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NEW STRATEGIES FOR ODOUR ANNOYANCE ASSESSMENT: FROM SAMPLING TO DISPERSION MODELLING



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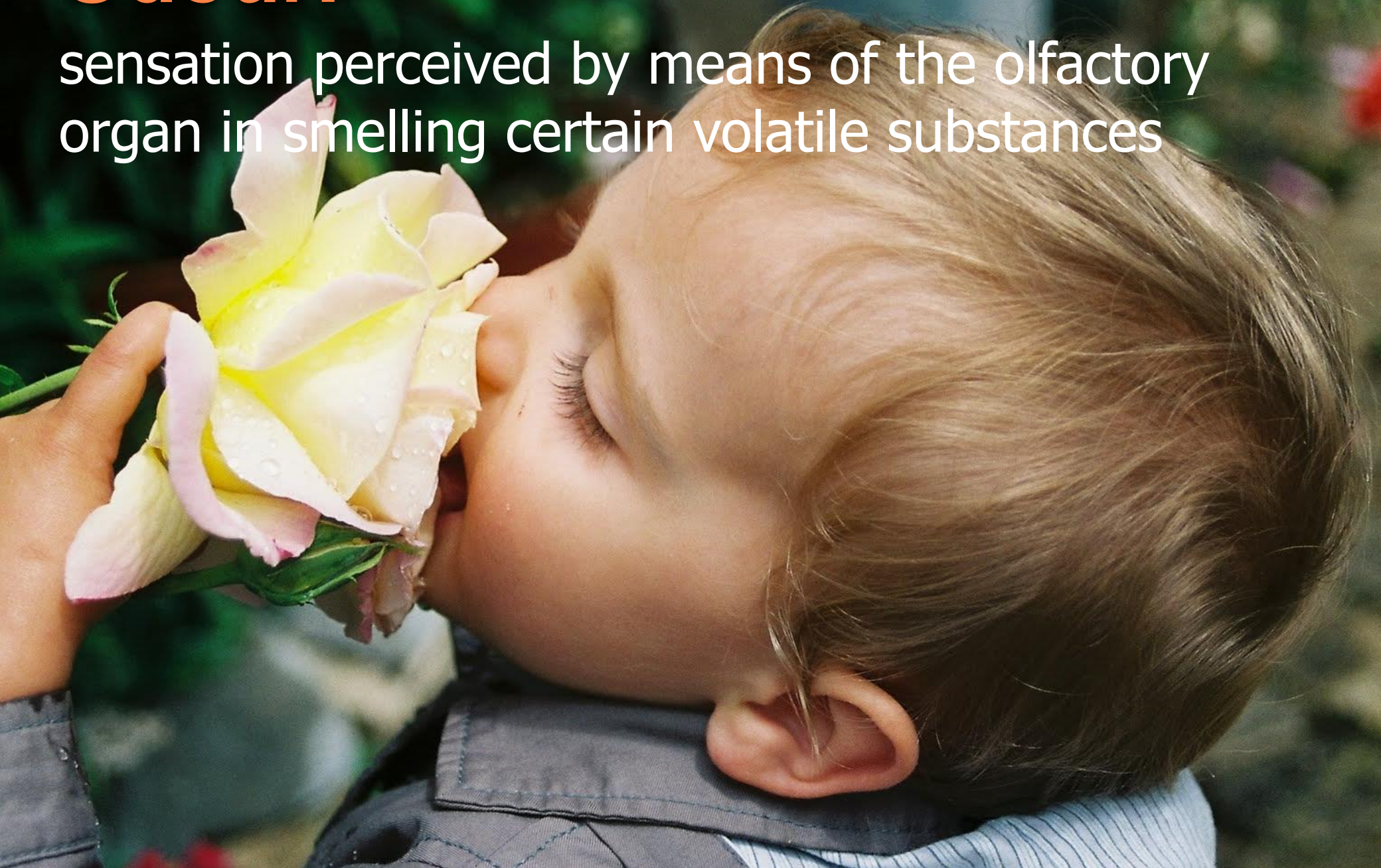
IDAD-Institute of Environment and Development / Portugal

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Odour:

sensation perceived by means of the olfactory organ in smelling certain volatile substances



Odour annoyance

Disturbance in the sense of well-being caused by the repeated perception of unpleasant odours.



Subjective

- ❖ Difficult to manage!
- ❖ Difficult to measure!
- ❖ Hard to ignore!
- ❖ Originates complaints to operators and authorities particularly with regard to industrial facilities located in the immediate vicinity of residential buildings.

Continuous
and **real time**
measurements?

