Local measurements of ammonia emissions of soiled soils and spatial extrapolation to the cattle building

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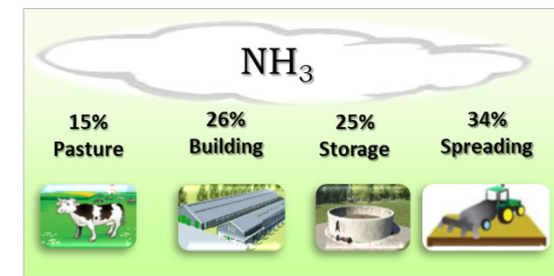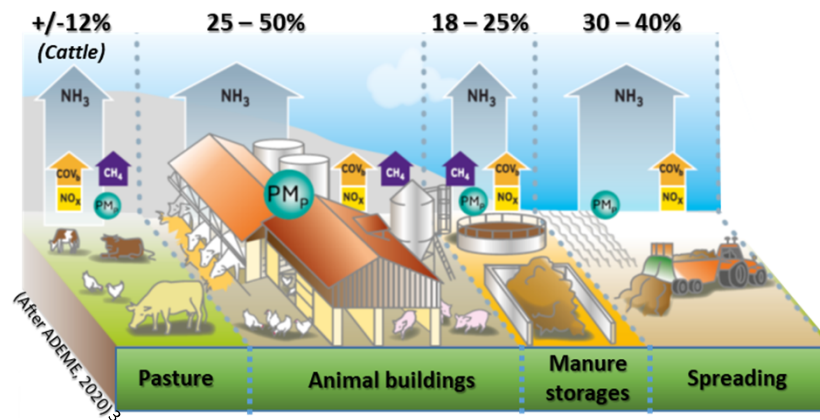
- **Focusing on ammonia (NH_3) emissions**

- **Ammonia has health[1] and environmental[2] impacts**

- **In France agriculture is the main contributor**

Contribution to the French national emissions			
(Citepa 2016)[4]	Agricultural sector	Cattle sector	Cattle building
Ammonia NH_3	**98 %**	**42 %**	**26 %**

[1]: Donham et al, 2002;
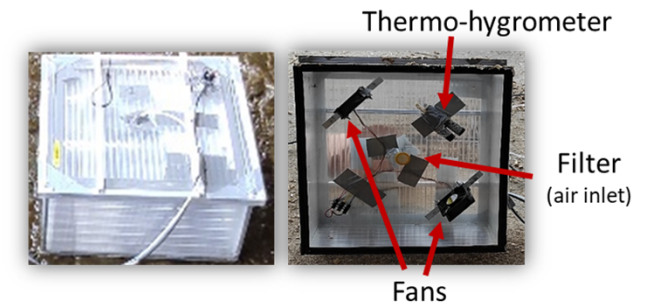
[2]: Ademe and MEDDTL, 2012

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The "EMISOLBV" project

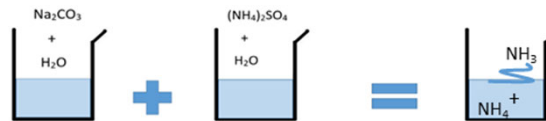Developed for setting up a field method to:
- being able to verify the emission reductions of equipment or practices
- assess the contribution of hotspots in cattle buildings

I. Use of **ventilated semi-static chambers** for ammonia emission assessments

II. Use of **traceable solutions**

   (Na$_2$CO$_3$ and (NH$_4$)$_2$SO$_4$ in aqueous solution)

$$Na_2CO_3 + H_2O \quad + \quad (NH_4)_2SO_4 + H_2O \quad = \quad NH_3 \;/\; NH_4^+$$

III. Use of the **Near Infra-Red Spectroscopy (NIRS)** for soiled soil characterisation and spatial extrapolation

Thermo-hygrometer

Filter
(air inlet)

Fans

- Use of traceable solutions *(Na$_2$CO$_3$ and (NH$_4$)$_2$SO$_4$ in aqueous solution)*

ISSUE

Chamber measurements must deal with potential variabilities
in pumping, ventilation, adsorption, etc.

