

# Soil N<sub>2</sub>O Emissions in the 2006 IPCC Guidelines

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# UNFCCC Request

... should explore the need and ways to clarify, improve and provide updated information, as appropriate, related to, inter alia ... information in chapter 11 relevant to direct and indirect nitrous oxide emissions from soils.

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# 2006 IPCC Guidelines

- Chapter 11 of Volume 4 provides methods for estimating total national anthropogenic emissions of  $\text{N}_2\text{O}$  (**direct and indirect**) from managed soils
  - Managed soils are all soils on land, including Forest Land, which is managed
- Chapter 7 of Volume 1 provides methods for indirect  $\text{N}_2\text{O}$  from non-agricultural sources of atmospheric  $\text{NO}_x$  and  $\text{NH}_3$

# 2006 IPCC Guidelines

- Methods given are simple and reflect the state of knowledge when the guidelines were compiled
  - Basic three-tier approach
- Changes relative to 1996 IPCC Guidelines
  - Full sectoral coverage of indirect N<sub>2</sub>O emissions
  - Revised emission factors for N<sub>2</sub>O from agricultural soils
  - Removal of biological nitrogen fixation as a direct source of N<sub>2</sub>O
    - lack of evidence of significant emissions arising from the fixation process

# Emissions of $\text{N}_2\text{O}$ from soils

- Direct
  - Directly from the soils to which N is added or released
- Indirect
  - Emissions resulting from the atmospheric deposition of  $\text{NH}_3$  and  $\text{NO}_x$  and their products  $\text{NH}_4^+$  and  $\text{NO}_3^-$  to soils and waters.  $\text{NH}_3$  and  $\text{NO}_x$  are emitted from agricultural and non-agricultural sources (e.g. fuel combustion, industrial sources, and biomass burning)
  - Emissions from water from the leaching and runoff of N (mainly as  $\text{NO}_3^-$ ) from managed soils

# Direct emissions

- The methodology in Chapter 11 addresses following N sources of N<sub>2</sub>O from managed soils
  - synthetic N fertilisers
  - organic N applied as fertiliser (e.g., animal manure, compost, sewage sludge, rendering waste)
  - urine and dung N deposited on pasture, range and paddock by grazing animals
  - N in crop residues (above-ground and below-ground), including from N-fixing crops and from forages during pasture renewal
  - N mineralisation associated with loss of soil organic matter resulting from change of land use or management of mineral soils
  - drainage/management of organic soils (i.e., Histosols)



# Direct emission: Emission factors

- Three EFs are needed (Tier1 and 2)
  - $EF_1$  : amount of  $N_2O$  emitted from the various synthetic and organic N applications to soils, including crop residue and mineralization of soil organic carbon in mineral soils due to land-use change or management,  $kg\ N_2O-N / kg\ N$
  - $EF_2$ : amount of  $N_2O$  emitted from an area of drained/managed organic soils,  $kg\ N_2O-N / ha$
  - $EF_{3PRP}$ : amount of  $N_2O$  emitted from urine and dung N deposited by grazing animals on pasture, range and paddock,  $kg\ N_2O-N / kg\ N$
- Default emission factors are in Table 11.1

# Direct emission: Emission factors

- Changes as compared to the *1996 IPCC Guidelines*
  - $EF_1$ : changed from 1.25% to 1% (*result of new analyses of the available experimental data*)
  - $EF_2$ : values for both temperate and tropical climates have been changed from the values provided in the *1996 IPCC Guidelines to those contained in the GPG2000*
  - $EF_{3PRP}$ : addition of a default EF for sheep (disaggregated for different animal types)



# Indirect emissions

- Chapter 11 addresses agricultural N sources of indirect N<sub>2</sub>O from managed soils
  - synthetic N fertilisers
  - organic N applied as fertiliser (e.g., applied animal manure, compost, sewage sludge, rendering waste and other organic amendments)
  - urine and dung N deposited on pasture, range and paddock by grazing animals
  - N in crop residues (above- and below-ground), including N-fixing crops and forage/pasture renewal returned to soils
  - N mineralisation associated with loss of soil organic matter resulting from change of land use or management on mineral soils

# Indirect emissions

- Non-agricultural sources of  $\text{NO}_x$  and  $\text{NH}_3$ 
  - Methods for indirect emissions of  $\text{N}_2\text{O}$  from deposition of  $\text{NO}_x$  and  $\text{NH}_3$  from non-agricultural sources are given in Volume 1 Section 7.3
    - To ensure inventories are complete
  - These use the same methods as agricultural sources
    - Gases are indistinguishable once emitted
  - To make these estimates a national inventory of  $\text{NO}_x$  and  $\text{NH}_3$  is needed
    - Guidelines suggest they should only be included if such an inventory already exists

# Indirect emissions of N<sub>2</sub>O

Categories	Activity data / source emissions		Emissions
	Emissions NH <sub>3</sub>	Emissions NO <sub>x</sub>	N <sub>2</sub> O
	(Gg NH <sub>3</sub> )	(Gg NO <sub>2</sub> - equivalents)	(Gg N <sub>2</sub> O)
<b>5A.1 Energy</b>			
<b>5A.2 Industrial Processes and Product Use</b>			
<b>5A.3 Agriculture, Forestry and Other Land Use</b>			
3C5 Indirect N <sub>2</sub> O Emissions from managed soils			
3C6 Indirect N <sub>2</sub> O Emissions from manure management			
Other <sup>(3)</sup> (Please specify)			
<b>5A.4 Waste</b>			
<b>5A Other (Please specify)</b>			

These categories are included in the Agriculture category 3C and are repeated here for clarity

# Indirect emissions: Emission factors

- Two EFs are needed (Tier1)
  - $EF_4$  : amount of  $N_2O$  emitted from atmospheric deposition of N on soils and water surfaces,  $kg\ N_2O-N / (kg\ NH_3-N + NO_x-N\ volatilised)$
  - $EF_5$ : amount of  $N_2O$  emitted from N leaching and runoff,  $kg\ N_2O-N / kg\ N\ leached\ and\ runoff$
- Default emission factors are in Table 11.3

# Indirect emissions: Emission factors

- Changes as compared to the *1996 IPCC Guidelines*
  - The overall value for  $EF_5$  has been changed from 0.025 to 0.0075 kg  $N_2O-N$ /kg N leached/ in runoff water (incorporates three components:  $EF_{5g}$ ,  $EF_{5r}$  and  $EF_{5e}$ , which are EFs for groundwater and surface drainage, rivers, and estuaries, respectively)

# Soil N<sub>2</sub>O Questions

- Consider if 2006 Guidelines methods and default factors still reflect the latest science
- Can new methods or default emission factors be provided?
- Are there any improvements to existing guidance that can be provided?
- Are there any emission factors that should be entered into the EFDB?

# Presentations

- Soil management and nitrous oxide (N<sub>2</sub>O) emissions
  - Beáta MADARI (Brazil)
- New research on agricultural soil N<sub>2</sub>O emissions
  - Philippe ROCHETTE (Canada)
- Estimating N<sub>2</sub>O emission from Chinese croplands by statistical modeling
  - Xiaoyuan YAN (China)



Thank you

