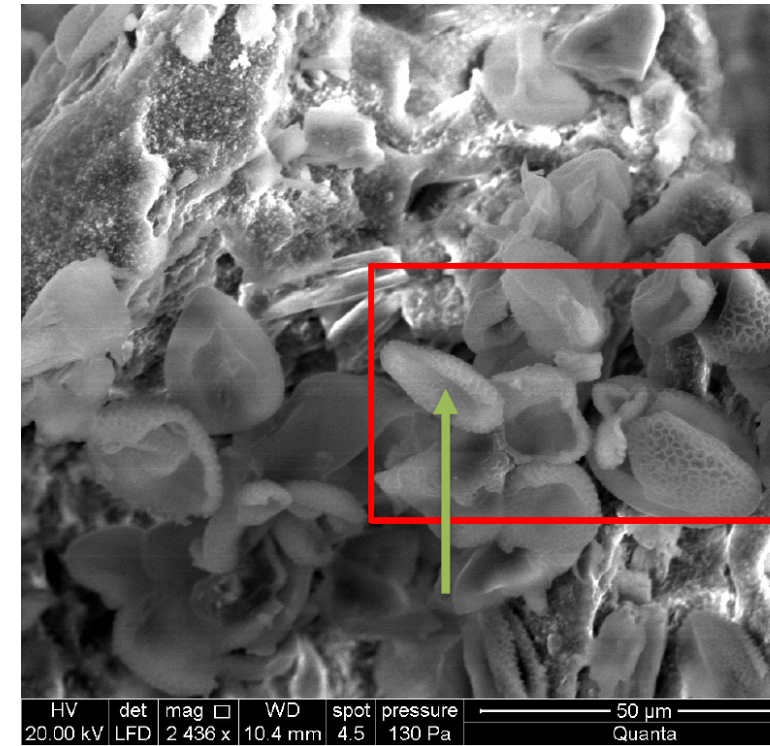
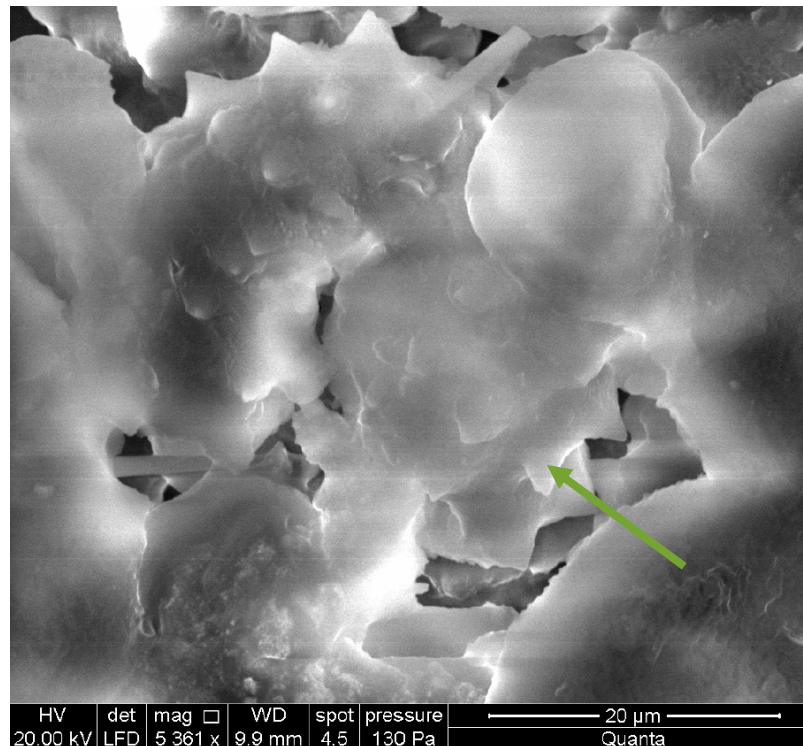
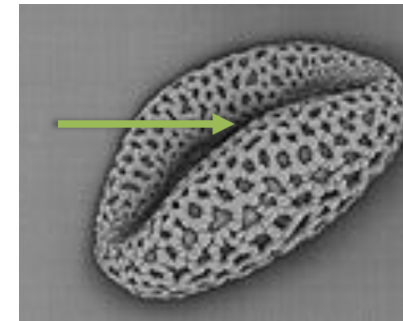
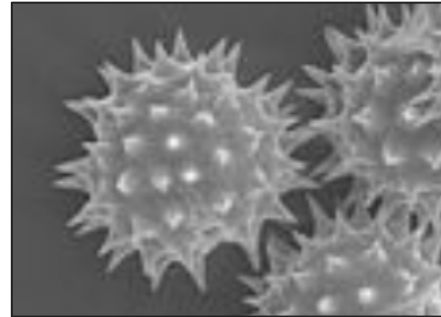