Effect on emission calculations

OBJECTIVES

- Verify the **relationship between the observed concentrations and the calculated emissions** from on-site measurements

- the **reliability** of these measurements

CONSTRAINT

They must be **comparable to the slurry characteristics:**

- observed **NH$_4^+$** in slurry in the range of 0,043 to 0,15 mol/l
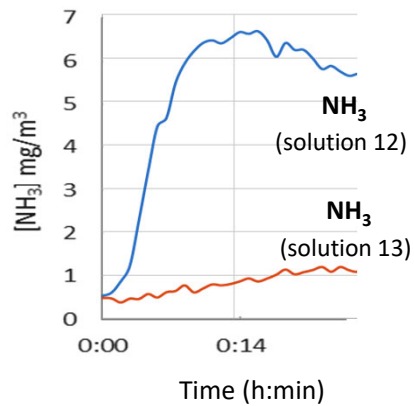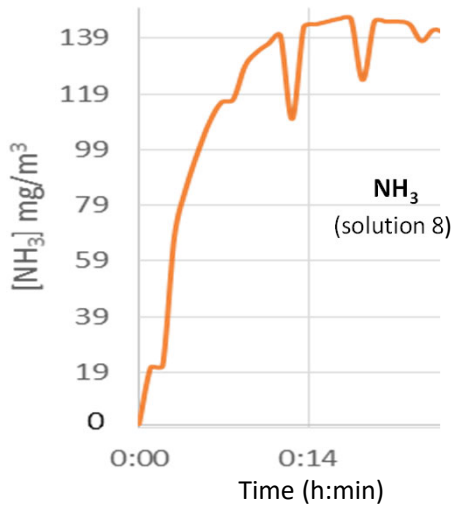- observed **pH** between 7 and 9.3
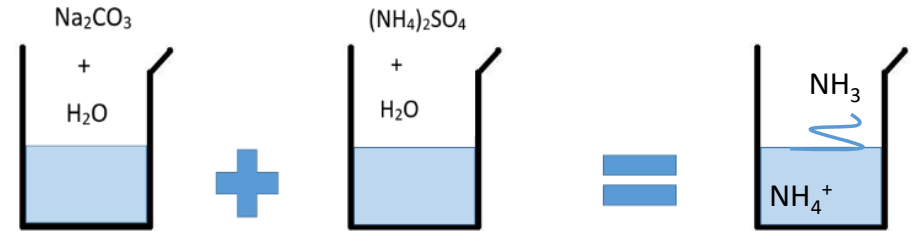
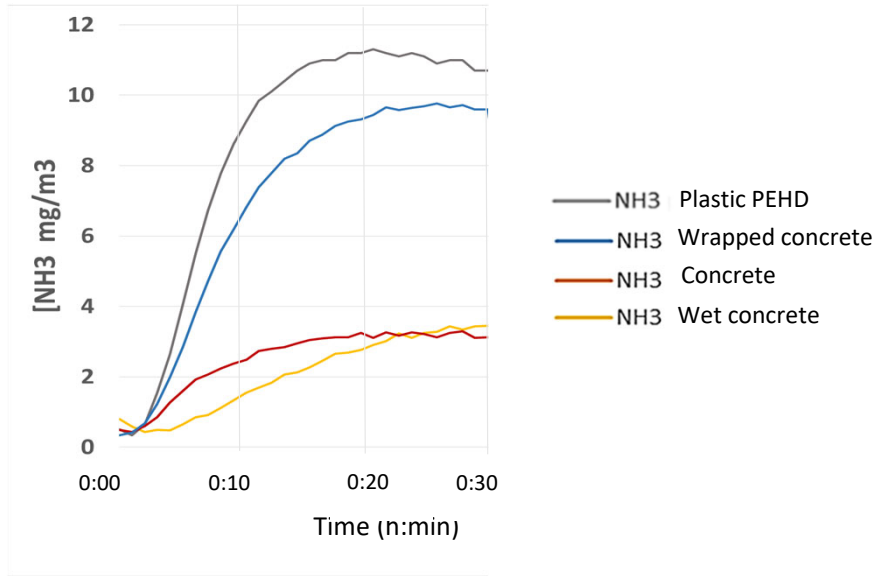| Solution	[NH$_4^+$] mol/L	pH
Solution 1	0,125	7,49
Solution 2	0,125	7,88
Solution 3	0,124	8,12
Solution 4	0,124	8,45
Solution 5	0,123	8,73
Solution 6	0,120	9,05
Solution 7	0,114	9,50
Solution 8	0,105	9,85
Solution 9	0,102	10,35
Solution 10	0,148	8,43
Solution 11	0,075	8,35
Solution 12	0,037	8,56
Solution 13	0,037	7,15

