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Data Article

# Global high-resolution gridded dataset of $N_2O$ Emission and mitigation potential from maize and wheat fields

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ABSTRACT

This data article provides a high-resolution raw data on Nitrous Oxide ($N_2O$) emission and its mitigation potential from global maize and wheat fields. The analytical results, discussion and conclusion thereof is presented in the related manuscript "Model Comparison and Quantification of Nitrous Oxide Emission and Mitigation Potential from Maize and Wheat Fields at a Global Scale" [1]. This raw dataset has a spatial resolution of 0.0833° × 0.0833°, and comprises pixel level baseline emissions estimated using four empirical $N_2O$ emission models (CCAFS-MOT, IPCC Tier-I, IPCC Tier-II and Tropical-N2O) and the model results were validated using experimental data extracted from the literature. Spatially explicit soil, climate and crop management data were obtained from various sources detailed in "Experimental Design, Materials and Methods" section below. $N_2O$ mitigation potential were then quantified under four scenarios of excess nitrogen

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reduction (i.e. 25%, 50%, 75% and 100% reduction of excess nitrogen). We believe that the dataset is a valuable source of information to assess $N_2O$ emissions and mitigation measures from maize and wheat fields and to make informed decision. Countries can use this dataset to determine emissions reduction targets in their nationally determined contributions (NDCs) from agricultural sector.



## Specifications Table

| | |
|---|---|
| Subject | Agriculture, Environmental Sciences |
| Specific subject area | Landscape ecology, Climate change, Nitrous oxide emissions. |
| Type of data | Data Cube (Raster X Level) in NetCDF |
| How data were acquired | Estimated using four $N_2O$ models from Maize and Wheat fields. In addition, different levels of excess N reduction (25%, 50%, 75% and 100%) were applied for each model and crop for estimation of possible mitigation potentials. |
| Data format | Raw (soil, climate and management data), estimated (emission and mitigation potential data)<br>NetCDF (Network Common Data Form): is a set of software libraries and machine-independent data formats that support the creation, access, and sharing of array-oriented scientific data. It is also a community standard for sharing scientific data. |
| Parameters for data collection | Global annual estimation from maize and wheat fields for the year 2013, 0.0833 × 0.0833 spatial resolution, raster data. |
| Description of data collection | Global input datasets were collected from a number of major sources, as recommended by the global $N_2O$ model inter-comparison project (NMIP). The description and sources of these datasets were given in Table 1 of related article [1]. |
| Data source location | Global scale: from maize and wheat fields |
| Data accessibility | With the article and a public repository<br>Repository name: Mendeley Data<br>DOI: 10.17632/hcvm3zrb95.1<br>Direct URL to data:<br>https://data.mendeley.com/datasets/hcvm3zrb95 |
| Related research article | [1] K. Tesfaye, R. Takele, T.B. Sapkota, A. Khatri-chhetri, D. Solomon, C. Stirling, F. Albanito, Model comparison and quantification of nitrous oxide emission and mitigation potential from maize and wheat fi elds at a global scale, Sci. Total Environ. 782 (2021) 146,696. https://doi.org/10.1016/j.scitotenv.2021.146696. |

## Value of the Data

- The dataset is global, has a spatial resolution of 0.0833° × 0.0833°, which can increases knowledge and improve understanding of the spatial variations of $N_2O$ emissions from maize and wheat fields to prioritize mitigation work.
- The dataset can better informs and guides countries in assessing $N_2O$ emissions and mitigation measures as well as reporting their NDC targets under the United Nations Framework Convention on Climate Change (UNFCCC).
- The dataset is functional and can be utilized by experts outside of environmental science, e.g. insurances companies, policy makers, fertilizer industries, or researchers who wish to integrate this type of data into multidisciplinary studies such as disaster risk management, fertilizer production and distribution, food security.
- This dataset also contains N2O emissions under four scenarios of excess N reduction (25%, 50%, 75% and 100%) , demonstrating mitigation potentials that countries can aim to.

- The dataset can also be used to compare with the outputs of process-based $N_2O$ emission models to better understand the sources of $N_2O$ model uncertainty and the knowledge gaps in fully accounting for the $N_2O$ processes.

## 1. Data Description

The high-resolution $N_2O$ emission and mitigation potential dataset covers the globe (−179.9581 to 179.9812 degrees east and 83.59216 to −89.92174 degrees north) at 0.0833° × 0.0833° spatial resolution from maize and wheat fields at annual temporal resolution for the year 2013. The unit of emission data is kg-$N_2O$–N $ha^{-1}$ . It comprises estimation from four empirical $N_2O$ emission models; (a) CCAFS-MOT [2], (b) IPCC Tier-I [3–6], (c) IPCC Tier-II [3–6] and (d) Tropical-N2O [7]. The files are in NetCDF4 format and were generated by using library version 4.7.3. They are available at N2Oemission_2013_Maize.nc, where XXXX indicates the type of the crop. The dataset is freely available at mendeley data (https://data.mendeley.com/drafts/hcvm3zrb95).

### *1.1. Usage notes*

The $N_2O$ emission dataset is a valuable source of information on $N_2O$ emission and mitigation potential. However, caution is necessary, due to inherent uncertainties, to make user findings derived by analyzing the dataset. The estimated emissions are model estimates and not free from error due to imperfect modeling, inaccurate inputs and misreporting in agricultural census statistics. Users must noted when resampling the data to different spatial resolutions, as this could lead to different conclusions.

