FUGITIVE GHG FLUX ESTIMATION USING MOBILE ONSITE MEASUREMENTS AND REVERSE MODELLING

Applicated Service on WWTP and landfills

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suez

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Contents

1.

INTRODUCTION

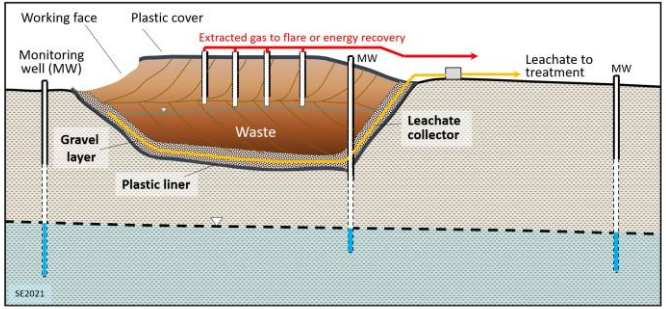
Waste Water Treatment Plants (WWTP)

CH4 & N20 TYPICAL SOURCES

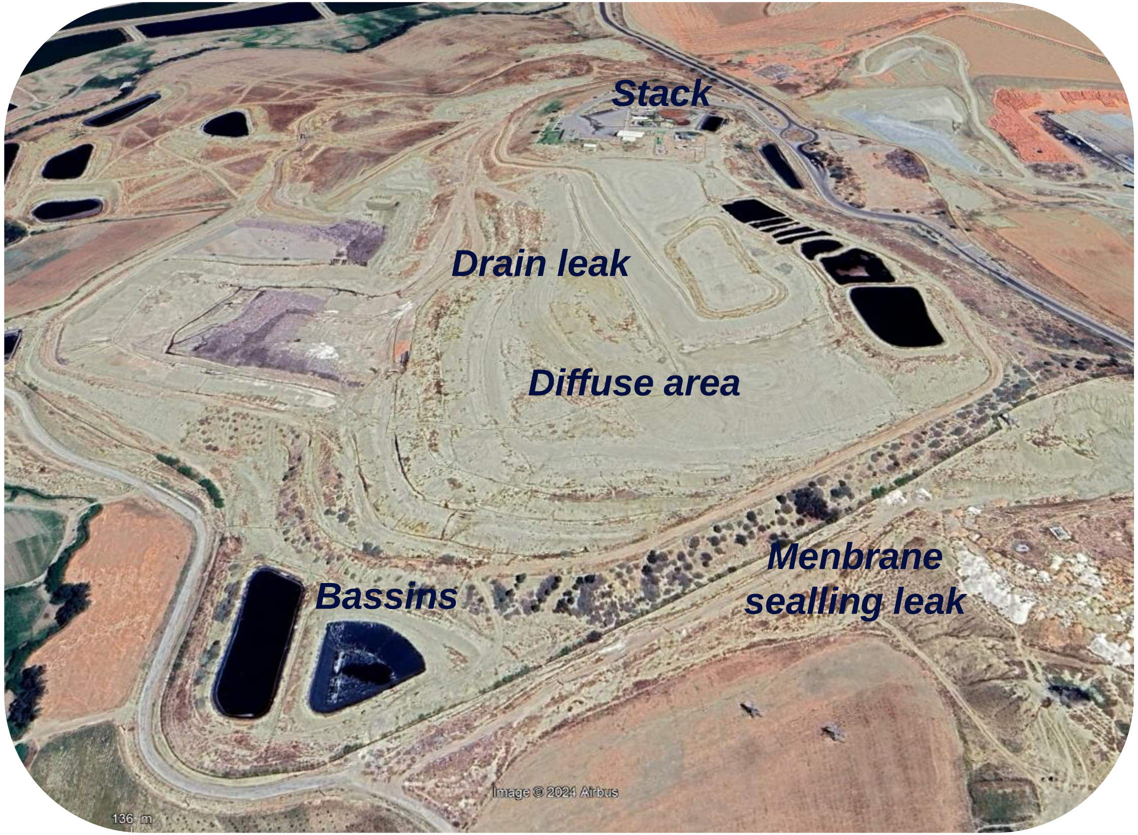
Tank leak

Landfills

CH4 TYPICAL SOURCES

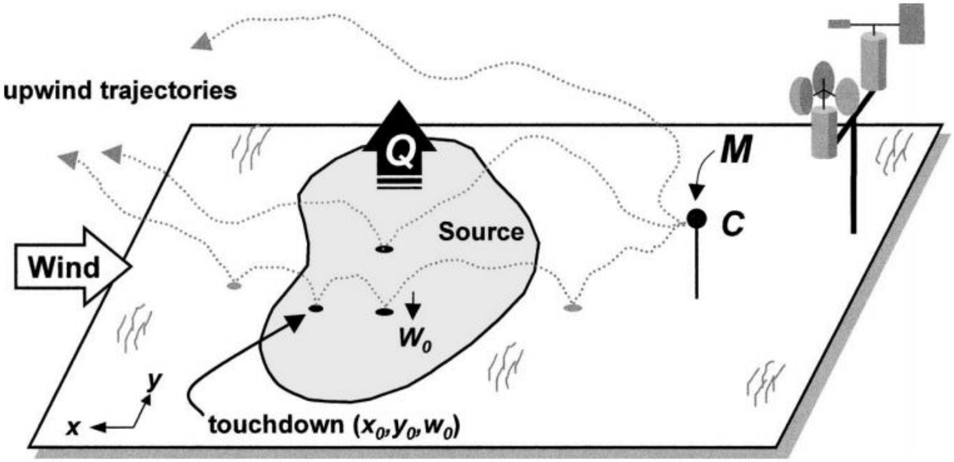


Picture from « Environmental geology »



Previous work

- BEGAN IN 2015: JOINT WORK SUEZ ARIA LSCE
- WASTE MITI EIT PROJECT
- ALBERGEL ET AL 2017 IN HARMO18

