New method of N_2O emission reporting in Germany

Roland Fuß, Gokul Prasad Mathivanan and Heinz Flessa
Thünen Institute of Climate-Smart Agriculture, Germany



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New N_2O emission factors for crop residues and fertiliser inputs to agricultural soils in Germany

Gokul Prasad Mathivanan [a], Max Eysholdt [b], Maximilian Zinnbauer [b], Claus Rösemann [a], Roland Fuß

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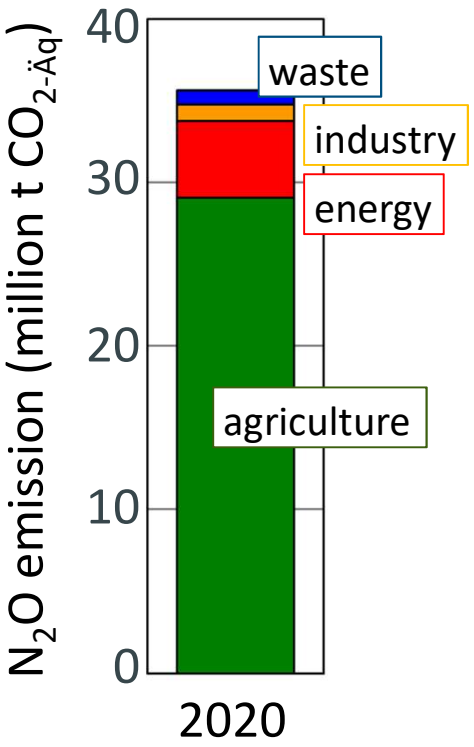
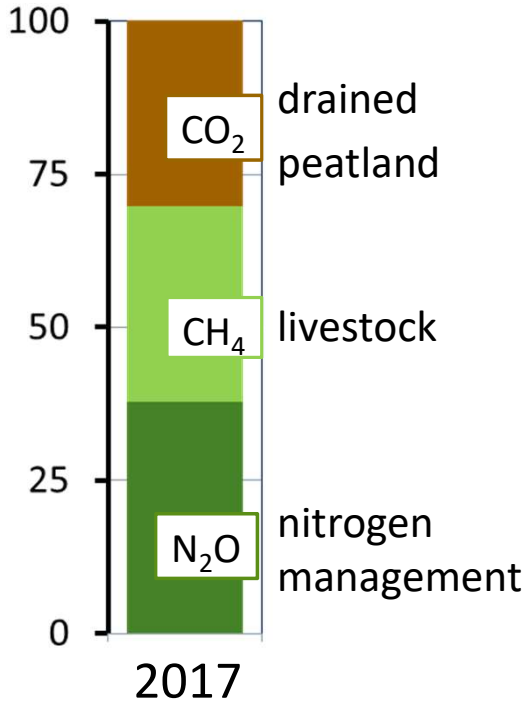
N_2O emission in Germany

Total N_2O emission in Germany



More specific information on N_2O emission is required

Total GHG emission from agriculture with LULUC in Germany



- N_2O from agriculture is a key category of GHG emission in Germany
- N_2O emission is a main factor of uncertainty in the German GHG reporting

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IPCC N_2O emission factors

- **IPCC 2006 emission factor**: EF_1 = 1 % (0.3 to 3 %) of N input is emitted as N_2O

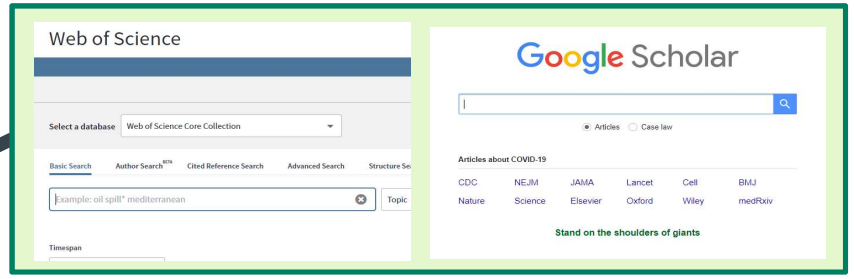
- **IPCC 2019 refinement of the N_2O emission factor**:
  - Aggregated EF_1: 1 % (0.1 to 1.8 %) of N additions from synthetic fertilizer, manure, crop residues, and loss of soil organic matter is emitted as N_2O
  - Recommended: Disaggregation of EF_1 (fertilizer type, climate):
    Synthetic fertiliser input in wet climates: 1.6 % (1.3 to 1.9 %) of N added
    Other N inputs in wet climates (e.g. manure): 0.6 % (0.1 to 1.1 %) of N added
    All N inputs in dry climates: 0.5 % (0 to 1.1 %) of N added is emitted as N_2O