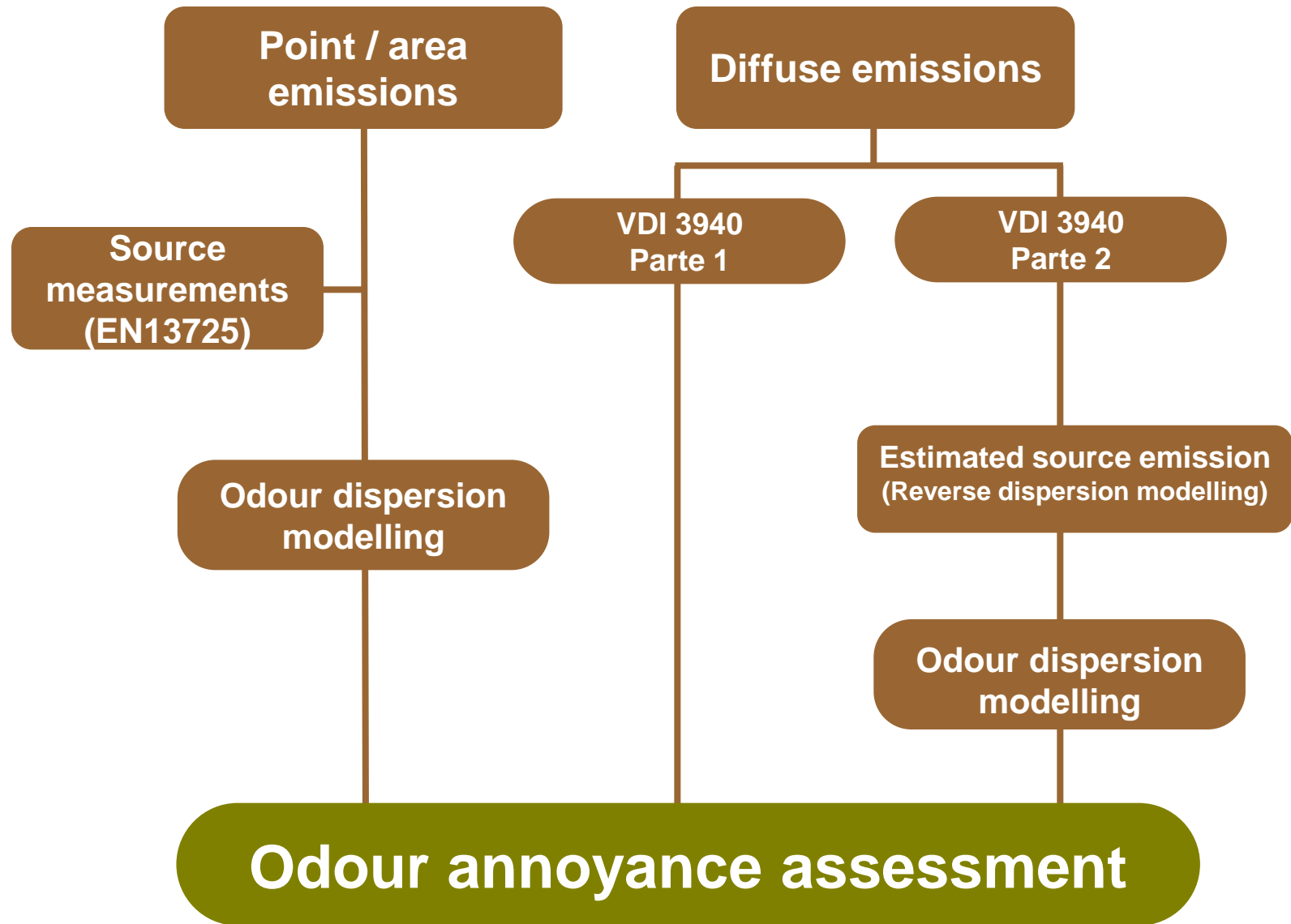
Surveys?

Source
characterization?

Predict odour
impacts with
mathematical
models?

Measurement of
impacts in the
field?

Methods for odour annoyance assessment



Frequency of odour perception (%) or Concentration (OU/m³)

Case study

Waste water treatment facility located within an urban area

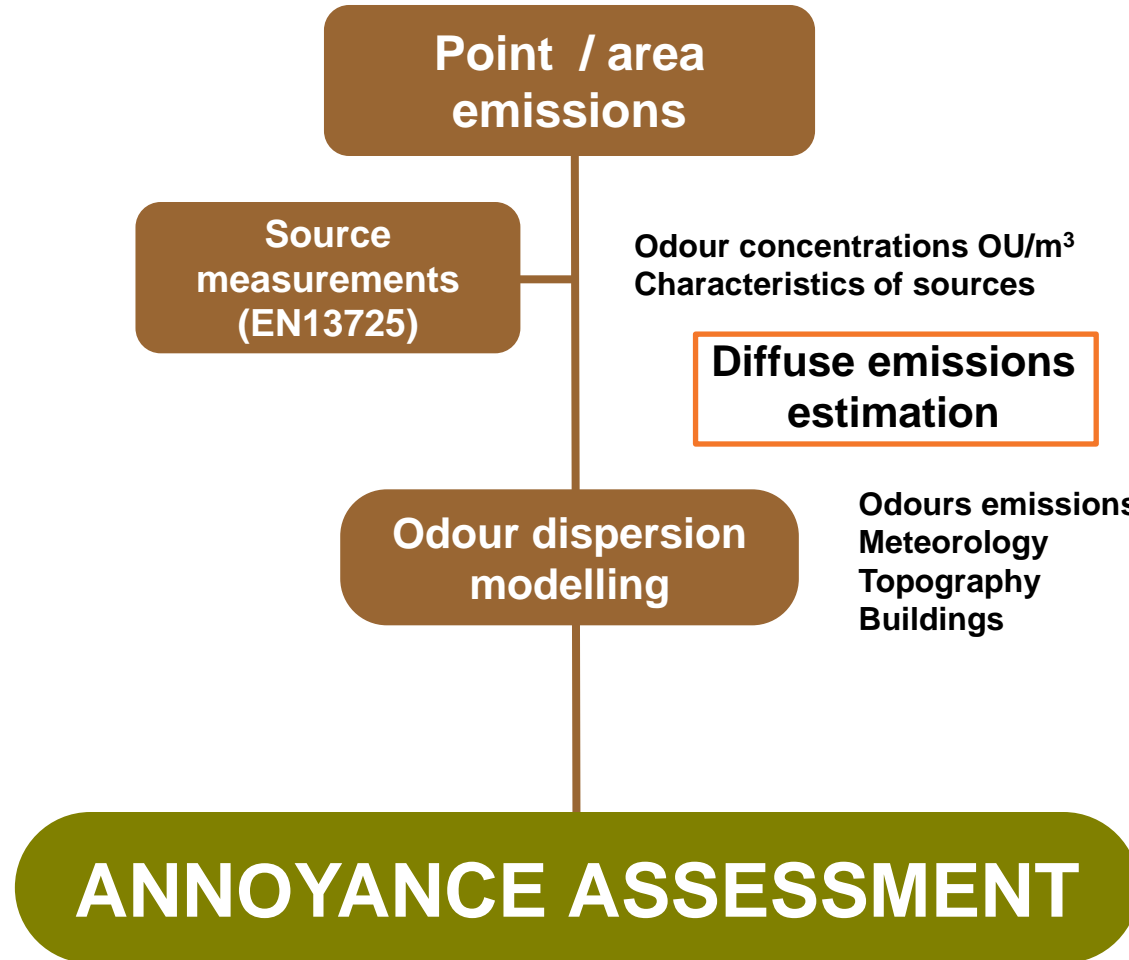
- ❖ Facility located in the immediate vicinity of residential buildings(<20m)
- ❖ Several complaints
- ❖ Diffuse and point emissions sources
- ❖ Information about diffuse sources (weekly periodical complains)
- ❖ Objective:
 - ❖ Confirm odour impacts in surrounding areas
 - ❖ Define strategies to prevent/minimize impacts



Which methodology to apply?

