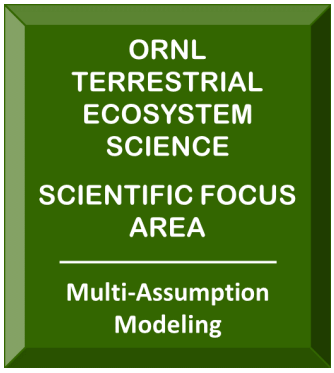
March 11, 2021

Microbial Biomass in Soils Receiving Varying Levels of Organic Inputs - A Data Compilation



Summary

This dataset contains soil microbial biomass data compiled from published laboratory studies and field manipulations of organic inputs to soils. Each study included at least three levels of a given type of organic input applied to a given type of soil.

Studies were selected from the literature that had experimentally manipulated organic input rates to soils using unburned, non-synthetic material (e.g. plant litters, manures, and composts). Fifty-five (55) studies, conducted from 1997 to October 2019, were chosen and compiled into a dataset with 358 observations from 96 combinations of a given organic material applied to a given soil in agricultural systems, laboratory incubations, forests, or grasslands.

- Studies were selected when biomass measurements used the chloroform fumigation-extraction procedure followed by carbon analysis, or, in two instances, studies estimated microbial biomass using phospholipid fatty acid analysis.

- Studies that used fewer than three input rates or characterized microbial biomass via substrate induced respiration were excluded.

- The temporal and spatial aspects of the laboratory and field studies were not essential to the analyses (Craig et al., 2021) and were not included with the measurement data. These data were used to assess the relationship between organic input amounts and microbial biomass. Complete reference citations are provided if additional information is needed.

- Note that one study (#10) that confounded organic inputs with nutrient inputs was retained in the dataset, but not included in analyses reported in the related publication (Craig et al., 2021).

The compiled data are provided in two .csv files: (1) soil treatments and microbial biomass data and (2) literature citations. The “Study” field is the cross reference between files.

Also provided is the R code for reproducing the results in the related publication.

Data Citation:

Cite this data set as follows:

Matthew E. Craig, Anthony P. Walker. 2021. **Microbial Biomass in Soils Receiving Varying Levels of Organic Inputs - A Data Compilation.** Oak Ridge National Laboratory, TES SFA, U.S. Department of Energy, Oak Ridge, Tennessee, U.S.A. https://doi.org/10.25581/ornlsfa.021/1768047

Related Publication:

A description and analysis of these data are presented in the following publication:

Craig ME, Mayes MA, Sulman BN, Walker AP. Biological mechanisms may contribute to soil carbon saturation patterns. ***Global Change Biology***

Related TES SFA Dataset:

Matthew E. Craig, Anthony P. Walker. 2021. **Biological Mechanisms May Contribute to Soil Carbon Saturation Patterns: Modeling Archive.** Oak Ridge National Laboratory, TES SFA, U.S. Department of Energy, Oak Ridge, Tennessee, U.S.A. https://doi.org/10.25581/ornlsfa.022/1768048

Acknowledgments:

Data were compiled by Matthew E. Craig (Postdoctoral Research Associate at Oak Ridge National Laboratory, Environmental Sciences Division and Climate Change Science Institute) in collaboration with Dr. Anthony P. Walker (walkerap@ornl.gov). Direct correspondence to Matthew Craig (craigmatthewe@gmail.com; ORCID: https://orcid.org/0000-0002-8890-7920).

Data and Documentation Access:

For public access to data from the US Department of Energy Terrestrial Ecosystem Science Scientific Focus Area (TES-SFA), please visit: https://tes-sfa.ornl.gov/

ORNL TES-SFA Data Policy: Archiving, Sharing, and Fair-Use

Overview of Terrestrial Ecosystem Science Scientific Focus Area

The TES SFA supports research to understand and predict the interaction of Earth's terrestrial ecosystems and climate, and to assess vulnerability of terrestrial ecosystems to projected environmental change. The research focuses on how terrestrial ecosystems affect atmospheric CO_2 and other greenhouse gases (e.g., CH_4) and how the responsible ecosystem processes interact with climate and with anthropogenic forcing factors.

- Targeted experiments are conducted to quantify and predict ecosystem responses to warming and elevated CO_2 (eCO_2) and the feedbacks from ecosystems to the atmosphere and climate.
- Other process research aims to accurately quantify the exchange of CO_2, water vapor, and energy between the atmosphere and land ecosystems through processes such as photosynthesis, evapotranspiration, net production, storage pools, and autotrophic and heterotrophic respiration.
- TES SFA research also includes efforts to provide comprehensive databases, above- and belowground, to benefit the analytical needs of Earth System Models.
- Understanding achieved by TES SFA tasks on the fundamental functions and interactions of vegetation, microbial community and soil is used to improve mechanistic representation of ecosystem processes within terrestrial biosphere models.