- **Objective:** To derive specific, stratified N_2O emission factors for Germany
  - Approach used: meta-analysis of N_2O field studies in Germany

N_2O emission data in Germany

Database of IPCC 2019 Refinement

23 studies (217 data points) from Germany



Exclusion criteria

- lab and modelling studies
- pasture excrements
- slow release fertilizers
- natural ecosystems
- legumes
- measurement period < 150 days

71 studies, 43 locations, 676 data points

Mineral soils

59 studies

593 data points

Organic soils

12 studies

83 data points

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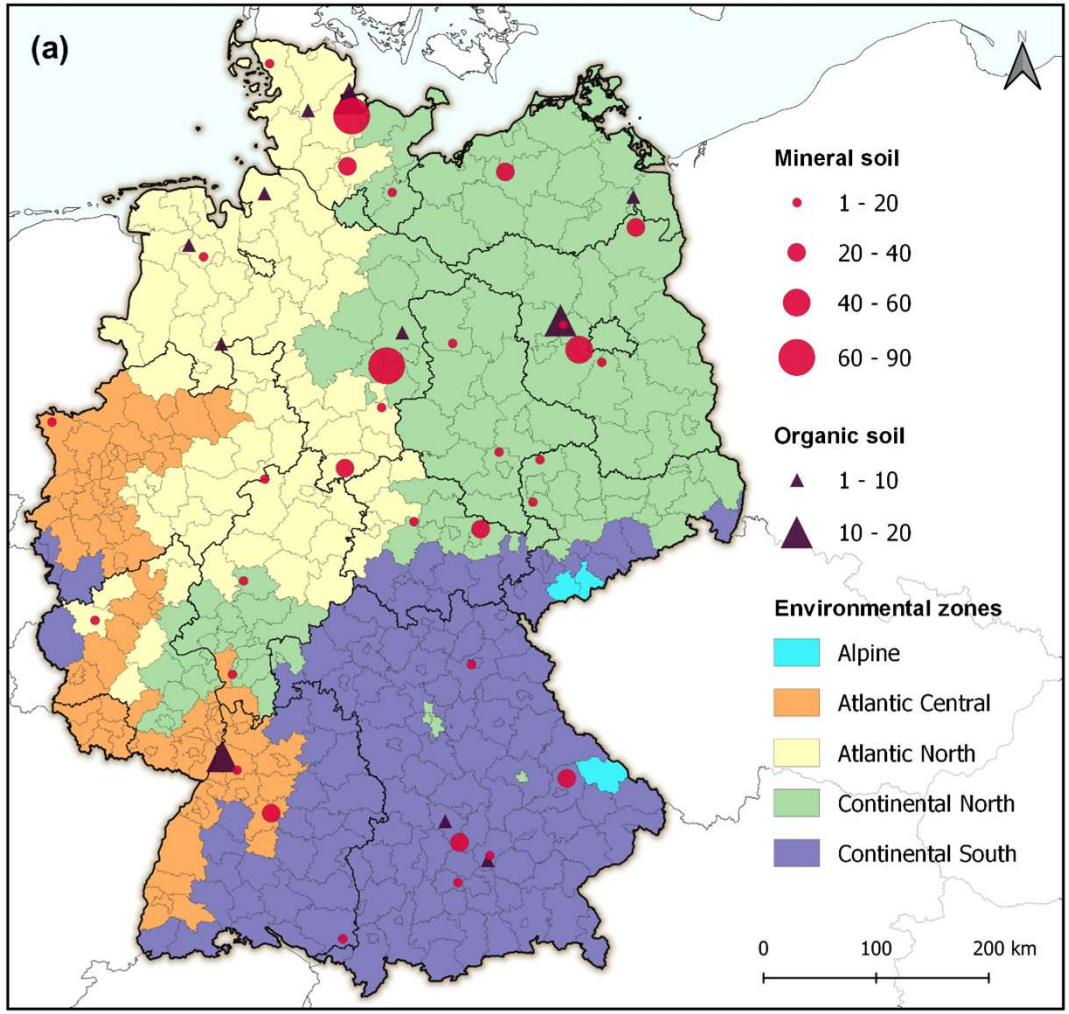
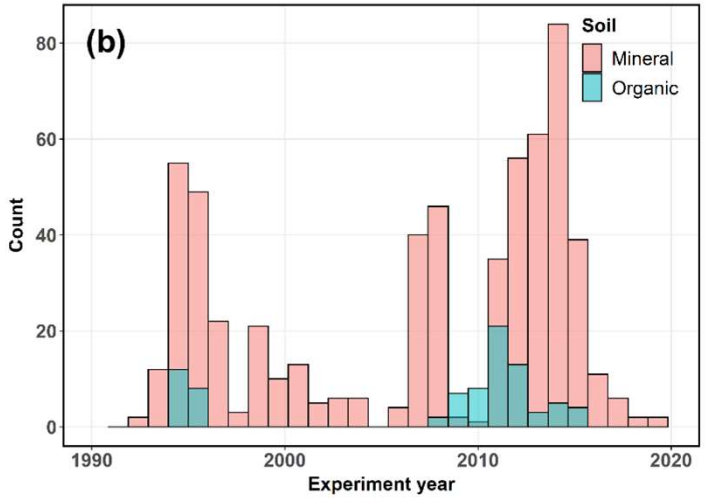
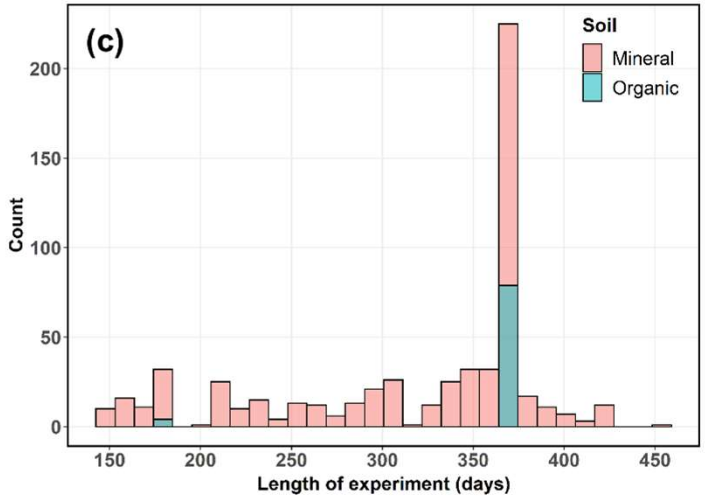
N_2O emission: field data in Germany







