Emissions of N$_2$O from Canadian Agricultural Sources: An IPCC Tier II approach.

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Introduction

- International initiatives (UNFCCC and Kyoto) require that countries conduct national inventories of their greenhouse gas emissions.
- Intergovernmental Panel on Climate Change (IPCC) recommends that country-specific (Tier II) inventory methodology be used when local information on emissions is available.

Objective

- Develop and use a country-specific (Tier II) methodology to estimate N$_2$O emissions from agricultural sources in Canada for the period 1990-2005.

Material and Methods

1) N$_2$O from agricultural sources (N$_2$O$_{agriculture}$)
   - County-specific methodology
   - Based on activity of Canadian field research data
   - Activity data (e.g. crop yields, livestock populations, fertilizer use, etc.)
   - Tier II methodology likely improves national soil N$_2$O estimates

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3) Direct N$_2$O emissions from Agricultural Soils (N$_2$O$_{soils}$)
   - Tier II methodology
   - N$_2$O emissions from agricultural soils in Canada for the period 1990-2005.

4) In the Québec-Ontario Region
   - Activity data, emission factors and N$_2$O emissions were estimated as being equal to N$_2$O$_{inputs}$
   - Large inter-annual variations due to variations in precipitations, livestock populations and crop yields
   - EF value of 0.012 kg N$_2$O kg$^{-1}$ N was used for irrigated soils

5) Activity data
   - Tier II methodology
   - N$_2$O$_{soils}$ emissions from agricultural soils in Canada for the period 1990-2005.

6) EF for the Québec-Ontario Region
   - Tier II methodology
   - N$_2$O$_{soils}$ emissions from agricultural soils in Canada for the period 1990-2005.

7) EF was determined for 2 region
   - Tier II methodology
   - N$_2$O$_{soils}$ emissions from agricultural soils in Canada for the period 1990-2005.

8) "EF not determined for 2 region"
   - Tier II methodology
   - N$_2$O$_{soils}$ emissions from agricultural soils in Canada for the period 1990-2005.

9) EF and fraction of land
   - Tier II methodology
   - N$_2$O$_{soils}$ emissions from agricultural soils in Canada for the period 1990-2005.

10) N$_2$O$_{soils}$ emissions from agricultural soils in Canada for the period 1990-2005.

11) N$_2$O$_{agriculture}$ emissions from agricultural soils in Canada for the period 1990-2005.

12) N$_2$O$_{agriculture}$ emissions from agricultural soils in Canada for the period 1990-2005.

13) N$_2$O$_{agriculture}$ emissions from agricultural soils in Canada for the period 1990-2005.

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Results and Discussion

- Tier II estimates are lower than Tier I estimates.
- No net increase in direct emissions from soils between 1990 and 2005.
- Large inter-annual variations due to variations in precipitations, livestock populations and crop yields
- Emissions associated with the practice of summerfallow and no-till decreased from 1990-2005.
- Other sources were stable or slightly increased over the period.

Conclusions

- A function relating EF to climate (ratio of precipitation to potential evapotranspiration) was developed to estimate annual emission factors at the ecodistrict scale (avg. area of agricultural ecodistricts = 150,000 ha).
- Regional coefficients were also developed to account for the effect of several additional factors on soil N$_2$O emissions (soil texture, topography, tillage, summerfallow, spring thaw and irrigation).
- Total direct annual N$_2$O emissions from agricultural soils averaged 37.9 Gg N yr$^{-1}$ between 1990 and 2005 with variations from 32.3 to 45.4 Gg N yr$^{-1}$.
- Application of synthetic N fertilizers was the largest source of soil N$_2$O followed by crop residues, grazing animals and manure applied to soils.
- These estimates are approximately 22% lower than estimates obtained using the IPCC default (Tier I) methodology. Differences were mostly the result of lower emission factors in the dry central Prairies and the omission of emissions associated with the biological N fixation by legume crops.
- Because it is based on country-specific emission coefficients, the Tier II methodology likely improves national soil N$_2$O estimates compared to the Tier I approach.