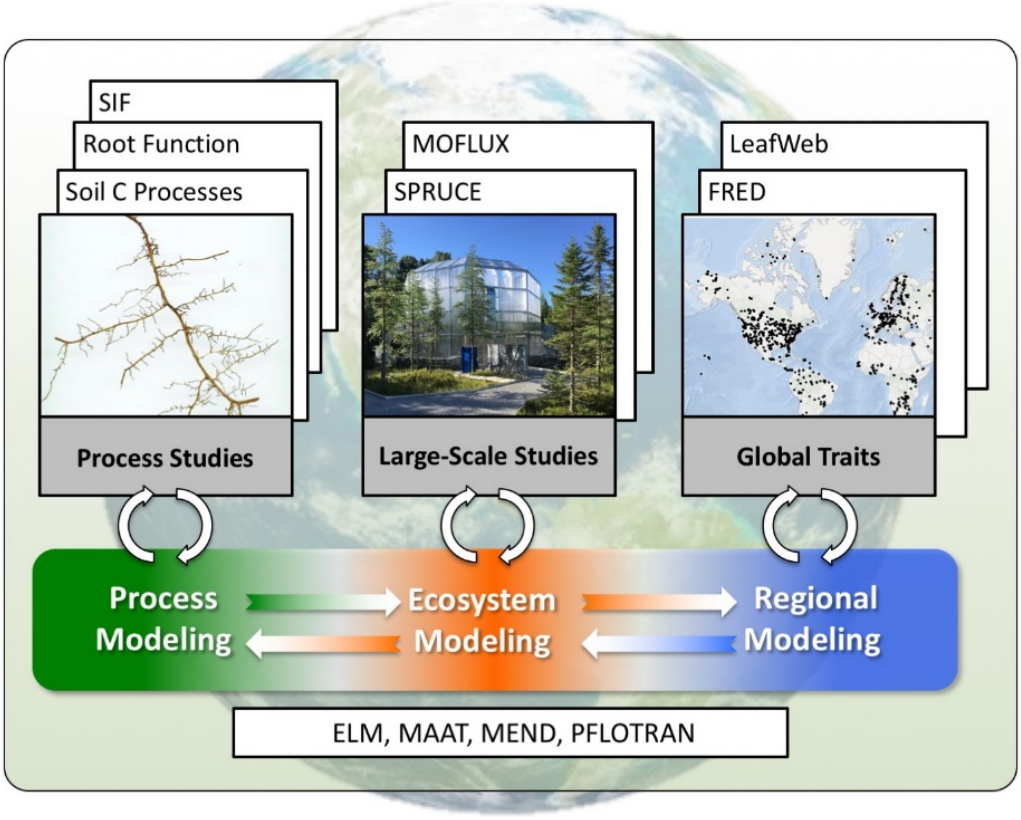


Diagram of the TES-SFA research philosophy and flow illustrating an iterative exchange between model projections, question or hypothesis development and the execution of observations and experiments to better understand impacts of multi-factor environmental changes on ecosystems.

Table of Contents

1. Data Set Overview:

We compiled soil microbial biomass data from articles describing experimental manipulations of organic soil inputs. Each study used at least three levels of a given type of organic input applied to a given type of soil. Measurements were mostly made following the Chloroform fumigation-extraction procedure (Vance et al. 1987)—followed by carbon analysis—with the exception of a couple of studies that estimated microbial biomass using phospholipid fatty acid analysis (Quideau et al. 2016). These data were used to assess the shape of the relationship between organic input amounts and microbial biomass and R code for this analysis is included along with the data set.

2. Data Characteristics:

Temporal Coverage:

All studies were published between 1997 and 2019.

Temporal Resolution:

The temporal aspects of the laboratory and field studies were not essential to the analyses (Craig et al., 2021) and were not included with the measurement data.

Experiments ranged from days to years. Where repeated measurements were taken, these were either averaged (for short-term lab incubations) or the most recent measurement was taken (in the case of long-term field experiments with repeated organic matter additions or removals).

Spatial Coverage:

The spatial aspects of the laboratory and field studies were not essential to the analyses (Craig et al., 2021) and were not included with the measurement data. No geographic criteria were used during data selection.

The location for this data compilation will be listed as the Oak Ridge National Lab (ORNL): 35.9311 N, -84.3100 W.

Data File Descriptions:

The compiled data are provided in two .csv files: (1) soil treatments and microbial biomass data and (2) literature citations. The "Study" field is the cross reference between files.

Also provided is the R code for reproducing the results in the related publication.

Data Dictionary:

Microbial biomass data: MBC_data_compilation_20210309.csv

Column Number	Column Name	Data Type	Description
1	Study	factor; integers (range: 1-55)	Study identifier corresponding to field of the same name ("Study") in "refs" table.
2	ID	factor; integers (range: 1-96)	Identifier for each individual manipulation. There are multiple manipulations within a given study when different organic compounds were added or different experimental conditions were studied (e.g. tilled versus no-till agricultural fields, different study sites, or different soils). The differences in these manipulations are defined in the "Treatment" field.
3	System	factor (agricultural, laboratory incubation, forest, grassland)	Study system.
4	Treatment	character	For each record this field describes the type of organic input. If different conditions were studied, the condition is described after a semi-colon.
5	trt_dur_yr	character	Years between start of treatment and sampling or, in the case of repeated measurements, a range of years over which samples were collected.
6	median_dur	numeric	Years between start of treatment and sampling or, in the case of repeated measurements, the median of the range of years over which samples were collected.