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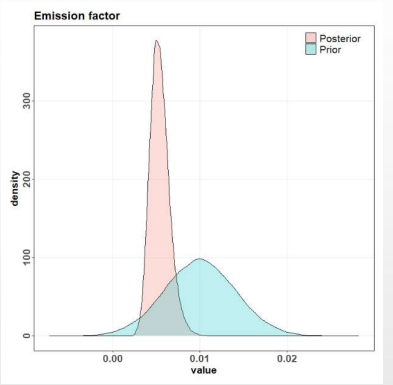
Modelling N_2O emission factors

- Separate modelling for mineral and organic soils
- Modelling N_2O emission as linear fuction of N application rates (Bowman, 1996)
- Using a generalised linear mixed model (GLMM) with gamma distribution to account for varying levels of skewness of N_2O emission data.
  The mixed-effects model approach was used to account for correlations within location clusters and within measurement years.
- Bayesian modelling with prior and posterior probability distribution
  - Different models were tested with a combination potential predictors: e.g.: N input and duration; N input and duration and fertilizer type; N input and duration and environmental zone (location and year remained as random effects)
  - Goodness of the fit and predictive power were analysed by $RMSE_{fit}$ and $RMSE_{CV}$



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Best models for estimating direct N_2O emission

Mineral soils

- Predictors:
  - N input
  - duration of measurements
  - environmental zone

Climate zone	Emission Factor (EF)
Atlantic North *(North-West Germany)*	0.49% (0.26-0.78%)
Continental North *(North-East Germany)*	0.39% (0.17-0.66%)
Atlantic Central *(South-West Germany)*	0.72% (0.37-1.08%)
Continental South *(South-East Germany)*	0.88% (0.38-1.43%)

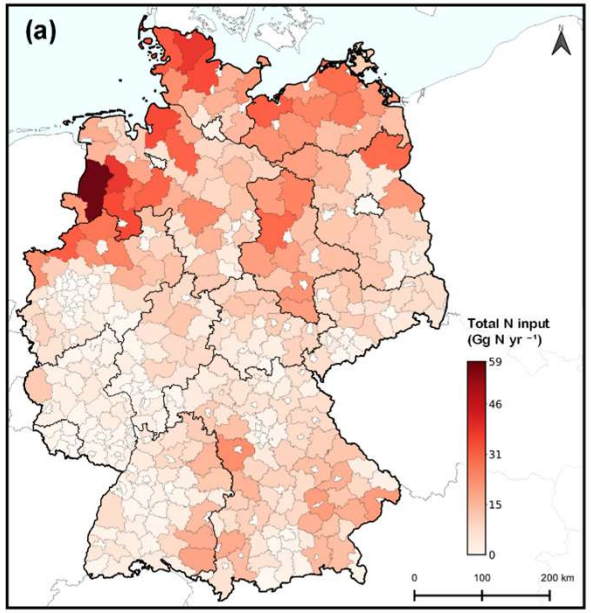
- No evidence that emission factors of synthetic fertilizers and manure differ