Integrated approach with combination of methods!

Methodology



Frequency of perception of odours (%)

Methodology

Emissions measurement

- ❖ Standardized sampling and analysis techniques (EN 13725:2003)
- ❖ Concentrations assessed by olfactometric analysis (not chemical analysis or speciation)
- ❖ Odour emission rate determined by multiplying the source odour concentration by the volumetric gas emission rate

Diffuse emissions estimation

- ❖ CONTAM - *Multizone Airflow and Contaminant Transport Analysis Software* to calculate the diffuse volumetric flow rate on the basis of the building air exchange rate

Modelling of Odours dispersion

- ❖ Application of AUSTAL model (best suited for odours)

Study area



Residential buildings



Airflow software



NIST Multizone Modeling Website

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[Case Studies](#)

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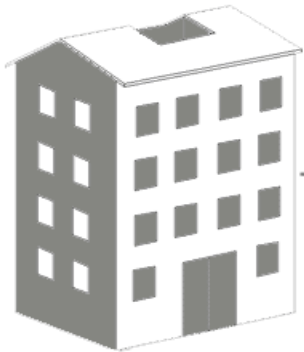
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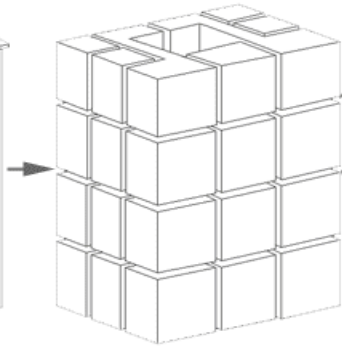
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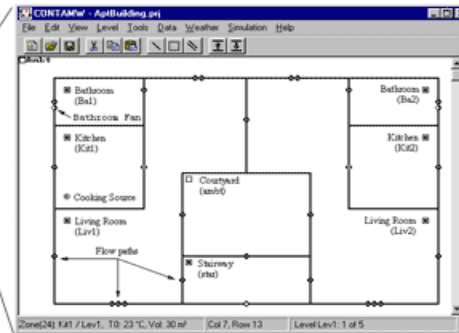
Welcome to the NIST Multizone Modeling Website



REAL
BUILDING



Idealized
Building



CONTAM
Building Model

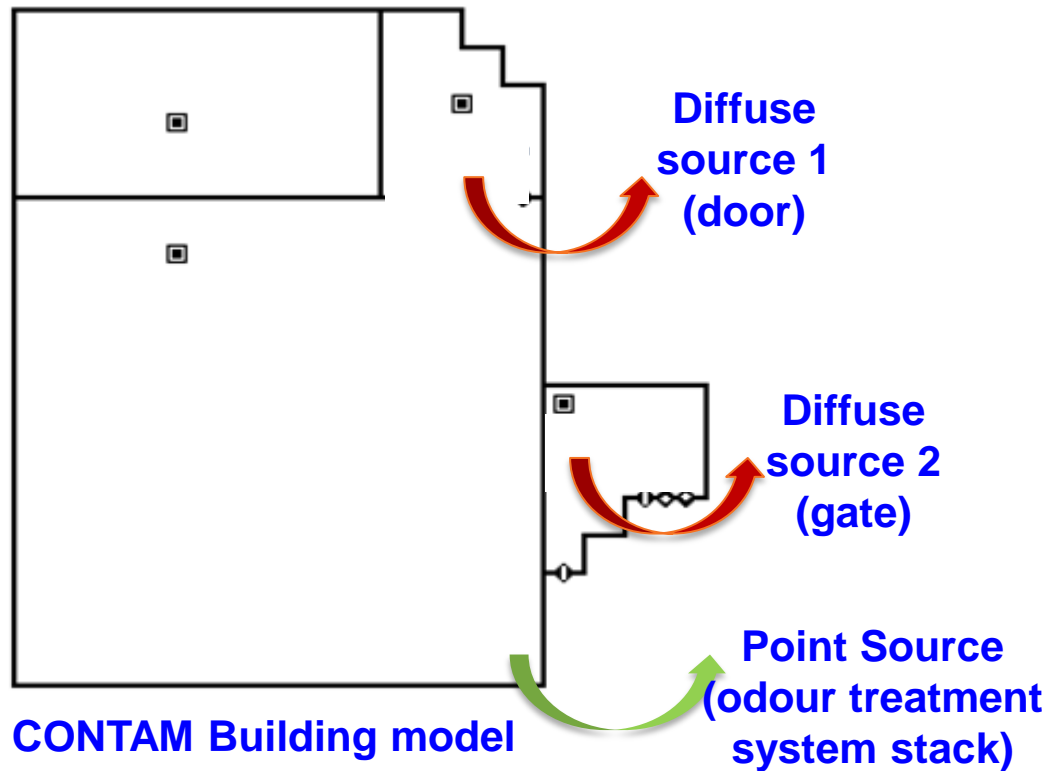
CONTAM - Multizone Airflow and Contaminant Transport Analysis Software

1 - Airflow Rates: airflow rates in building systems driven by mechanical systems, wind pressures, or effects induced by the indoor and outdoor air temperature difference.

2 - Contaminant concentrations: dispersion of contaminants; chemical transformation; adsorption, desorption, filtration, re-suspension; source mechanisms.