Column Number	Column Name	Data Type	Description
7	c_lev	numeric	Amount or yearly rate of organic additions to soil.
8	c_lev_units	character	Units for organic addition rates. These are consistent within a study but vary between studies. "X" represents "times", a relative addition rate. For example, some studies had three relative levels: a removal of existing inputs (0X), a control with baseline inputs (1X), and a doubling of baseline inputs (2X). For data presented in this way, more precise units are likely available in the reference.
9	mbc	numeric	Microbial biomass carbon: With two exceptions (see "mbc_units" description), these data are from Chloroform-fumigation-extraction protocols, the details of which are provided in the source references.
10	mbc_units	character	Microbial biomass units. These are nearly all reported as: mg C kg^{-1} soil. However, studies #10 and #22 used phospholipid fatty acid extractions to estimate microbial biomass and are therefore presented on a molar basis.

Citation information and notes: MBC_data_compilation_citations_20210309.csv

Column Number	Column Name	Data Type	Description
1	Study	factor; integers (range: 1-55)	Study identifier corresponding to field of the same name ("Study") in "data" table
2	Notes	character	Notes on how data were pulled from specific articles. If there are differences from the general data acquisition approach, they are described here.
3	Title	character	Title
4	Authors	character	Authors
5	Source_Title	character	Source Title
6	Publication_Date	character	Publication Date
7	Publication_Year	character	Publication Year
8	Volume	character	Volume
9	Issue	character	Issue
10	Special_Issue	character	Special Issue
11	Beginning_Page	character	Beginning Page

Column Number	Column Name	Data Type	Description
12	Ending_Page	character	Ending Page
13	Article_Number	character	Article Number
14	DOI	character	DOI
15	Conference_Title	character	Conference Title
16	Conference_Date	character	Conference Date

3. Applications and Derivation:

Data can be used to examine the relationship between organic matter input rates or types and microbial biomass, and to examine whether such relationships vary with experiment durations or study systems. References could be revisited to augment this dataset with covariates.

4. Quality Assessment:

The data were compiled from peer-reviewed publications. We assumed they were subject to routine quality checks in the labs where they originated, and no additional quality checks were performed.

5. Data Acquisition Materials and Methods:

Literature Compilation:

On 21 October 2019, we used Web of Science™ to locate studies using the terms *soil carbon* and *microbial biomass* in combination with *input(s)*, *application*, or *amendment* and *rate* or *quantity*. The specific topic query was: (soil carbon microbial biomass ((input* OR application OR amendment) NEAR/3 (rate OR quantity))), refined to return only article document types (Indexes=SCI-EXPANDED, CPCI-S, ESCI.).

Within the compiled literature, we identified studies that experimentally manipulated organic input rates using unburned, non-synthetic material (e.g. plant litters, manures, and composts). Studies that used fewer than three input rates or characterized microbial biomass via substrate induced respiration were excluded resulting in 55 studies. One study that confounded organic inputs with nutrient inputs was retained in the dataset, but not included in analyses in Craig et al. (2021).). Fifty-five (55) studies, conducted from 1997 to October 2019, were chosen and compiled into a dataset with 358 observations from 96 combinations of a given organic material applied to a given soil in agricultural systems, laboratory incubations, forests, or grasslands.

Data Extraction:

Citation information, microbial biomass data, the type and amount of organic input, the treatment duration, the study system category, and additional information about the experimental treatment conditions were extracted from each reference. Non-tabular data were extracted using WebPlotDigitizer (Version 4.2; https://automeris.io/WebPlotDigitizer/).

Many studies took multiple measurements of microbial biomass. For laboratory experiments with one-time manipulations of inputs, we averaged across measurements to obtain one value per observation. For field experiments with regular (e.g. yearly) manipulations of inputs, we took microbial biomass data from the most recent year.

Data Analysis:

Prior to analysis, microbial biomass and input rates were mean-centered and standardized (z-transformed) to account for different methods, conversion factors, baseline input rates, and units.

- **These transformations are calculated in the "analysis.R" file (i.e. the dataset contains untransformed values).**

This allowed the underlying, qualitative nature of the relationship to be evaluated regardless of experiment- or site-specific factors.

6. References:

Quideau, S. A. et al. Extraction and Analysis of Microbial Phospholipid Fatty Acids in Soils. J Vis Exp (2016) doi:10.3791/54360.

Vance, E. D., Brookes, P. C. & Jenkinson, D. S. An extraction method for measuring soil microbial biomass C. Soil Biology and Biochemistry 19, 703–707 (1987).

7. Data Access:

For public access to ORNL TES SFA data please visit the TES SFA Web Site: https://tes-sfa.ornl.gov/home

Contact for Data Access Information: https://mnspruce.ornl.gov/contact