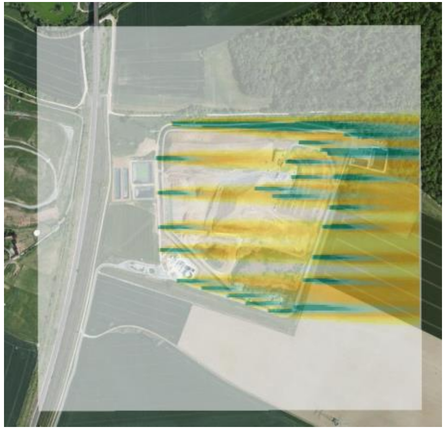


n **sources and** ***m*** **sensors :**

$$\begin{pmatrix} \left(\frac{C_{1,1}}{Q_1}\right)_{sim} & \cdots & \left(\frac{C_{1,n}}{Q_n}\right) \\ \vdots & \ddots & \vdots \\ \left(\frac{C_{m,n}}{Q_1}\right)_{sim} & \cdots & \left(\frac{C_{m,n}}{Q_n}\right) \end{pmatrix} \begin{pmatrix} Q_1 \\ \vdots \\ Q_n \end{pmatrix} + \begin{pmatrix} C_{background} \\ \vdots \\ C_{background} \end{pmatrix} = \begin{pmatrix} C_1 \\ \vdots \\ C_m \end{pmatrix}$$

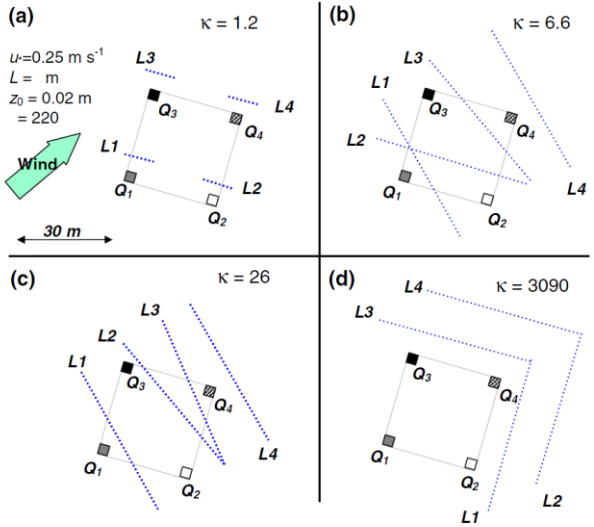
Previous work

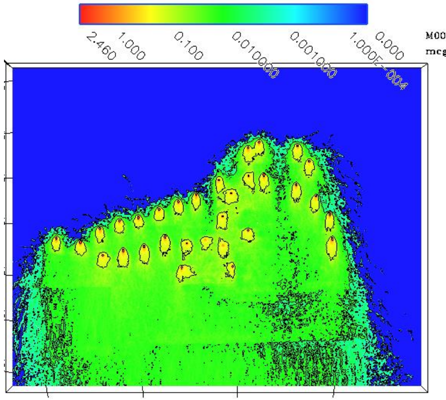
- **FORWARD/BACKWARD PLUMES WITH PMSS MODEL**
- **CONDITION NUMBER CRITERIA**
- **TESTED ON 2 LANDFILLS**



