
Aggregated Sources and Non-CO₂ Emission Sources
3C2 Liming, 3C3 Urea Application

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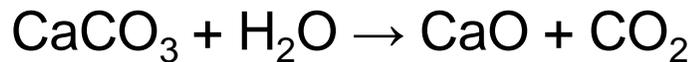
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Outline

- Liming
 - Background
 - Methodology for liming
- Urea application
 - Background
 - Methodology for Urea application
- Exercise by using the IPCC Software

Liming: Background

- Liming is used to reduce soil acidity and improve plant growth, particularly agricultural lands (sometimes in managed forest).
- Adding carbonates to soils in the form of lime (e.g., calcic limestone (CaCO_3), or dolomite ($\text{CaMg}(\text{CO}_3)_2$) leads to CO_2 emissions as the carbonate limes dissolve and release bicarbonate (2HCO_3^-), which evolves into CO_2 and water (H_2O).



- Estimation method
 - CO_2 Emission = $AD * EF * 44/12$

Methodology for Liming : EF

■ Emission Factor

- Atomic weight: Ca=40.08, C=12.01, O=16.0, Mg=24.3
- Molecular weight :
 - ◆ Lime: $\text{CaCO}_3 = 100.09$
 - ◆ Dolomite: $\text{CaMg}(\text{CO}_3)_2 = 184.41$
- EF: t-C/t-amount of lime applied/yr
 - ◆ Lime: $\text{C}/\text{CaCO}_3 = 12.01/100.09 \doteq 0.12$
 - ◆ Dolomite: $2\text{C}/\text{CaMg}(\text{CO}_3)_2 = 24.02/184.31 \doteq 0.13$
- Uncertainty: -50% for default EF. Note: Maximum Emissions are estimated with default EFs
- Tier.1 :Using default EF directly
- Tier.2: Using CS-EF. Maybe lower emission occurred due to site-specific effect.
- Tier.3: Using such as flux Model

Methodology for Liming : AD

■ Activity Data

- Source data: amount of lime/dolomite applied
 - ◆ Statistical data (amount of fertilization use)
 - ◆ Sales data (assumed as sold lime is applied in the same year)
 - ◆ Survey of agriculture practice (ex, x kg/ha/yr for average)
- Note: Potential “IE” occurred between IP sector. (Domestic lime production sometimes covers CO₂ applied to agriculture soil)
- Tiers of AD depend on EF type. But, many countries use single national data with default EF in this category.

Urea Application: Background

- Adding urea to soils during fertilisation leads to a loss of CO₂ that was fixed in the industrial production process. Urea (CO(NH₂)₂) is converted into ammonium (NH₄⁺), hydroxyl ion (OH⁻), and bicarbonate (HCO₃⁻), in the presence of water and urease enzymes. Similar to the soil reaction following addition of lime, bicarbonate that is formed evolves into CO₂ and water.



- Estimation method
 - CO₂ Emission = AD * EF * 44/12

Methodology for Urea application : EF

■ Emission Factor

- Atomic weight: H=1.008, C=12.01, N=14.01, O=16.0
- Molecular weight :
 - ◆ $\text{CO}(\text{NH}_2)_2 = 60.062$
- EF: t-C/t-amount of urea applied/yr
 - ◆ $\text{C} / \text{CO}(\text{NH}_2)_2 = 12.01 / 60.062 \doteq 0.20$
- Uncertainty: -50% for default EF. Note: Maximum Emissions are estimated with default EF
- Tier.1 :Using default EF directly
- Tier.2: Using CS-EF
- Tier.3: Using Model taking into account various site condition

Methodology for Urea application : AD

■ Activity Data

- Source data: amount of Urea applied
 - ◆ Production and import/export data on urea
 - ◆ Sales and usage data may be used to refine AD
 - ◆ Usage statistics
 - ◆ Survey of agriculture practice (ex, x kg/ha/yr for average)
- Tiers of AD depend on EF type. But, many countries use single national data with default EF in this category.