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Traceable solutions - Measurements
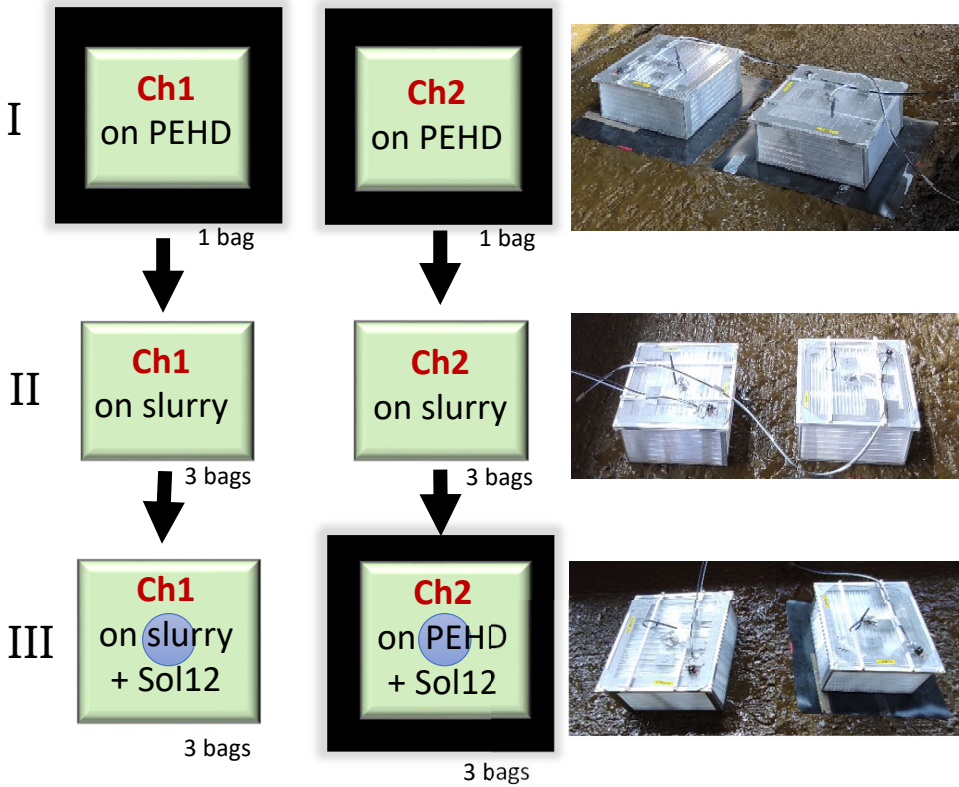
3 aqueous solutions kept for on-farm measurements

Adsorption effect

NH_3 (solution 8)

NH_3 (solution 12)

NH_3 (solution 13)