Tauw

ATMOSPHERIC  
DEPOSITION

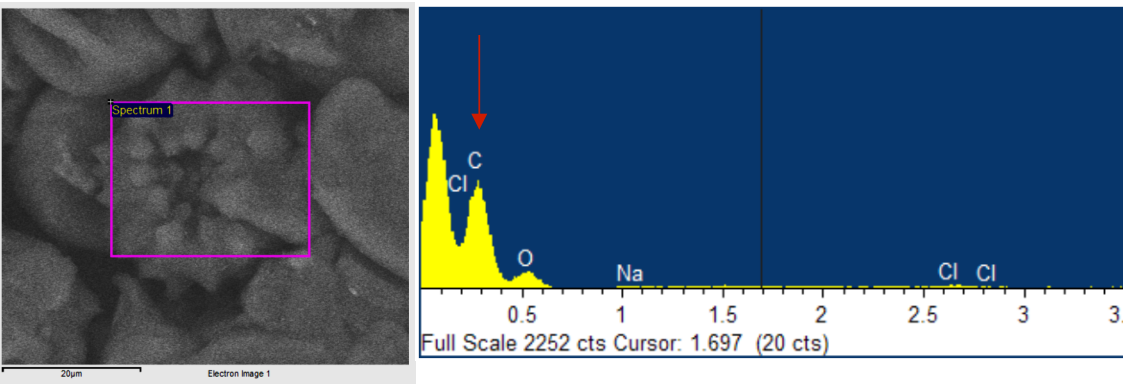
vs

BEE WASTE

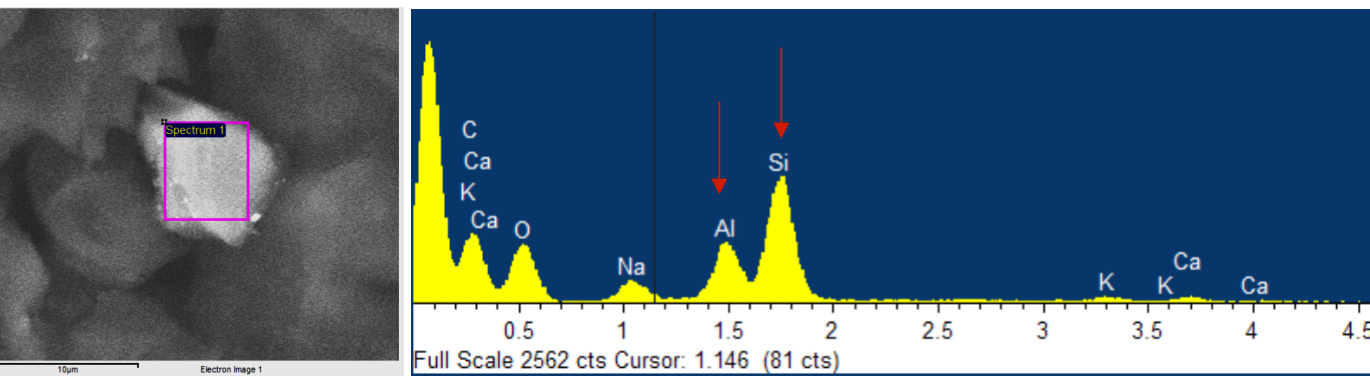
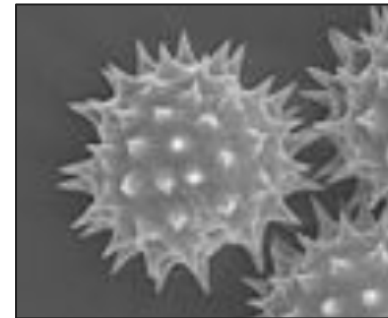


# Results

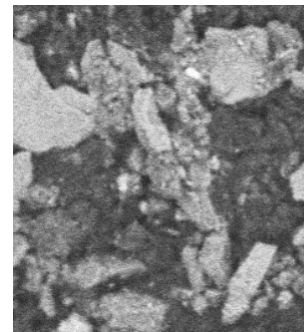
## Interpretation of MEB images by ecologists



Pollen grains mainly composed of carbon



Sand grains mainly composed of Si and Al





# Conclusions

*Atmospheric depositions are from fecal matter of honeybees...*



*... and not from LIPOR II*



# Conclusions

## A pluridisciplinary work team



- Resolving this problem would be impossible without a strong collaboration between expertises.
- Thanks to our diversity, we can
  - Get over initial judgments,
  - Imagine new hypothesis to investigate
  - Cross a larger range of tools for the investigations.

# Thanks

**Martin Jousot**

**Matthieu Letupe**

**José Paulo Ferreira da Silva**

**Alexiane Gaudain**

✖ Impossible d'afficher l'image liée. Le fichier a peut-être été déplacé, renommé ou supprimé. Vérifiez que la liaison pointe vers le fichier et l'emplacement corrects.



**Tauw**







Tauw

Thanks for your attention

