6-9-2016

LCA applied to residual organic fertilizing materials - An overview of emission inventory data at the spreading operation

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Life Cycle Assessment and Other Assessment Tools for Waste Management and Resource Optimization
June 5-10 2016, Cetraro, Italy

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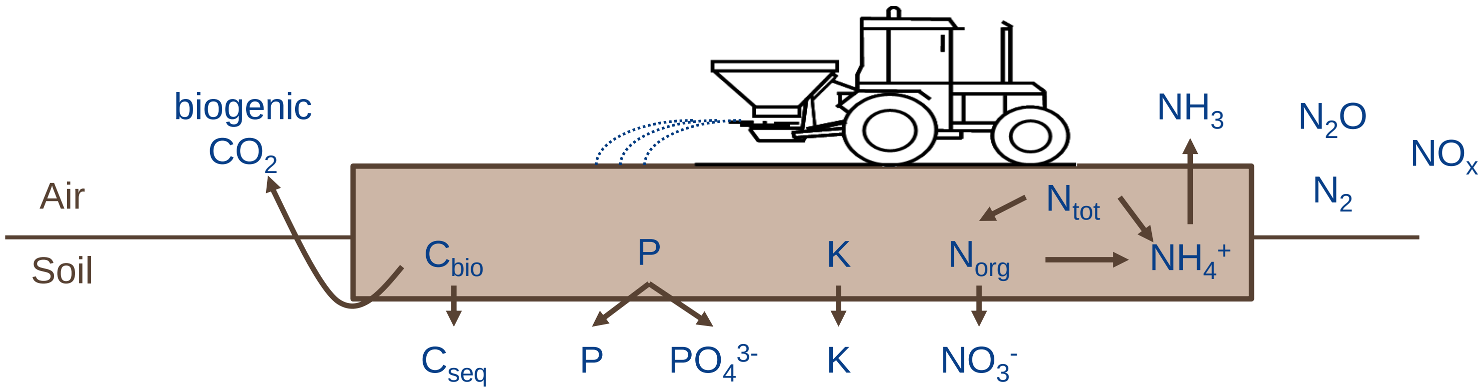
Need for data at the spreading operation

Application of a residual organic fertilizing material



Transformation rates depend on: substrate origin, fertilizing material type (digestate, compost), pedoclimatic conditions → Need for N balance

Assessment for the main function « to treat waste »

→ subtraction of mineral fertilizers

Literature study on emission data at the spreading operation for residual organic fertilizing materials and mineral fertilizers

Methodology

Queries

digestate
mineral fertilizer
LCA
substitution
allocation

LCA case studies of residual organic fertilizing materials (digestate, compost) including land spreading

emission data of organic wastes and mineral fertilizers at the spreading operation

N, P and trace metal element emissions

C emission and sequestration

- How are these emissions expressed at the spreading operation?
- Which emission rates?

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Emissions linked to the application of residual organic fertilizing materials

	Articles	Expression of the emission rates	Values	Comments
Direct N_2O	28/29	% of total N % of remaining N after NH_3 volatilization	[0,17%-2%]	Many sources, among which IPCC Consensual value ranges from IPCC
Indirect N_2O	13/29	% of N emitted as NH_3-N and NO_x-N	1%	
	8/29	% of N emitted as N-NO_3^-	[0,75-2%]	
NH_3	12/29	% of NH_4^+-N	[5-60%]	Very variable. Great sensitivity to pedoclimatic conditions so a pedoclimatic model should be used.
		% of total N	[1-25%]	
NO_x	5/29	% of N_2O-N	[10-21%]	Expressed as a % of direct and/or indirect N_2O emission produced during denitrification
		% of total N	[0,13-1,20%]	
NO_3^-	9/29	% of total N % of total N in the run-off fraction % of total N in the leachate fraction remaining after NH_3 volatilization % of NH_4^+-N in the leachate fraction remaining after NH_3 volatilization		Great variability on: - the emission rate values - the different forms the emission is expressed
N_2	3/29	% of total N	[8-9%]	Infrequent but needed to check N balance consistency

Emissions linked to the application of residual organic fertilizing materials

	Number of articles	Main units	Values	Comments
PO_4^{3-}	10/29	% of P	[1,7-10%]	Many sources
C_{bio}	3/29	% of biogenic C sequestered in the soil (leftovers emitted as biogenic CO_2)	[4-14%]	Very low consideration
		% of biogenic C emitted as CH_4	insignificant	
Trace metal elements	1/29	Concentration for each trace metal element: As, Cd, Cr, Cu, Pb, Ni, Zn, Hg, Se, Mb		Very low consideration. To explore (impacts on toxicity and ecotoxicity)

Difficult access to the quantified emission values considered in some papers

- Ungiven values
- Models used without specification of their utilization conditions

Impossible to distinguish consensus data for compost and digestate

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Emissions linked to the application of mineral fertilizers

N and P emissions

- 7/29 papers claim that the N and P emissions are considered, but values are only given for 5 papers

- Mineral fertilizers / residual organic fertilizing materials
  - Very close emission rate values
  - Emission rates issued from the same sources

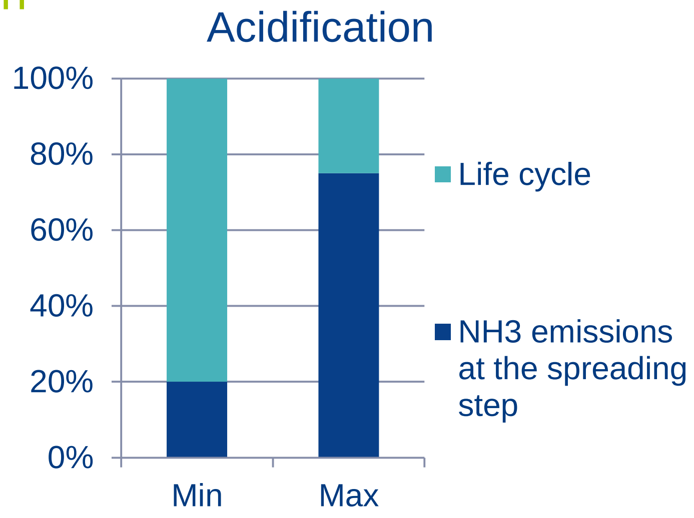
Trace metal element emissions

- 2/30 papers claim that the trace metal emissions are considered, but only 1 paper gives values

Influence of the spreading emissions of the organic products and the substituted mineral fertilizers on LCA results

Main contributions of the spreading operation

- NH_3 → acidification
- NH_3 and nitrate → eutrophication



Contributions, less often detected

- N_2O → climate change
- phosphate → eutrophication
- NO_x → particulate matter formation

Conclusion

- N_2O, NH_3, NO_3^-, PO_4^{3-} emissions more often considered than NO_x, N_2, C, trace metal elements in the case studies

- A heavy impact of the inventory emissions on results → recommendation to pay particular attention to the inventory emissions
  - Need to close the N balance, essential in LCI
  - Site-specific emissions (NO_3^-, NH_3, N_2O) → need for site measures or models
  - If the balance is not robust or if use of literature values → recommendation to perform a sensitivity analysis
  - Recommendations valid for organic products + mineral fertilizers (more difficult for the substituted system because of less data)

Thanks for your attention

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