3 - Personal Exposure: the prediction of exposure of occupants to airborne contaminants for eventual risk assessment

Odour source characterization



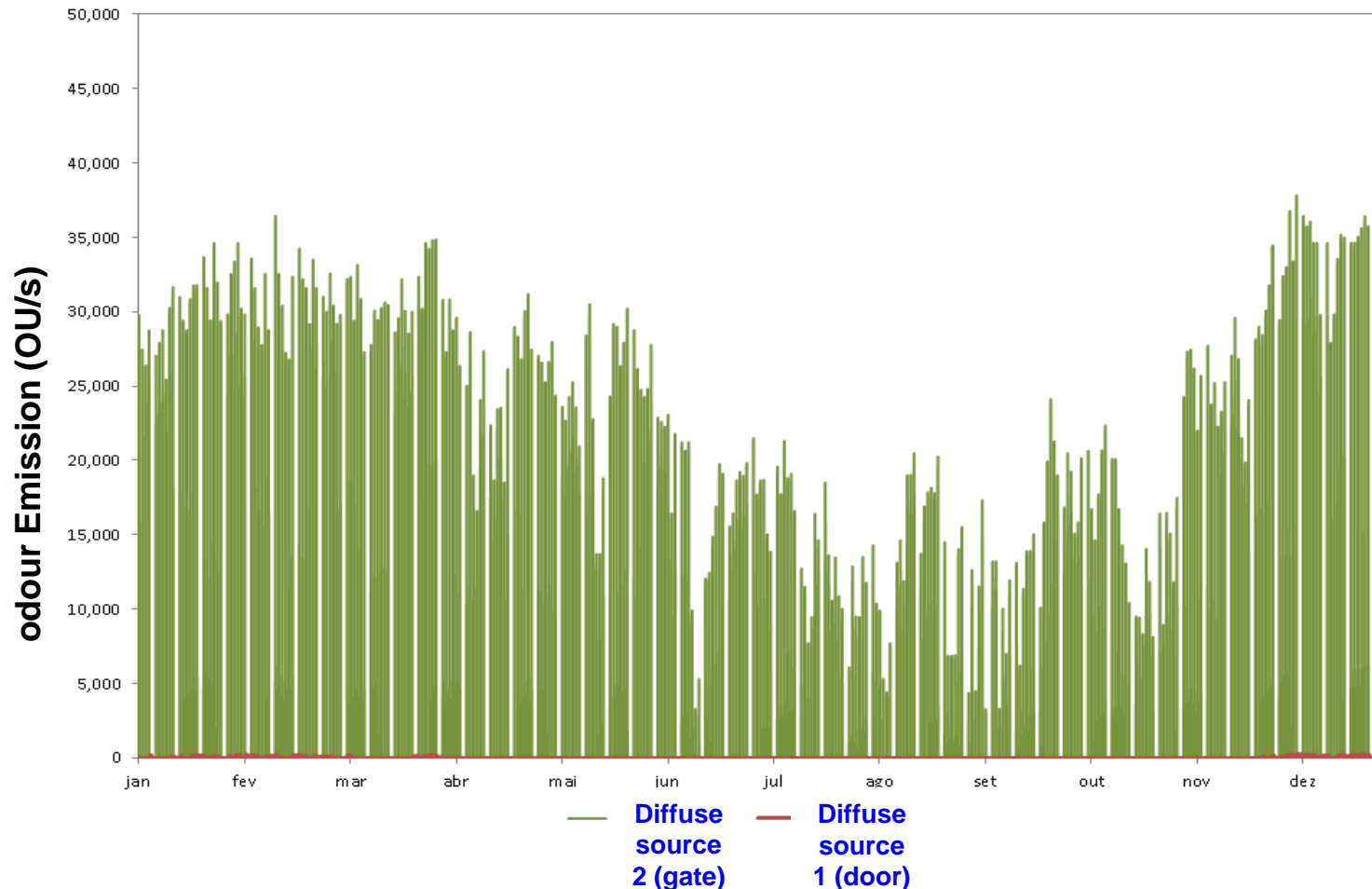
Sampling to determine the odour gas concentration at **representative indoor locations** so that a mean room concentration can be obtained

CONTAM software was used to simulate the air flow rates associated to the opening of doors and gates
→ **Diffuse emissions**

Standardized sampling and analysis technique (EN 13725:2003) for point source characterization
→ **Point source emissions**