Organic soils

- Predictors:
  - N input
  - duration of measurements
- Emission factor:
  - 1.01% (0.39- 1.65%)
  - emissions from mineralization of peat are not included
- N_2O emission per unit N input is higher for organic soils than mineral soils

Model application at the district scale of Germany

N input per district

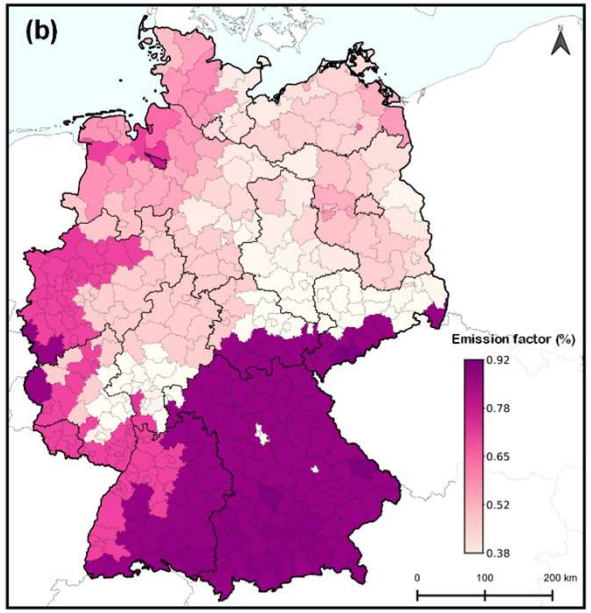


- Synthetic N fertilizers
- Manure, digestates, sludge
- Crop residues

Not included:

– N from: pasture excrements, soil organic matter decrease

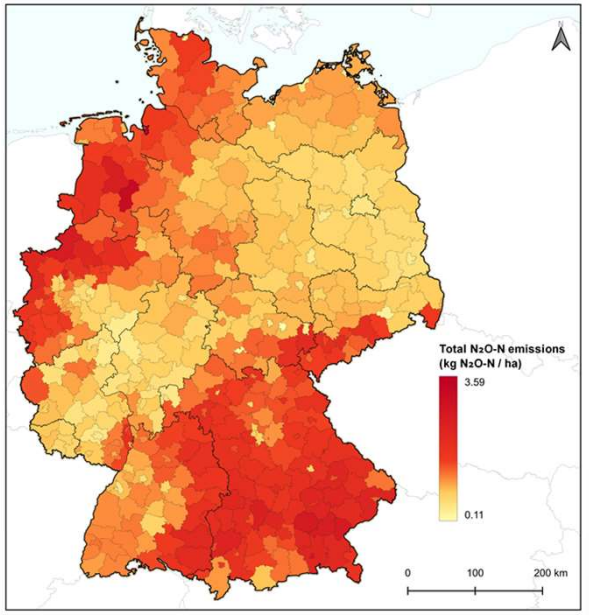
Mean N_2O emission factor (%)



Depend mainly on

- Environmental zone
- Abundance of farmed organic soils

Mean N_2O emission ha^{-1}



Depend mainly on

- Intensity of fertilization
- Environmental zone
- Abundance of farmed organic soils

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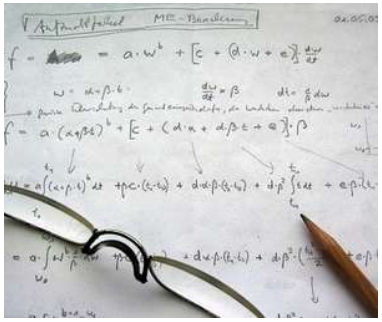
Conclusion

- On average 0.6 % (0.4-0.9%) of N applied with fertilizers is emitted as N_2O
  → new implied N_2O emission factor for Germany for direct N_2O emission
  - IPCC 2019 emission factor: 1.0 % (0.1- 1,8%)
- There is no evidence for a significant effect of fertilizer type (synthetic fertilizers versus manures) on the N_2O emission factor in Germany
- The model including interactions of N input and environmental zones showed the best performance → new basis for N_2O emission reporting in Germany
- Key points when working on Tier 2/3 methodologies for N_2O emission reporting:
  - Representative data on N_2O emission (networking with neighbouring countries)
  - Reliable activity data back to 1990 (N inputs)
  - Data on most important predictors influencing emission rates (climate, soil, …)
  - Peer reviewed publication of the proposed method



Thank thank you for your attention

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