Condition Number

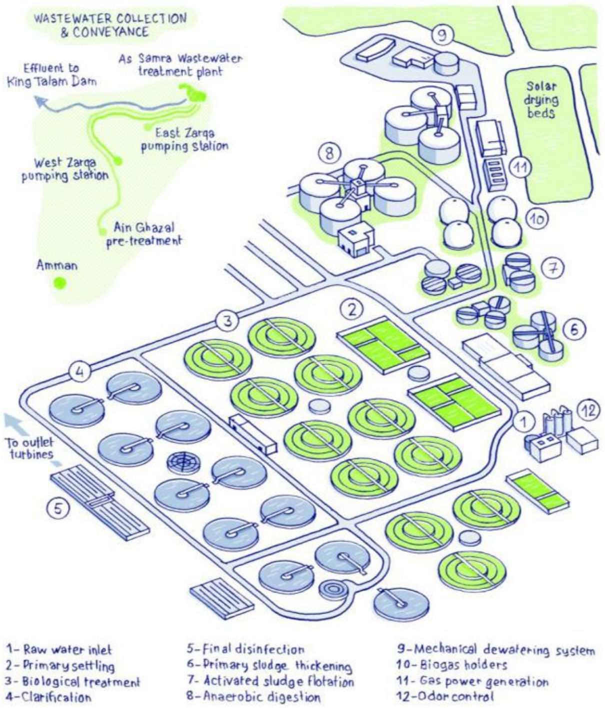
$$\kappa = \left\|\left(\frac{C}{Q}\right)_{sim}\right\| \left\|\left(\frac{C}{Q}\right)_{sim}^{-1}\right\|$$





Current Situation

- **Service branded as AirAdvanced®Scan360**
- **More than 40 cases (France, UK , South Africa)**
- **Landfills and WWTP**

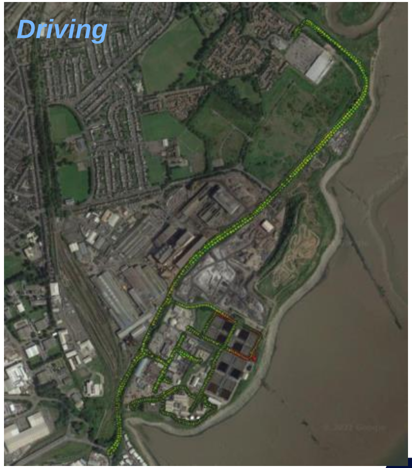


2.

METHODOLOGY

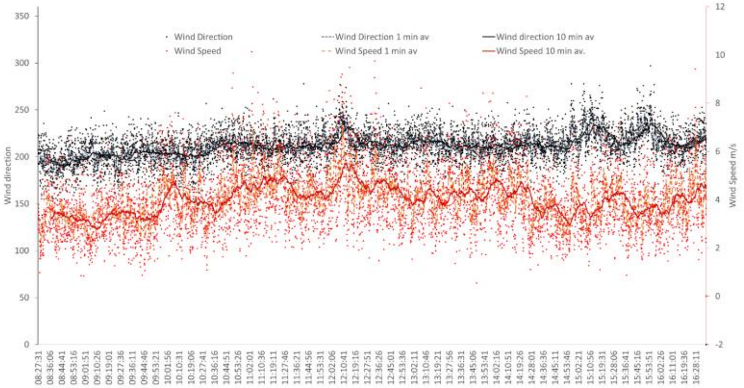
Step 1 : Field Campaign

- ON SITE METEO STATION
- SMALL SIZE ANALYZER (LICOR, LGR, AERIS)
- TOO EXPENSIVE FOR A NETWORK
- MOBILE MEASUREMENTS :
  - 1 Hz
  - Sniffing on SITE for source identification
  - Walking around sources
  - Driving around site