Input data for the odour dispersion calculation

Results - Diffuse emissions

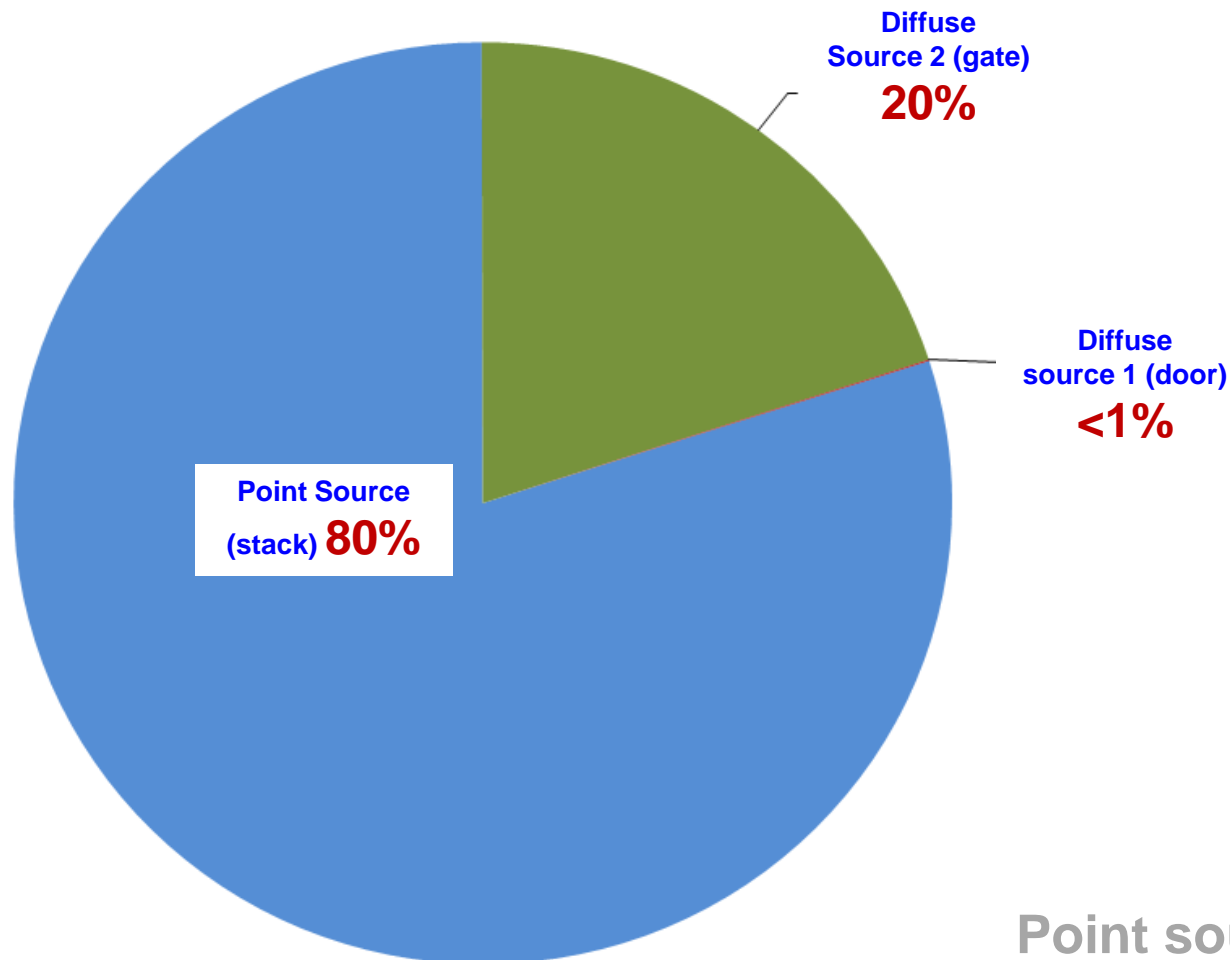


Importance of annual variation of meteorological conditions (wind pressures acting on the exterior of the building, and indoor/outdoor air temperature difference).

Diffuse source 1 (door) with residual contribution

Diffuse source 2 (gate) with important contribution

Results - total odour emission



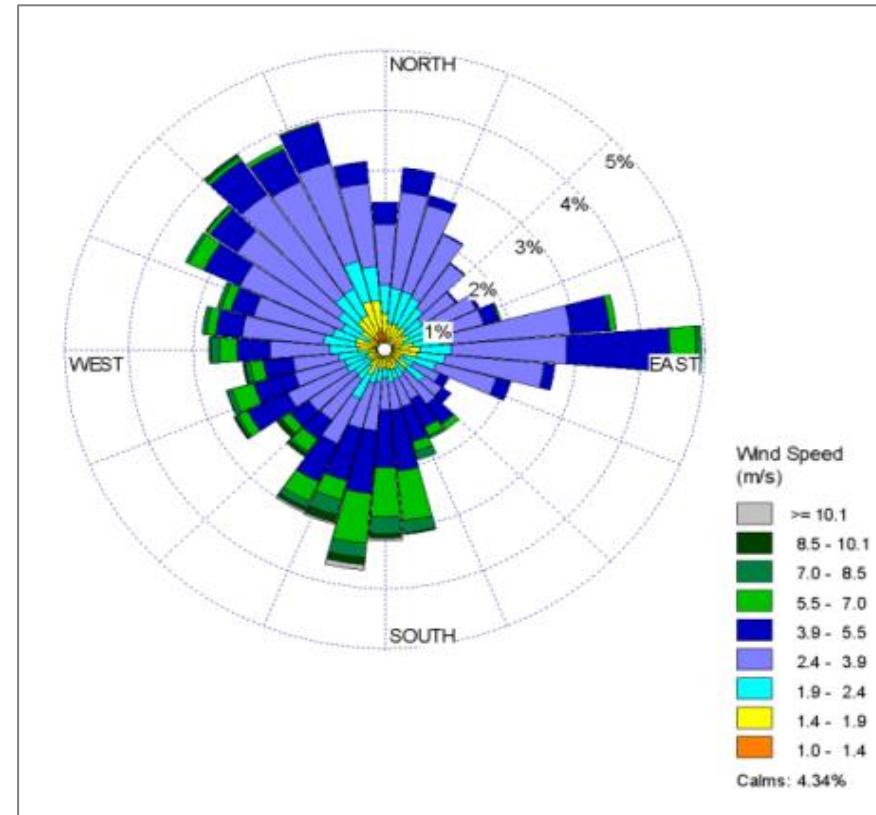
Diffuse source (gate) with an important contribution to total emissions (20%), despite being active only a few hours/day (opening of doors/gates).

Due to the high concentration of odour the diffuse emission annoyance potential is significant.

Point source (stack) refers to a continuous emission (odour treatment system), representing 80% during 24h/day.

