A Global Database of Carbon and Nutrient Concentrations of Green and Senesced Leaves

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Revision date: July 17, 2012

Summary:

This data set provides carbon (C), nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg) concentrations in green and senesced leaves. Vegetation characteristics reported include species growth habit, leaf area, mass, and mass loss with senescence. The data were compiled from 86 selected studies in 31 countries, and resulted in approximately 1,000 data points for both green and senesced leaves from woody and non-woody vegetation as described in Vergutz et al (2012). The studies were conducted from 1970-2009. There are two comma-delimited data files with this data set.

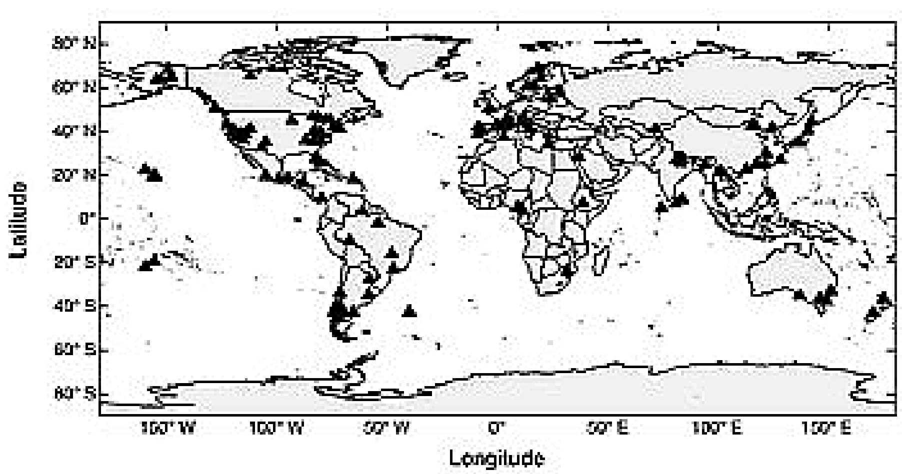

Figure 1. Global distribution of study locations.

Data Citation:

Cite this data set as follows:

Vergutz, L., S. Manzoni, A. Porporato, R.F. Novais, and R.B. Jackson. 2012. A Global Database of Carbon and Nutrient Concentrations of Green and Senesced Leaves. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A. http://dx.doi.org/10.3334/ORNLDAAC/1106

Table of Contents:

1. Data Set Overview:

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2. Data Characteristics:

Data are presented in two comma-delimited files.

File 1: Leaf_Carbon_Nutrients_data.csv

The file contains leaf carbon and nutrient concentrations along with Köppen Climate Classification (McKnight and Hess, 2000) , vegetation characteristics, and study site information.

Leaf_Carbon_Nutrients_data.csv

Column	Heading	Units/format	Description
1	Record_number		An index of all rows
2	Ref		Reference/Short citation
3	Study_number		Study number; index into the study reference data file
4	Country		Country
5	Region		State
6	City		City
7	Site_name		Site name or reference
8	Lat	decimal degree	Latitude: positive=north, negative=south
9	Long	decimal degree	Longitude: positive=east, negative=west
10	Köppen_CC		Köppen climate classification. A-tropical/megathermal, B-dry(arid and semiarid, including desert and steppe climates), C-temperate/mesothermal (including Mediterranean, oceanic, humid subtropical and subpolar oceanic climates, D-continental/microthermal, E-polar
11	Vegetation		Major vegetation type
12	Species		Study species
13	Family		Family
14	Growth_habit		Growth Habit
15	Senesced_sample_method		Senesced sample collection method (picked from the plant, recently fallen, or litterfall traps)
16	MAT	degree C	Mean annual temperature
17	TAP	mm	Total annual precipitation
18	Elevation	m	Meters above sea level
19	C_green_leaf	%	dry mass Carbon in green leaf
20	C_senesced_leaf	%	dry mass Carbon in senesced leaf
21	N_green_leaf	%	dry mass Nitrogen in green leaf
22	N_senesced_leaf	%	dry mass Nitrogen in senesced leaf
23	P_green_leaf	%	dry mass Phosphorus in green leaf
24	P_senesced_leaf	%	dry mass Phosphorus in senesced leaf
25	K_green_leaf	%	dry mass Potassium in green leaf
26	K_senesced_leaf	%	dry mass Potassium in senesced leaf
27	Ca_green_leaf	%	dry mass Calcium in green leaf

28	Ca_senesced_leaf	%	dry mass Calcium in senesced leaf
29	Mg_green_leaf	%	dry mass Magnesium in green leaf
30	Mg_senesced_leaf	%	dry mass Magnesium in senesced leaf
31	Spec_area_green_leaf	g/m2	Green leaf - specific area
32	Spec_area_senesced_leaf	g/m2	Senesced leaf - specific area
33	Area_green_leaf	cm2	Green leaf area
34	Area_senesced_leaf	cm2	Senesced leaf area
35	Mass_green_leaf	mg	Green leaf dry mass
36	Mass_senesced_leaf	mg	Senesced leaf dry mass
37	Leaf_loss	%	Leaf mass loss with senescence
38	Leaf_shrink	%	Leaf area shrinkage with senescence

Example data records:

