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# A Compilation of Global Soil Microbial Biomass Carbon, Nitrogen, and Phosphorus Data

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Revision Date: January 12, 2015

## Summary:

This data set provides the concentrations of soil microbial biomass carbon (C), nitrogen (N) and phosphorus (P), soil organic carbon, total nitrogen, and total phosphorus at biome and global scales. The data were compiled from a comprehensive survey of publications from the late 1970s to 2012 and include 3,422 data points from 315 papers. These data are from soil samples collected primarily at 0-15 cm depth with some from 0-30 cm. In addition, data were compiled for soil microbial biomass concentrations from soil profile samples to depths of 100 cm.

Sampling site latitude and longitude were available for the majority of the samples that enabled assembling additional soil properties, site characteristics, vegetation distributions, biomes, and long-term climate data from several global sources of soil, land-cover, and climate data. These site attributes are included with the microbial biomass data.

This data set contains two \*.csv files of the soil microbial biomass C, N, P data. The first provides all compiled results emphasizing the full spatial extent of the data, while the second is a subset that provides only data from a series of profile samples emphasizing the vertical distribution of microbial biomass concentrations.

There is a companion file, also in .csv format, of the references for the surveyed publications. A reference\_number relates the data to the respective publication.

The concentrations of soil microbial biomass, in combination with other soil databases, were used to estimate the global storage of soil microbial biomass C and N in 0-30 cm and 0-100 cm soil profiles. These storage estimates were combined with a spatial map of 12 major biomes (boreal forest, temperate coniferous forest, temperate broadleaf forest, tropical and subtropical forests, mixed forest, grassland, shrub, tundra, desert, natural wetland, cropland, and pasture) at 0.05-degree by 0.5-degree spatial resolution. The biome map and six estimates of C and N storage and C:N ration in soil microbial biomass are provided in a single netCDF format file.

In summary, there are two .csv files of soil microbial biomass C, N, and P concentration data and one netCDF file of global C and N soil profile storage estimates with this data set.