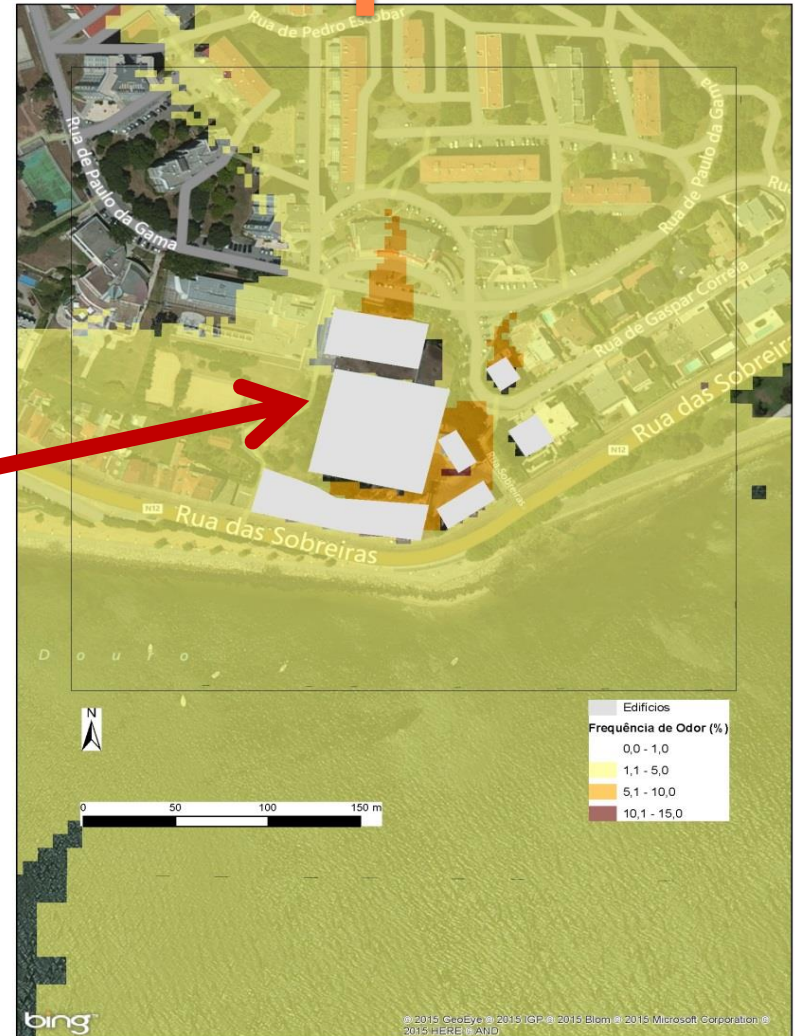
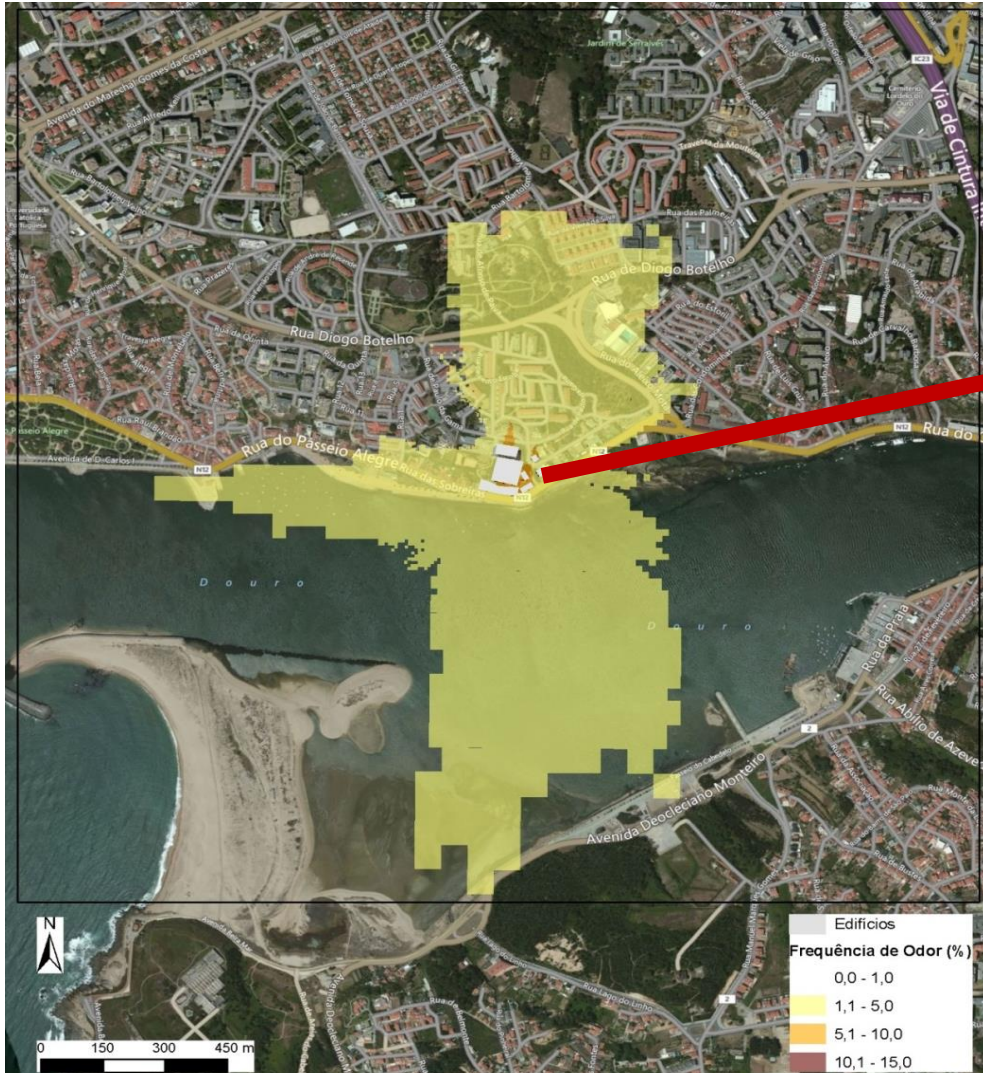
Dispersion Modelling

- ❖ AUSTAL model
- ❖ Meteorological data 2014
- ❖ Use of different operating situations of the diffuse sources estimated by CONTAM
- ❖ Application of the model to a 2300 m² and 360 m² domain (64 m² and 4 m² nesting)
- ❖ Comparison with German Guidelines (annual frequency of the odours perception)
 - 10% - residential areas
 - 15% - industrial areas



