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USING THE BOTTOM-UP INVENTORY METHOD CADASTRE_NH3 TO ASSESS THE EFFICIENCY OF MITIGATION TECHNIQUES TO REDUCE AMMONIA EMISSIONS IN FRANCE

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INTRODUCTION

France is one of the first ammonia (NH₃) emitting countries in Europe, and this gas comes mostly from the agricultural sector (97%) (CITEPA, 2017). It is mainly produced in the animal sector, but building and effluent storage emissions can easily be measured thus improving the estimates. However, due to high nutrient content, animal effluents are used as fertilisers in arable fields and meadows. Due to different local pedoclimatic conditions of sprayed fields, NH₃ emission varies highly at the national scale. When it reacts with industrial or vehicle emissions, NH₃ contributes to the formation of fine particle matter (PM_{2.5}), a highly potent air pollutant having adverse impacts on human health. Mitigation to decrease NH₃ emissions measures have been proposed since 1999 through the Gothenburg protocol. However, due to the high variability of the field emissions, the efficiency of these measures is difficult to assess at national scale.

The aim of this study is to show how the application of a bottom-up method (CADASTRE_NH3, Ramanantenasoa *et al.* in review) on the proposed mitigation scenarios is an asset for the evaluation of the efficiency of the NH₃ emission reduction.

MATERIAL AND METHODS

Our approach relies on the use of three resources: a national survey, a modelling tool and a guidance document. Nitrogen fertilization management data were issued from the national AGRESTE survey of cultural practices for arable crops and grassland, conducted by the Department of Statistics and Forecasting of the French Ministry of Agriculture, during the crop years 2010/2011, for the 13 main crops and 21 regions (NUTS2) (AGRESTE, 2014). From this survey, statistical calculations were carried out to aggregate representative cultural practices at regional scale [cf. abstract “An overview of nitrogen fertilisation practices in France” in the poster session].

CADASTRE_NH3 is a tool based on the Volt'Air model. The latter is a process-based 1D model predicting NH₃ emissions from N fertilizers on bare soils, from physical, chemical and biological processes. It takes into account the influence of soil, meteorological and agricultural variables and runs at an hourly time step at the field scale for a period of several weeks (Garcia *et al.* 2012). Simulation units (SU) were determined using a Geographical Information System, as the intersection of departments (NUTS3) and homogenous agricultural region (AR), thus creating 713 SU. Local features were attributed to each SU: local pedoclimatic conditions, the area of each surveyed crop and the corresponding N fertilizing practices. All details about this method can be found in Ramanantenasoa *et al.* (in review).

Based on the guidance document for preventing and abating ammonia emissions from agricultural sources of the Gothenburg protocol (ECE/EB.AIR/113/Add.1, decision 2012/11), the two following scenarios will be applied to the N fertilisation practices and their efficiency will be evaluated:

- Scenario 1: Substitution of 60% of urea by ammonium nitrate
- Scenario 2: Abatement techniques for slurry and solid manure application (injection, incorporation within 24h of application, band-spreading)

First series of results are calculated using (i) the AGRESTE survey data for the amount of mineral N applied in whole France in 2010-11, and (ii) the EMEP/EEA (2013) Tier 2 emission factors (EF) for NH₃

emissions in the field. Abatement factors for Scenario 2 (organic fertilizers) come from the Gothenburg protocol. Then simulations will be run through CADASTRE_NH3 to sharpen the efficiency of these measures, taking into account the local pedoclimatic conditions. The outcomes of these simulations will be available in March 2018.

RESULTS AND DISCUSSION

As an example of results obtained using EMEP EF, Scenario 1 (substitution of 60% of urea by ammonium nitrate) demonstrates a reduction of 14% of NH₃ emissions (from 204 to 176 kgNH₃) at the national scale (Table 1). However, even if urea represents 10% of total mineral N applied, this ratio varies enormously amongst the regions (from 1% to 48%). Therefore more local incentive could be implemented to help the application of the substitution where bigger urea amounts should be replaced. Besides, this analysis did not consider the local pedoclimatic conditions that could impact greatly the NH₃ emissions rates and thus increase the regional disparity or affect the efficiency of this mitigation scenario.

Table 1. Amount of mineral N fertilizer applied (in tN) and distribution between the main forms (urea and ammonium nitrate, in % of N applied) from the survey, estimates of NH₃ emissions (in kgNH₃) from EF (EMEP/EEA, 2013) for the product distribution from the survey and for Scenario 1. The table presents a selection of 3 contrasted regions.

Example of region (NUTS2)	Total N applied (tN)	Distribution of N products		Calculated total NH ₃ emissions (EMEP method) (kgNH ₃)		Simulated total NH ₃ emissions (CADASTRE_NH3) (kgNH ₃)	
		Urea	Ammonium nitrate	Survey	Scenario 1	Survey	Scenario 1
BOURGOGNE	226 565	9%	47%	21	19	<i>Available in March 2018</i>	
PICARDIE	162 667	1%	47%	14	14		
AQUITAINE	96 165	48%	38%	14	9		
Total	2 253 783	10%	53%	204	176		

CONCLUSION

A complete bottom-up modelling will produce more accurate results of NH₃ emissions from local conditions than using EF. The efficiency and pertinence of each proposed mitigation measure can be assessed for each French region individually. This will help to direct incentive or compensation measures depending on local contexts. Moreover, the effects of other mitigation measures could be tested as an application of interdiction periods (to avoid peak pollution) or area limitations (to minimize environment contamination).

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