NH3 Plastic PEHD
NH3 Wrapped concrete
NH3 Concrete
NH3 Wet concrete

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On-site measurements

I
Ch1 on PEHD — 1 bag
Ch2 on PEHD — 1 bag

II
Ch1 on slurry — 3 bags
Ch2 on slurry — 3 bags

III
Ch1 on slurry + Sol12 — 3 bags
Ch2 on PEHD + Sol12 — 3 bags

Batteries
Switches
Sockets for fans
Battery control
Controler
Sampling tubes

Prog. ON
Fans start — 0 / 5sec
Ch. down — 1min — 1min
Air Ch. « Stabilization » — 4min
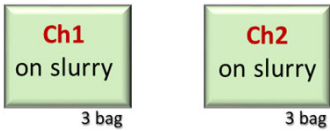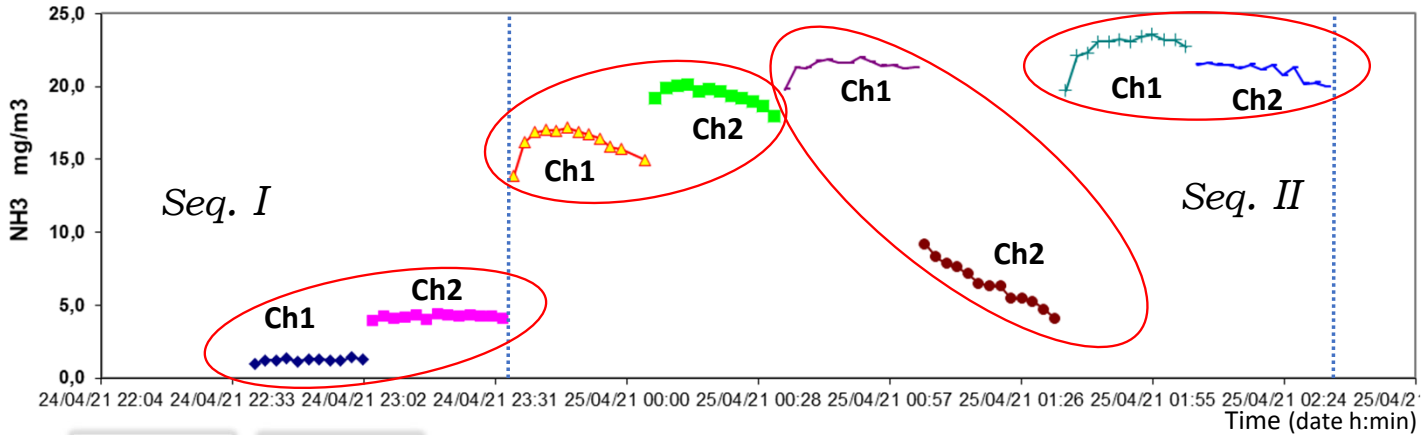Start Meas. — 6min — 2min
End Meas. — 8min

14 sampling bags

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Measured NH$_3$ concentrations

Finally:

Measured concentrations,

+

Air temperature monitored in the chamber

**+**

Corrections based on the lab and field measurements

Calculation of the NH$_3$ emissions from each chamber

- Chamber variability
- Need of replicates

- Increase in concentrations and then plateau
- First measurements to be left

Use of the Near Infra Red Spectroscopy (NIRS)