Exercise by using IPCC software: Liming

- Identify Land type
- Identify Lime Type: two types, Limestone / Dolomite can be chosen from the dropdown list.
- Select EF: default EF is only shown in the dropdown list
- Input data of annual amount of lime applied to soil (must be a new estimation in the next cycle)

2006 IPCC Categories

- 2.H.2 - Food and Beverages
- 2.H.3 - Other (please specify)
- 3 - Agriculture, Forestry, and Other
 - 3.A - Livestock
 - 3.B - Land
 - 3.C - Aggregate sources and non
 - 3.C.1 - Emissions from biomass
 - 3.C.1.a - Biomass burnin
 - 3.C.1.b - Biomass burnin
 - 3.C.1.c - Biomass burnin
 - 3.C.1.d - Biomass burnin
 - 3.C.2 - Liming
 - 3.C.3 - Urea application
 - 3.C.4 - Direct N2O Emission
 - 3.C.5 - Indirect N2O Emission
 - 3.C.6 - Indirect N2O Emission
 - 3.C.7 - Rice cultivations
 - 3.C.8 - Other (please specify)
 - 3.D - Other
 - 3.D.1 - Harvested Wood Pro
 - 3.D.2 - Other (please specify)
- 4 - Waste
 - 4.A - Solid Waste, Diagonal

Annual CO₂-C emissions from Liming

Worksheet

Sector: Agriculture, Forestry, and Other Land Use
 Category: Aggregate Sources and Non-CO₂ Emissions Sources on Land
 Subcategory: 3.C.2 - Liming
 Sheet: 1 of 1

Data

Gas: CARBON DIOXIDE (CO₂)

Land Types	Subcategories for reporting year	Lime Type	M	EF	CO ₂ -C Emissions	CO ₂ Emissions
			Annual amount of lime (tonnes / yr)	Emission Factor (tonnes of C / tonne of lime)	Annual C emissions from liming (tonnes C / yr)	Annual CO ₂ emissions from liming (tonnes CO ₂ / yr)
					CO ₂ -C Emissions = M * EF	CO ₂ -C Emissions = CO ₂ -C Emissions * 44/12
(Total)	(Total)	Limestone	0	0.12	0	0
	(Total)	Dolomite	0	0.13	0	0
Total			0		0	0

Exercise by using IPCC software: Urea application

- Identify Land type
- Select EF: default EF is shown in the dropdown list
- Input data of annual amount of urea fertization to soil

2006 IPCC Categories

- 2.H.2 - Food and Beverages
- 2.H.3 - Other (please specify)
- 3 - Agriculture, Forestry, and Other
 - 3.A - Livestock
 - 3.B - Land
 - 3.C - Aggregate sources and non-aggregate sources
 - 3.C.1 - Emissions from biomass
 - 3.C.1.a - Biomass burning
 - 3.C.1.b - Biomass burning
 - 3.C.1.c - Biomass burning
 - 3.C.1.d - Biomass burning
 - 3.C.2 - Liming
 - 3.C.3 - Urea application
 - 3.C.4 - Direct N₂O Emission
 - 3.C.5 - Indirect N₂O Emission
 - 3.C.6 - Indirect N₂O Emission
 - 3.C.7 - Rice cultivations
 - 3.C.8 - Other (please specify)
 - 3.D - Other
 - 3.D.1 - Harvested Wood Products
 - 3.D.2 - Other (please specify)

Annual CO₂ emissions from Urea Fertilization

Worksheet

Sector: Agriculture, Forestry, and Other Land Use
 Category: Aggregate Sources and Non-CO₂ Emissions Sources on Land
 Subcategory: 3.C.3 - Urea application
 Sheet: 1 of 1

Data

Gas: CARBON DIOXIDE (CO₂)

Land Types	Subcategories for reporting year	M	EF	CO ₂ -C Emissions	CO ₂ Emissions
		Annual amount of Urea Fertilization (tonnes / yr)	Emission Factor (tonnes of C / tonne of urea)	Annual CO ₂ -C emissions from Urea Fertilization (tonnes C / yr)	Annual CO ₂ emissions from Urea Fertilization (tonnes CO ₂ / yr)
				CO ₂ -C Emissions = M * EF	CO ₂ -C Emissions = CO ₂ -C Emissions * 44/12
(Total)	(Total)	0.2		0	0
Total		0		0	0