Results - Odour Dispersion

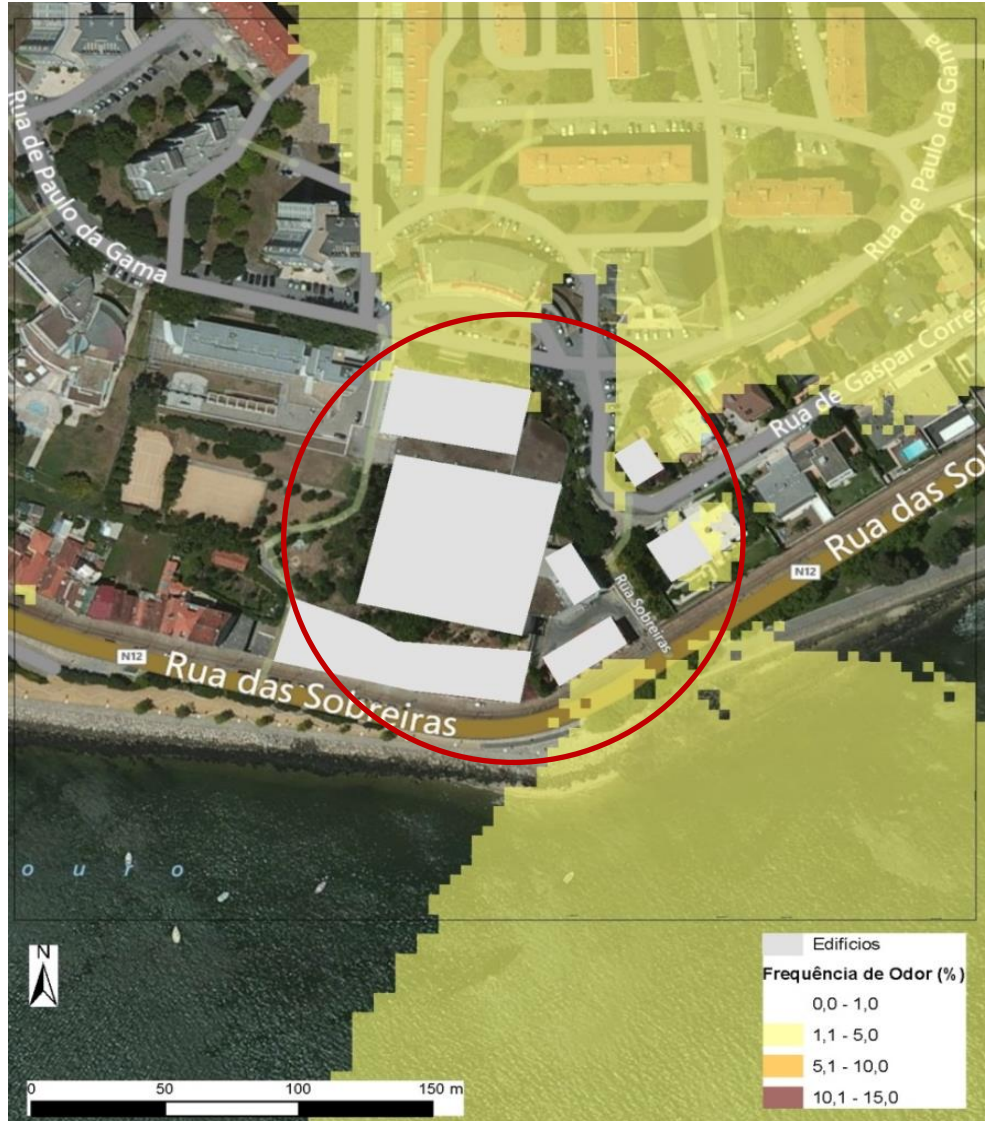
(point + diffuse sources)



The results confirm that the odours frequency perception, from the operation of the facility, could get to the population at a level higher than the 10% (limit value).

Results - Odour Dispersion

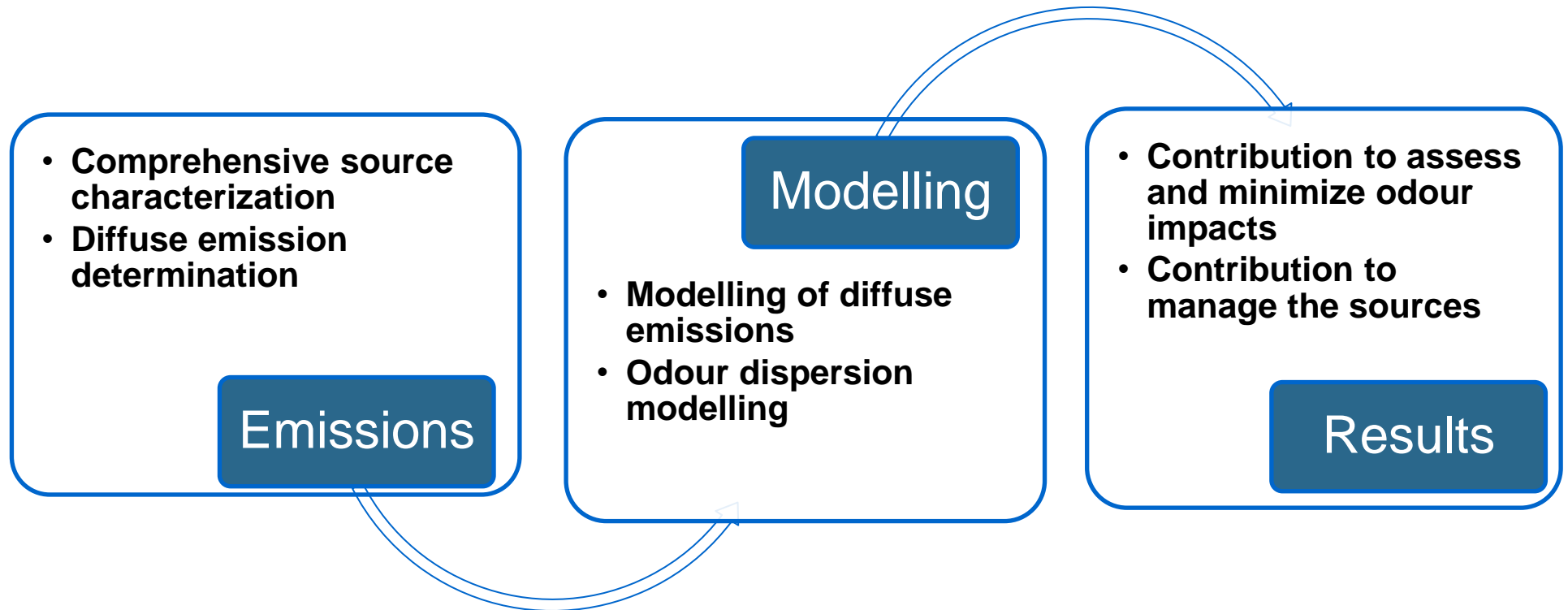
(without diffuse source 2 to understand the effect)



Tests were performed to understand the functioning of diffuse sources.