### *1.2. Description of the NetCDF data structure*

Two data files present estimated values from Maize and Wheat fields. The metadata in the individual netCDF files describes individual variables. This data has three dimensions, namely *latitude, longitude* and *Nreduction* in a global latitude-longitude coordinate. The *Nreduction* dimension variable has 5 levels (0%, 25%, 50%, 75%, 100%), describing the percentage amount of reduced excess nitrogen to each variable/model. The *no data valu*e is decoded by the value "*−9999*". The variable names comprising the estimated values from the four empirical $N_2O$ emission models are described as follows.

Where:

- "N2O.ccafsMOT": estimated emission values from CCAFS-MOT
- "N2O.ipccTR1": estimated emission values from IPCC Tier-I
- "N2O.ipccTR2": estimated emission values from IPCC Tier-II
- "N2O.tropicalN2O": estimated emission values from Tropical-$N_2O$

## 2. Experimental Design, Materials and Methods

Fig. 1 shows the various input data required for estimating $N_2O$ emissions, types of models used for estimating emission, model validation, mitiation scenarios and development of $N_2O$ emission mitigation datasets. Briefly, we estimated annual $N_2O$ emissions from maize and wheat fields using four empirical models i.e. CCAFS-MOT [2], Tropical-$N_2O$ [3] and IPCC Tier-I & Tier-II [4,5] at a horizontal resolution of 5-arcminutes (~0.0833 × 0.0833 degrees). Pixel level data on crop management and inputs, soil, and climate were obtained from various secondary

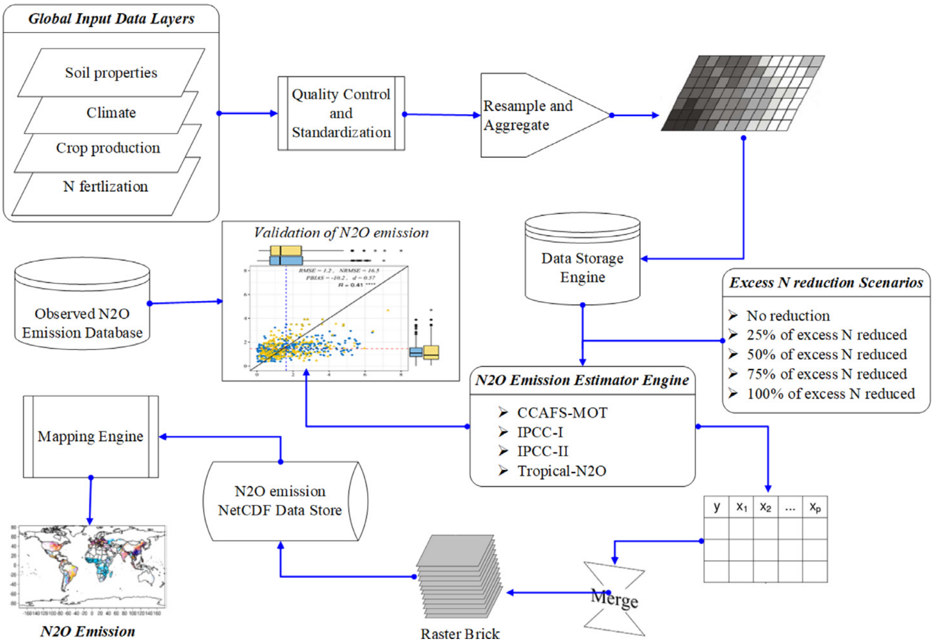


**Fig. 1.** Methodological framework for developing global dataset of $N_2O$ Emission and mitigation potential from Maize and Wheat fields.

sources explained in detail and cited in the related paper [1]. Briefly, crop area, production and duration were obtained from IFPRI [6] and IIASA/FAO [7]. Inorganic nitrogen application in agricultural land was obtained from Lu and Tian [8] whereas nitrogen from manure application was estimated from the dataset of Zhang et al. [9]. Location specific soil data were obtained from International Soil Reference and Information Centre [10]. Climatic information were obtained from Joint Research Centre of the European Commission [11]. Spatially explicit excess N from maize and wheat fields were estimated using mass balance approach considering all sources of N input and output folloiwng the approach of West et al. [12].

Raw data on estimated $N_2O$ emission from all four models using the input data mentioned above are presented for the crop year 2013. Model outputs were validated using $N_2O$ emissions data extracted from previous publications made available through the global $N_2O$ database (https://samples.ccafs.cgiar.org/n2o-dashboard/). We then prepared four scenarios keeping all other information same but changing N input assuming four scenarios of excess N reduction i.e. 25, 50, 75 and 100% reduction of excess N and estimated $N_2O$ emissions from all four models under each of four scenarios. We estimated $N_2O$ mitigation potential under four scenarios as difference in emissions with actual N input and N inputs estimated under four scenarios of excess nitrogen reduction. While we presented summary of the result and analysis in the related paper [1], here we present grid-level raw data of current $N_2O$ emission and that under the four mitigation scenarios.

## Ethics Statement

Data compiled in this database were gathered from various sources and model output of four empirical models. The input data were available publicly and these sources are properly acknowledged. See “specification table” and “Experimental Design, Material & Methods” section for details of data sources and source citation.

## CRediT Author Statement

**Tek B. Sapkota:** Conceptualization, Design, Coordination, Writing, reviewing & editing; **Kindie Tesfaye:** Conceptualization, Data extraction & analysis, Writing, reviewing & editing; **Robel Takele:** Data extraction & analysis, Writing, reviewing & editing; **Arun Khatri-Chhetri:** Writing, review and editing; **Dawit Solomon:** Review and editing; **Clare Stirling:** Coneptualization, Review and editing; **Fabrizio Albanito:** Review and editing.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests.

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## Supplementary Materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.dib.2021.107239.

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