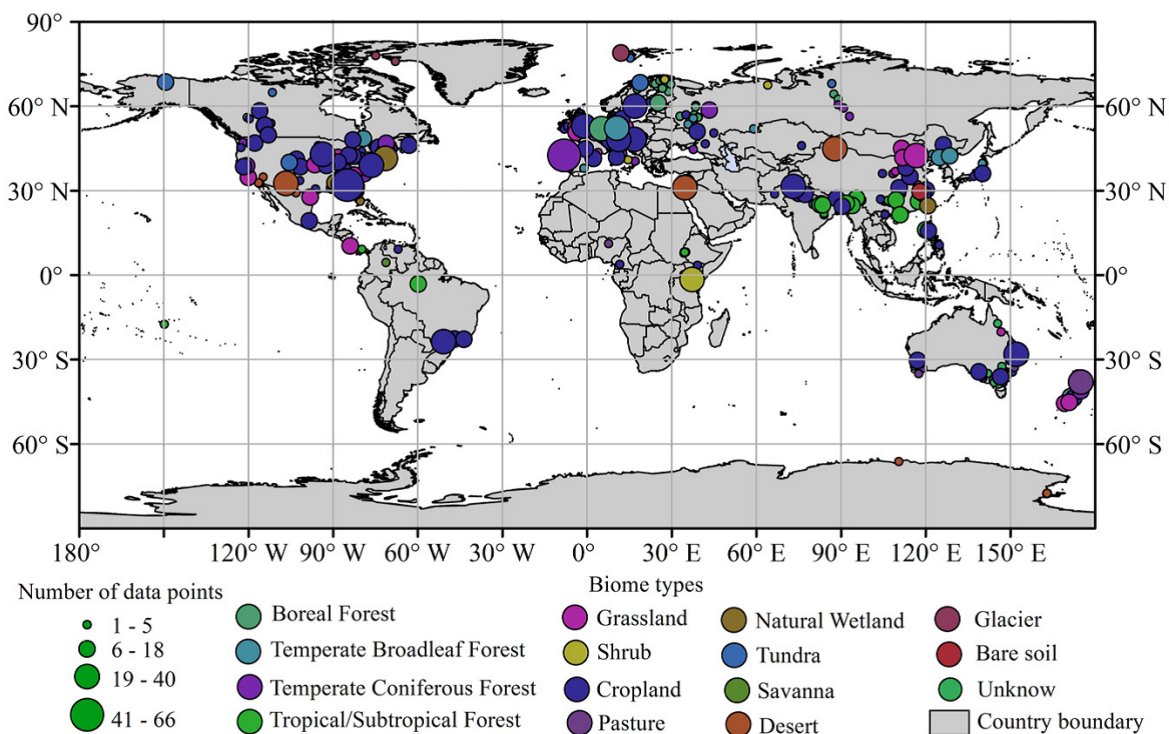


Figure 1. Distribution of the data points used in this study (3,259 out of 3,422 data points with geographical coordinates are shown in this map (from Xu et al., 2013)).

**Data and Documentation Access:**

**Get Data:** [http://daac.ornl.gov/cgi-bin/dsvviewer.pl?ds\\_id=1264](http://daac.ornl.gov/cgi-bin/dsvviewer.pl?ds_id=1264)

**Companion Documentation:**

[XuXF2013\\_GEB.pdf](#): A global analysis of soil microbial biomass carbon, nitrogen and phosphorus in terrestrial ecosystems

[Soil\\_Microbial\\_Biomass\\_C\\_N\\_P\\_references.csv](#): References for the surveyed publications

**Data Citation:**

**Cite this data set as follows:**

Xu, X., P.E. Thornton, and W.M. Post. 2014. A Compilation of Global Soil Microbial Biomass Carbon, Nitrogen, and Phosphorus Data. Data set. Available on-line [<http://daac.ornl.gov>] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, USA. <http://dx.doi.org/10.3334/ORNLDAAC/1264>

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**1. Data Set Overview:**

This data set provides the concentrations of soil microbial biomass carbon (C), nitrogen (N) and phosphorus (P), soil organic carbon, total nitrogen, and total phosphorus at biome and global scales. The data were compiled from a comprehensive survey of publications from the late 1970s to 2012 and include 3,422 data points from 315 papers. These data are from soil samples collected primarily at 0-15 cm depth with some from 0-30 cm. In addition, data were compiled for soil microbial biomass concentrations from soil profile samples to depths of 100 cm.

Sampling site latitude and longitude were available for the majority of the samples that enabled assembling additional soil properties, site characteristics, vegetation distributions, biomes, and long-term climate data from several global sources of soil, land-cover, and climate data. These site attributes are included with the microbial biomass data.

## 2. Data Characteristics:

### Data File Information

There are two data files in comma-separated (.csv) format and one NetCDF v3/v4 (\*.nc4) file at 0.05-degree by 0.5-degree spatial resolution.

**File #1: Soil\_Microbial\_Biomass\_C\_N\_P\_spatial.csv**

**File #2: Soil\_Microbial\_Biomass\_C\_N\_P\_vertical.csv**

**Both files have the same column headings. Recall that the \*\_vertical.csv file is a subset of the \*\_spatial.csv file.**

Missing values for both character and numeric fields are null (blank cells). The % completeness column (out of 3,422 possible values in the Soil\_Microbial\_Biomass\_C\_N\_P\_spatial.csv file) shows that most publications offered carbon results and fewer with nitrogen and phosphorus.