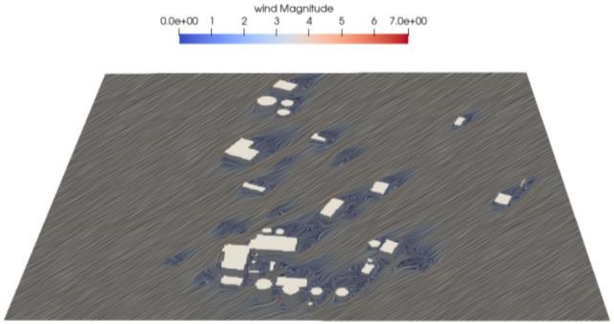


Step 2 : Modelling

- **METEO DATA ANALYZE**
  - **STEADY SITUATION**
  - **SUB PERIOD SELECTION**
- **SENSORS AGGREGATION**
  - **AUTOMATIC SELECTION FOR LOCAL MAX**
- **EMISSIONS PRIOR**
  - **GEOMETRY : SNIFFING+EXPERT**
  - **PROPORTIONAL TO AREA & NEARBY CONCENTRATION**

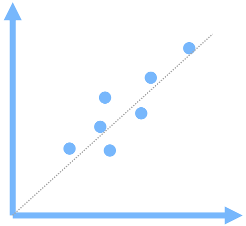


Step 2 : Modelling



- **DISPERSION MODELLING**
  - **PMSS 3D MODEL : PSWIFT+PSPRAY**
  - **FORWARD PLUME – EXTRACTION AT AGGREGATE POINTS LOCATION**

- **INVERSION METHODS**



OPTION #1: SINGLE FACTOR REGRESSION WITH QQ-PLOT

OPTION #2: SINGLE FACTOR REGRESSION WITH SCATTER PLOT

OPTION #3: MULTIPLE FACTORS REGRESSION :

CONDITION NUMBER OFTEN HIGH

$$\begin{pmatrix} \left(\frac{C_{1,1}}{Q_1}\right)_{sim} & \cdots & \left(\frac{C_{1,n}}{Q_n}\right) \\ \vdots & \ddots & \vdots \\ \left(\frac{C_{m,n}}{Q_1}\right)_{sim} & \cdots & \left(\frac{C_{m,n}}{Q_n}\right) \end{pmatrix} \begin{pmatrix} Q_1 \\ \vdots \\ Q_n \end{pmatrix} + \begin{pmatrix} C_{background} \\ \vdots \\ C_{background} \end{pmatrix} = \begin{pmatrix} C_1 \\ \vdots \\ C_m \end{pmatrix}$$

OPTION #4: ITERATIVE FITTING

3.

SITES CONTRAINS & PERFORMANCES

Sites Constrains : theory versus real life

NO PERFECT SITE !

IN THE SITES :

- **ATEX ZONE**
- **OSBTACLES**
- **STEEP TERRAIN**

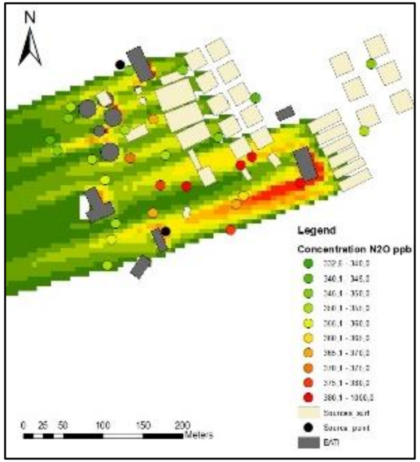
OUT OF THE SIDE :

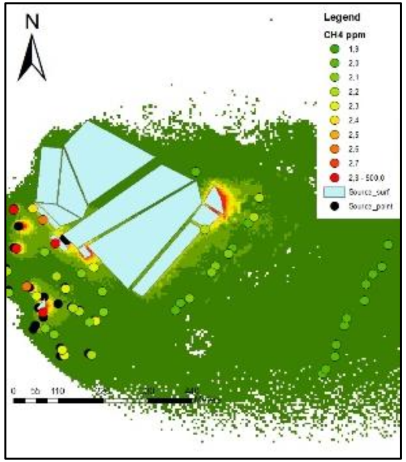
- **PRIVATE PROPERTIES**
- **PARASITE SOURCES**
- **TOO FAR : TOO LOW CONCENTRATION**