NIRS is known to help characterizing the animal manure
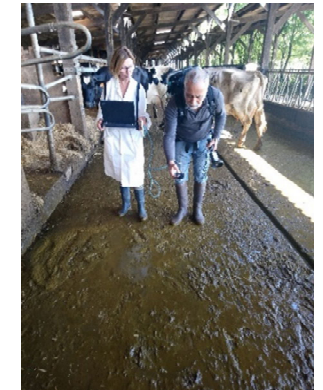
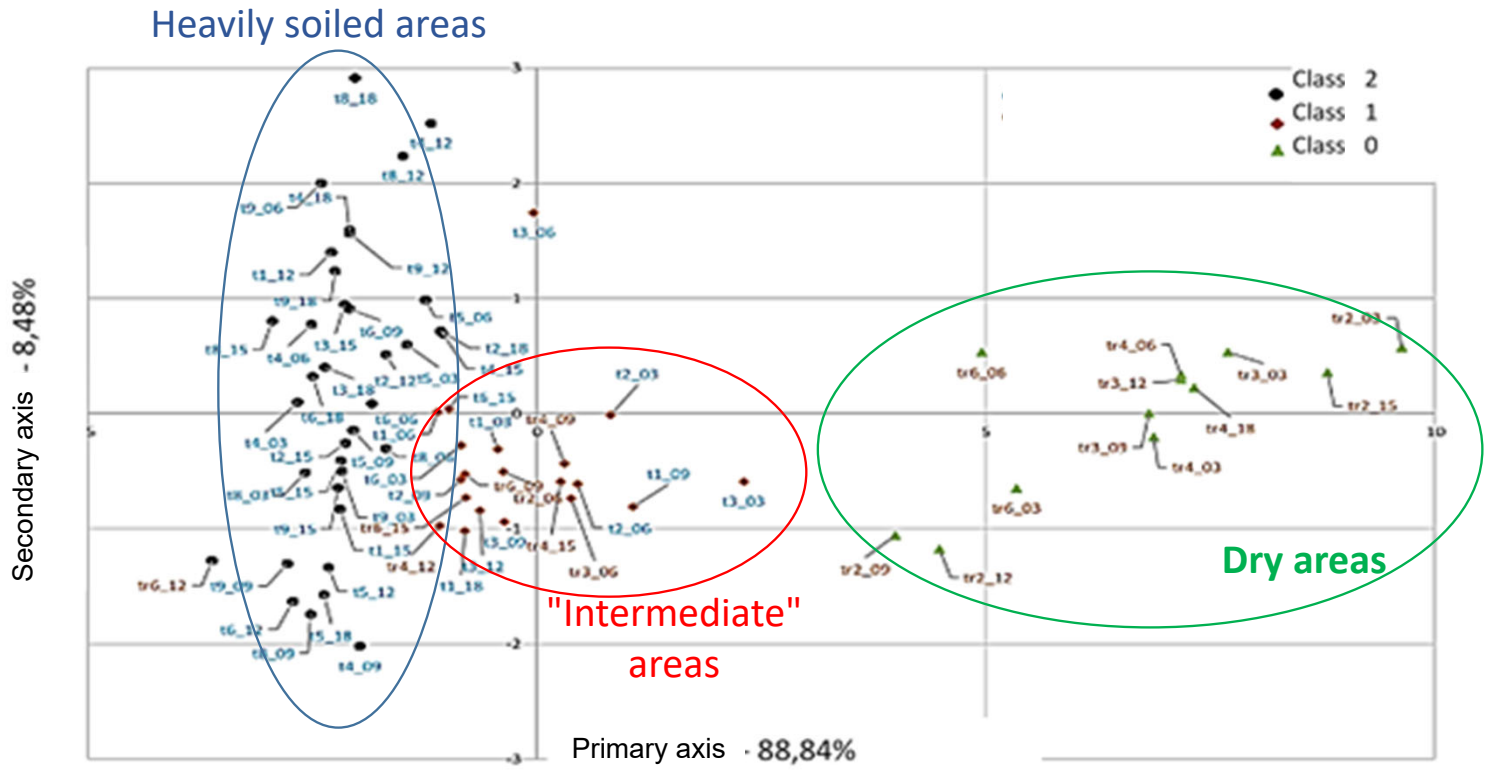Simultaneous **spectra** and **pictures** have been collected in the **walking areas**

