Aggregated Sources and Non-CO_2 Emission Sources 3C2 Liming, 3C3 Urea Application

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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 ($CaMg(CO_3)_2$) leads to CO_2 emissions as the carbonate limes dissolve and release bicarbonate ($2HCO_3$-), which evolves into CO_2 and water (H_2O).

  $CaCO_3 + H_2O \rightarrow CaO + CO_2$

  $CaMg(CO_3)_2 \rightarrow CaO + MgO + CO_2$

- 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:$CaCO_3$ = 100.09
    - Dolomite: $CaMg(CO_3)_2$= 184.41
  - EF: t-C/t-amount of lime applied/yr
    - Lime: $C/CaCO_3$= 12.01/100.09 ≒ 0.12
    - Dolomite: $2C/ CaMg(CO_3)_2$ = 24.02/184.31 ≒ 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 CO_2 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 CO_2 that was fixed in the industrial production process. Urea ($CO(NH_2)_2$) is converted into ammonium (NH_4^+), hydroxyl ion (OH^-), and bicarbonate (HCO_3^-), in the presence of water and urease enzymes. Similar to the soil reaction following addition of lime, bicarbonate that is formed evolves into CO_2 and water.

  $$CO(NH_2)_2 + H_2O \rightarrow 2NH_3 + CO_2$$

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

Methodology for Urea application : EF

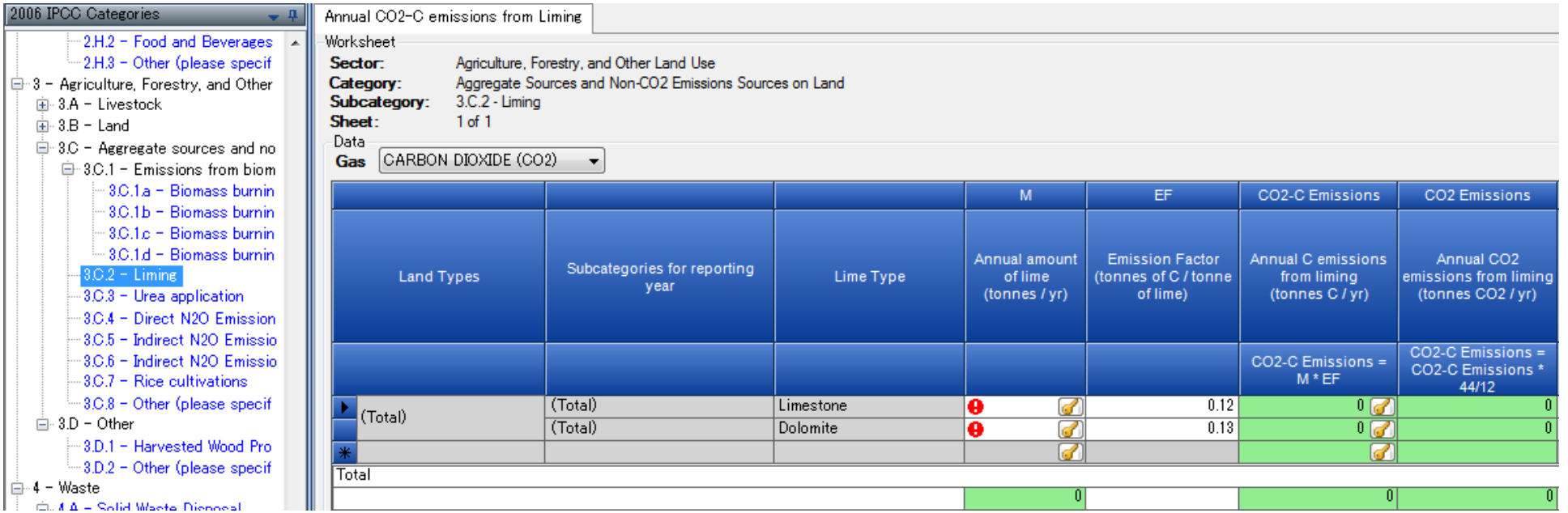
- Emission Factor
  - Atomic weight: H=1.008, C=12.01, N=14.01, O=16.0
  - Molecular weight :
    - $CO(NH_2)_2$ = 60.062
  - EF: t-C/t-amount of urea applied/yr
    - C/ $CO(NH_2)_2$ = 12.01/ 60.062 ≒ 0.20
  - Uncertainty: -50% for default EF. Note: Maximum Emissions are estimated with default EF
  - 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)



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