Column	Column heading	Units/format	Description	% Completeness of 3,422 possible values in *_spatial.csv
1	Country		Country of study site where data were collected	100
2	Biome	categorical	Biome type used for regional extrapolation: Boreal forest; Temperate Coniferous forest; Temperate Broadleaf forest; Tropical/Subtropical forest; Mixed forest; Grassland; Shrubland; Tundra; Desert; Natural wetlands; Cropland; Pasture	100
3	Lat	decimal degrees	Latitude of study site where soil samples were collected	95
4	Lon	decimal degrees	Longitude of study site where soil samples were collected	95
5	Elevation		Elevation of study site where soil samples were collected	23
6	Vegetation		Vegetation at study site where soil samples were collected	77
7	MAT	degrees C	Temperature for the region where soil samples were collected in degrees C. Climate data were provided by the University of East Anglia Climatic Research Unit ( <a href="http://www.cru.uea.ac.uk/">http://www.cru.uea.ac.uk/</a> )	33
8	MAP	mm	Precipitation data for the region where data were collected in mm. Climate data were provided by the University of East Anglia Climatic Research Unit ( <a href="http://www.cru.uea.ac.uk/">http://www.cru.uea.ac.uk/</a> )	38
9	Soil Microbial Biomass Carbon	mmol Kg-1	Soil microbial biomass carbon	93
10	Soil Microbial Biomass Nitrogen	mmol Kg-1	Soil microbial biomass nitrogen	42
11	Soil Microbial Biomass Phosphorus	mmol Kg-1	Soil microbial biomass phosphorus	21
12	Soil Organic Carbon	mmol Kg-1	Soil organic carbon	86
13	Total Nitrogen	mmol Kg-1	Total nitrogen	63
14	Total Organic Phosphorus	mmol Kg-1	Total organic phosphorus content	16
15	pH		Soil pH	64
16	Date		Date when soil samples were collected at study site	70
17	Upper_depth	cm	Upper depth of soil sample interval	89
18	Lower_depth	cm	Soil sampling depth in cm	86
19	Depth	character	Soil sampling depth in cm	89
20	Note	character	Note pertaining to study site where data were collected	54
			Method used in studies to measure soil microbial biomass C, N, or P.	

21	Method	character	FE: fumigation extraction (Vance et al., 1987) FI: fumigation incubation (Jenkinson, 1966, 1988) SIR: substrate induced respiration (Anderson and Domsch, 1978)	100
22	Geographical coordinate	character	Note pertaining to the collection and assignment of the geographical coordinates for the study sites	52
23	Reference_number	integer	Reference for the data source	100

**File #3: Global\_Soil\_Microbial\_BiomassCN.nc:** A NetCDF v3/v4 (\*.nc4) file at 0.05-degree spatial resolution. Missing and fill values are reported as -9999.

**Data Center Processing Note:** Attributes in the netCDF header were modified by the ORNL DAAC to bring the file into CF Convention compliance. All other aspects of the file were left unchanged.

Parameter	Units/format	Description
Lat	decimal degrees	Latitude
Lon	decimal degrees	Longitude
Biome	categorical	Biome type used for regional extrapolation: Boreal forest; Temperate Coniferous forest; Temperate Broadleaf forest; Tropical/Subtropical forest; Mixed forest; Grassland; Shrubland; Tundra; Desert; Natural wetlands; Cropland; Pasture
SMC30cm	gC/m2	Soil microbial biomass carbon in top 30 cm soil profile
SMN30cm	gN/m2	Soil microbial biomass nitrogen in top 30 cm soil profile
SMC100cm	gC/m2	Soil microbial biomass carbon in top 100 cm soil profile
SMN100cm	gN/m2	Soil microbial biomass nitrogen in top 100 cm soil profile
CN30cm		C:N ratio of soil microbial biomass in top 30 cm soil profile
CN100cm		C:N ratio of soil microbial biomass in top 100 cm soil profile

### Spatial Coverage

Point data and spatial data in 0.5-degree resolution.

### Temporal Coverage

Compilation from published measurements taken between 1977/11/16 to 2012/06/01.

### Temporal Resolution

One time estimates

**Site boundaries:** (All latitude and longitude given in degrees and fractions)

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Global	-180	180	90	-90
Compiled data	-149.83	177.9	79	-77.63

## 3. Data Application and Derivation:

The units of compiled data points (mmol Kg<sup>-1</sup>) and the produced maps (gC/m<sup>2</sup>) are different. The steps for conversion and calculations from soil elemental concentration was calculated based on soil elemental density, soil bulk density, etc., when producing the global maps of carbon and nitrogen density in the soil microbial biomass, are not described here. See Xu et al., 2013.

## 4. Quality Assessment:

Sources of uncertainties for the compiled data and for the results of any analyses are described in Xu et al., 2013.