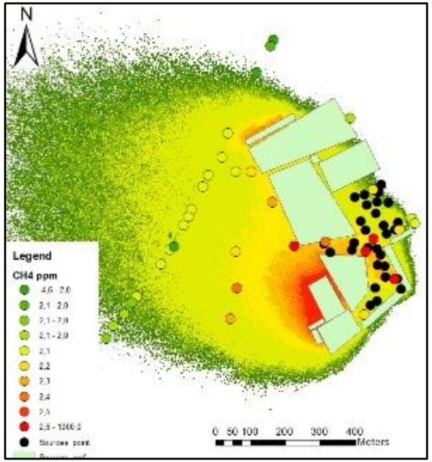
Typical observed configurations

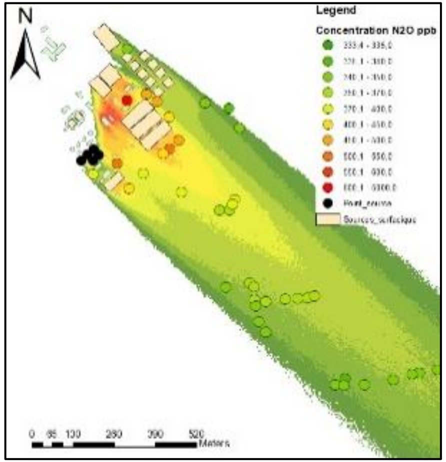
ONLY INSIDE OBSERVATIONS

INSIDE OBS + 1-2-3 CROSS OR ALIGNED SECTIONS







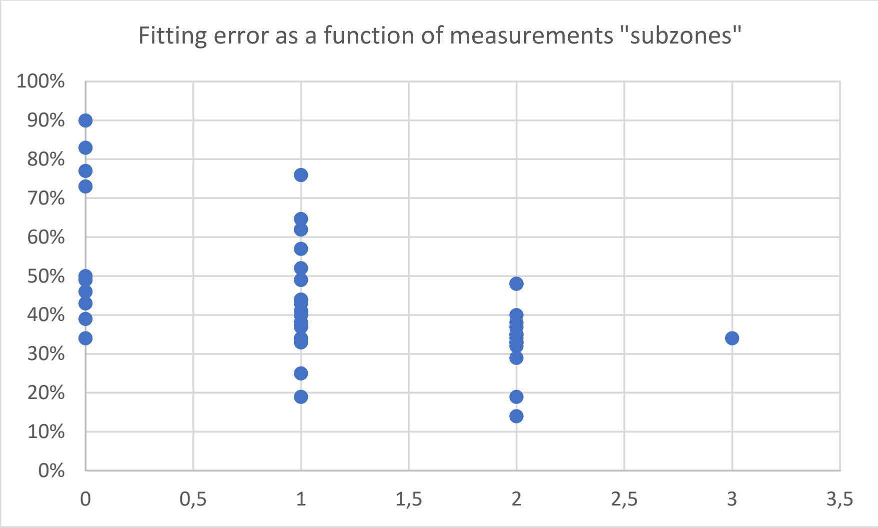


How to evaluate the performances of one SCAN360 ?

GLOBAL UNCERTAINTY ? UNCERTAINTY PER SOURCE ?

Cost of Sensitive study not compatible with low service price

wind speed measurement, wind direction measurement, CH_4/N_2O concentration measurement, GSP localization of CH_4/N_2O mobile sensor, wind speed steady state hypothesis for modelling, wind direction steady state hypothesis for modelling, aggregation of CH_4/N_2O points, model fitting error (regression error, atmospheric turbulence estimation, internal dispersion model error)



INDICATOR OF EASY OR NOT FITTING:

Average relative error

Statistics on the 40 cases :

43.3% for CH4 and 40.4% for N2O

43.2% for WWTP and 40.4% for Landfills

4.

PERSPECTIVES

Perspectives

BUILDING AN EMISSION FACTORS DATABASE

Improve knowledge

Improve automatic regression not only based on concentration but also on source type

PERFORMANCE & UNCERTAINTIES

Compute standard scores (FAC2, NMES, FB, R)

Automatization of sensitivity study

THANK YOU