Solid Manure

Reflectance (%) vs Wave Length (nm)
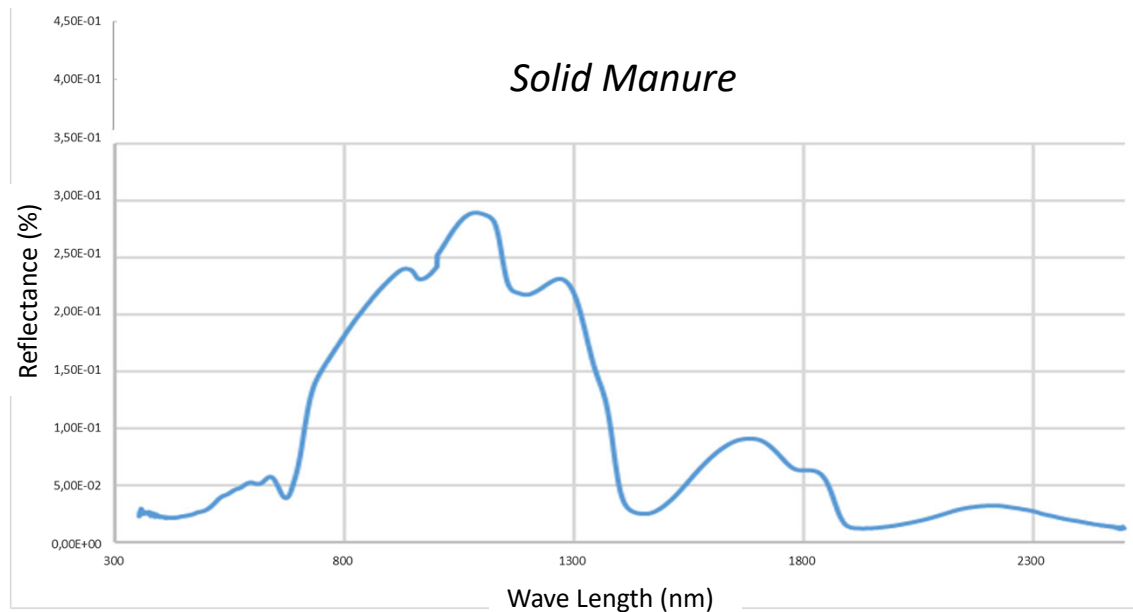
Spatializing the heterogeneity of **manure deposits**

All **spectra** have been **analyzed** (PCA[1]) and **classified** (HCA[2])

[1] : Principal Component Analysis
[2] : Hierarchal Cluster Analysis

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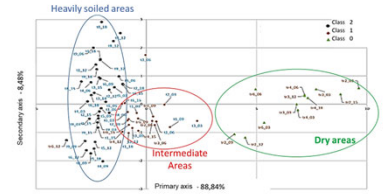# Use of NIRS for **spatial extrapolation** at the whole building

Class	Picture	Characteristics	% emissions
0		Mainly dry and clean areas	0%
1		Between classes 0 an 2	50%
2		Areas generally wet with urine and feces	100%

Use of NIRS for **spatial extrapolation** at the whole building

NH$_3$ emissions at the building scale

1- NIRS for estimating manure heterogeneity

2- Classification (0, 1 or 2) with measured areas

3- Chamber set over the class 2

4- Emissions calculations over the chamber area

5- Extrapolation for the whole building

Future Developments

1-

2-

EF$_{NH3}$ per class

3-

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Thank you

Aknowledgment

References
1. Donham, K.J, Cumro, D., Reynolds, S. ―Synergistic effects of dust and ammonia on the occupational health effects of poultry production workers‖. J Agromedicine. 2002 ; 8(2) : 57-76.
2. Ademe et MEDDTL. 2012. Les émissions agricoles de particules dans l'air. Etats des lieux et leviers d'action. Editions Ademe, 36 p.
3. Ademe, 2020. Guide des bonnes pratiques agricoles pour l'amélioration de la qualité de l'air. Editions Ademe, 43 p.
4. CITEPA, 2016. CITEPA, édition mars 2016. Inventaire des émissions de polluants atmosphériques en France métropolitaine, format CEE-NU