## 5. Data Acquisition Materials and Methods:

The data in this compilation are based on a comprehensive literature survey. Publications were collected by searching for 'soil microbial biomass' in Google Scholar. A few criteria were used to screen the data for this study. The criteria were: (1) the soil microbial biomass (at least one of soil microbial biomass C, N or P) must be reported; (2) the reported soil microbial biomass C, N and P must be less than organic C, total N and total P, respectively, in soils. Based on the second criterion, a few publications used in previous similar studies (Cleveland and Liptzin, 2007; Hartman, 2011) were excluded. Finally, 3,422 data points in 14 biomes across the globe were retrieved from 315 papers (Fig. 1). Fourteen biomes were finally aggregated into 12 biomes for robust statistical analysis. Associated information for the sampling site was also retrieved, including soil pH, sampling depth, sampling date, biome type, latitude, longitude, and climate variables. There is a dynamic version of this database hosted on Google Code (<http://code.google.com/p/global-soil-microbial-biomass/>).

The date of publications used spans from the late 1970s to 2012. The number of data points for several biomes were insufficient for a robust statistical analysis, therefore biomes with few data points were aggregated, specifically, savanna was combined into grassland. Several land-cover types were not included in the analysis, for instance glacier and bare soils (mainly urban and industrial sites). Surface soil data were aggregated into 12 major biome types.

The data points were collected for surface soils, primarily 0-15 cm depth with some 0-30 cm; all measurements were assumed to represent the top 0-30 cm soil profile, consistent with previous data sets on global soil organic C and total N (Batjes, 1996; Jobbagy and Jackson, 2000). For those data points with no geographical coordinates reported in the literature, geographical coordinates were searched on based on the names of site, state and country. There were 3,259 data points obtained with geographical information. These geographical coordinates were used to locate the sites on the global map (Fig. 1) and for retrieving the long-term climate conditions associated with these observational data. Also, any available soil microbial biomass data at depth along the soil profile to 100 cm were collected and used to estimate global storage of soil microbial biomass C and N in 0-30 cm and 0-100 cm soil profiles.

Global maps of vegetation distribution, soil properties and long-term climate data were used for spatial extrapolation in order to estimate global storage of soil microbial biomass C and N in terrestrial ecosystems. Climate data were provided by the University of East Anglia Climatic Research Unit (<http://www.cru.uea.ac.uk/>); the 1961–90 average climate data were used to represent the long-term climate conditions. The vegetation distribution data were generated by combining several data sources: global pasture and cropland data from Ramankutty et al. (2008); wetland coverage from global wetland distribution data (Aselmann and Crutzen, 1989); the spatial distribution of other biomes from a vegetation map developed by Ramankutty and Foley (1998).

A spatial map of 12 major biomes was generated: boreal forest, temperate coniferous forest, temperate broadleaf forest, tropical/subtropical forest, mixed forest, grassland, shrub, tundra, desert, cropland and pasture. The spatial distribution of soil property data is from the Harmonized World Soil Database (FAO/IIASA/ISRIC/ISSCAS/JRC, 2009) and soil element data are from the IGBP-DIS (Global Soil Data Task Group, 2000) data set (available online from Oak Ridge National Laboratory Distributed Active Archive Center). Since soil data for organic C and total N in the IGBP-DIS are for the 100-cm profile as a whole, the Harmonized World Soil Database was used to calculate the fraction of soil organic C and total N in the top 0-30 cm. It was then combined with the vertical distribution of soil microbial biomass to estimate the global storage of soil microbial biomass C and N in the 0-30 cm and 0-100 cm soil profiles.

Three different methods for measuring soil microbial biomass C, N and/or P over the past decades are presented in the data set. These include the fumigation extraction (FE) method (Vance et al., 1987), the fumigation incubation (FI) method (Jenkinson, 1966, 1988), and the substrate induced respiration (SIR) method (Anderson and Domsch, 1978). The FE and FI methods account for 55 and 26%, respectively, of the total measurements. The FE method was invented in 1987 (Vance et al., 1987), and after several years it was broadly applied. Since 1990, the FE, FI and SIR methods have contributed 62, 19 and 16% of the reported soil microbial biomass measurements. This is consistent with a recent summary of methods used in soil microbial biomass measurements (Joergensen, 2010; Joergensen et al., 2011).

## 6. Data Access:

These data are available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

### Data Archive Center:

Contact for Data Center Access Information:

E-mail: [uso@daac.ornl.gov](mailto:uso@daac.ornl.gov)

Telephone: +1 (865) 241-3952

## 7. References:

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