It was identified the diffuse source of odours 2 (gate) as the one with more annoyance on complainers.

CONCLUSIONS

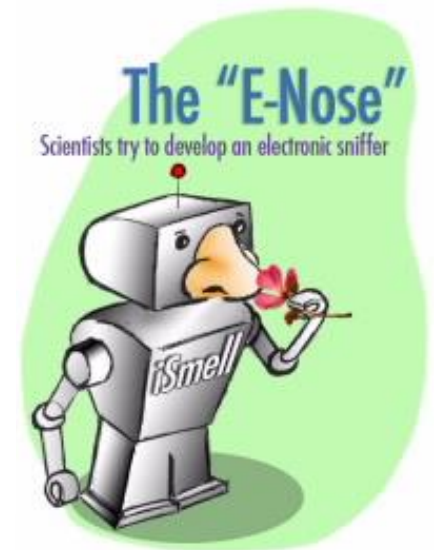


Results allowed to confirm and quantify the importance of different sources. This information permitted intervening in the process to limit/minimize emissions:

- by introducing changes in the schedules of internal operations;
- by controlling the time of opening to the outside;
- by changing the ventilation system in specific situations to compensate/minimize uncontrolled emissions to the outside.

Comments – sensor technologies application?

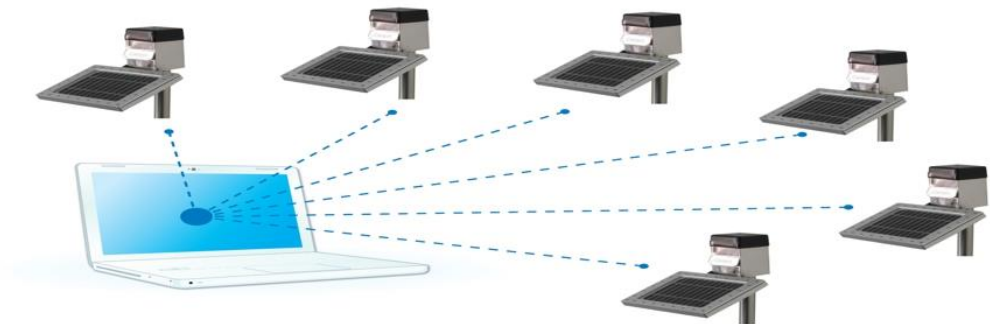
- Detecting changes in the composition of the ambient air using an **electronic nose** (e-nose) is a frequently used technique that has been introduced recently.
- E-noses have been used to continuously monitor gaseous emissions that have impacts in odour nuisance and safety risks.
- Some examples of application but still important limitations:
 - Odour perception \neq sum of each chemical concentration;
 - No standards/methods for calibration odour sensors (which gas/"mixture" as reference?);
 - Drift, humidity, high limit of detection;
 - Poor reproducibility, accuracy;
 - Lack of guidelines and protocols to implement and validate sensors systems



Comments – sensor technologies application?

In the present situation, a sensor network would be relevant to detect significant air quality changes, specially in the vicinity of the diffuse sources:

- ✓ incorporation of data collected into the central management of the building for the implementation of control measures (extraction flow, management of opening gates, changing schedules face the specific meteorological conditions);
- ✓ automatic implementation of measures to minimize/prevent emissions.



Comments – how to evaluate odour annoyance?

- Odours at source can be characterized by dynamic olfactometry according to the European Standard (EN 13725). The sources characterization allows the calculation of potential annoyance by using dispersion modelling → **not always applicable.**

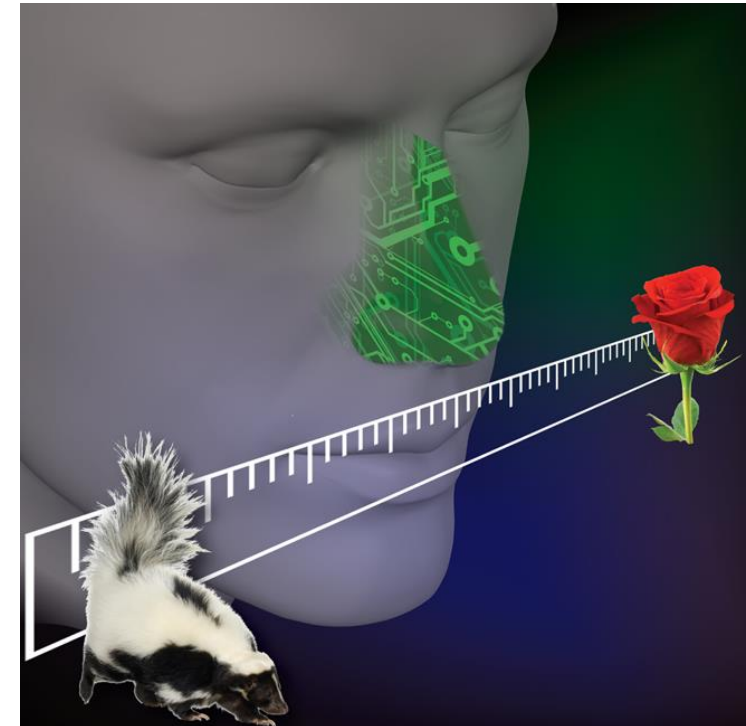


- Two other methods are proposed in the new European Standard: the **grid** and the **plume** method. In both cases, human panel members characterize an area by the presence or not of an odour. For both methods, this new European Standard does **not include relation with odour annoyance** (*no direct relation between the presence of recognizable odours and the occurrence of odour annoyance*).

Comments – how to evaluate odour annoyance?

- Policies and regulations: **no European limit values**. References in some country policies (eg. Germany, The Netherlands, Austria, UK, Australia, USA and Canada...)
- How to evaluate? Concentration? Emission? Technical questionnaires to population? Chemical analysis?

- ❖ Each case is a particular case!
- ❖ Integrated approach (diffusive emissions and modelling) and combined techniques/methodologies could be the best solution in most of the situations.



Thank you!

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