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Record_number,Ref,Study_number,Country,Region,City,Site_name,Lat,Long,Köppen_CC,
Vegetation,Species,Family,Growth_habit,Senesced_sample_method,MAT,TAP,
Elevation,C_green_leaf,C_senesced_leaf,N_green_leaf,N_senesced_leaf,P_green_leaf,P_senesced_leaf,K_green_leaf,K_senesced_leaf,
Ca_green_leaf,Ca_senesced_leaf,Mg_green_leaf,Mg_senesced_leaf,Spec_area_green_leaf,Spec_area_senesced_leaf,Area_green_leaf,
Area_senesced_leaf,Mass_green_leaf,Mass_senesced_leaf,Leaf_loss,Leaf_shrink

785,Allison & Vitousek (2004),1,USA,HI,,,19.7,-155.1,A,Wet tropical forest,Cibotium glaucum,Cibotiaceae,Ferns,
Picked from the plant or recently fallen,23.0,4000,150,1.40,0.75,0.10,0.04,87.7
786,Allison & Vitousek (2004),1,USA,HI,,,19.7,-155.1,A,Wet tropical forest,Dicranopteris linearis,Gleicheniaceae,Ferns,
Picked from the plant or recently fallen,23.0,4000,150,,,0.87,0.53,0.06,0.03,89.3
787,Allison & Vitousek (2004),1,USA,HI,19.7,-155.1,A,Wet tropical forest,Dicranopteris sandwichianum,Gleicheniaceae,Ferns,
Picked from the plant or recently fallen,23.0,4000,150,,,2.15,1.42,0.24,0.08,44.1 …
815,Killingbeck & Whitford (1996),85,USA,NM,Chihuahuan,,32.5,-106.8,B,Perennial desert shrubs,Rhus microphylla,Anacardiaceae,
Tree (deciduous),Litterfall,14.4,272,1200,,,2.30,1.10,
816,Killingbeck & Whitford (1996),85,USA,NM,Chihuahuan,,32.5,-106.8,B,Perennial desert shrubs,Rhus microphylla,Anacardiaceae,
Tree (deciduous),Litterfall,14.4,272,1200,,,2.80,1.60,
817,Killingbeck & Whitford (1996),85,USA,NM,Chihuahuan,,32.5,-106.8,B,Perennial desert shrubs,Rhus microphylla,Anacardiaceae,
Tree (deciduous),Litterfall,14.4,272,1200,,,2.60,1.40
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File 2: Study reference file: Leaf_Carbon_Nutrients_studies.csv

Column Names	Description
Study_number	Study number; a number assigned to data from a particular paper
Ref	Reference/Short citation
Author	List of author or authors
Title	Name of the article
Journal	The journal that the article was published in
Volume	Volume or usually the year of journal
Issue	Issue indicates the sequence of the publication
BP	Beginning page
EP	Ending page
PubYear	Year the article was published
Publisher	Producer of publication
Notes	Misc. notes

Example data records:

```
Study_number,Ref,Author,Title,Journal,Volume,Issue,BP,EP,PubYear,Publisher,Notes

1,Allison & Vitousek (2004),"Allison, S.D. and Vitousek, P.M.",Rapid nutrient cycling in leaf litter from invasive plants in
Hawai'i,Oecologia,141,4,612,619,2004,Springer,
2,Bertiller et al. (2006),"Bertiller, M.B. and Mazzarino, M.J. and Carrera, A.L. and Diehl, P. and Satti, P. and Gobbi, M. and Sain, C.L.",Leaf
strategies and soil N across a regional humidity gradient in Patagonia,Oecologia,148,4,612,624,2006,Springer
3,Blanco et al. (2009),"Blanco, J.A. and Imbert, J.B. and Castillo, F.J.",Thinning affects nutrient resorption and nutrient-use efficiency in two Pinus
sylvestris stands in the Pyrenees,Ecological Applications,19,3,682,698,2009,Eco Soc America
```

…
83,Zotz (2004),"Zotz, G. and others",The resorption of phosphorus is greater than that of nitrogen in senescing leaves of vascular epiphytes from lowland Panama,Journal of Tropical Ecology,20,6,693,696,2004,Cambridge Univ Press
84,Kazakou et al. (2007),"Kazakou, E. and Garnier, E. and NAVAS, M.L. and Roumet, C. and Collin, C. and Laurent, G.",Components of nutrient residence time and the leaf economics spectrum in species from Mediterranean old-fields differing in successional status,Functional Ecology,21,2,235,245,2007,Wiley Online Library
85,Killingbeck & Whitford (1996),"Killingbeck, K.T. and Whitford, W.G.",High foliar nitrogen in desert shrubs: an important ecosystem trait or defective desert doctrine?,Ecology,,,1728,1737,1996,JSTOR

Site boundaries: (All latitude and longitude are given in decimal degrees)

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Global (31 countries)	-159.7	176.9	68.5	-50

Time period:

- The data set covers the period 1970/01/01 - 2009/12/31

3. Data Application and Derivation:

Mass data were used in the calculation of the mass loss correction factor (MLCF), which is the ratio of the dry mass of green leaves, to the dry mass of senesced leaves. The MLCF was calculated directly when both dry masses were available and estimated as 1-LML/100 when only the percentage of leaf mass loss (LML) was given (Vergutz et al., 2012).

Nutrient concentration data were applied in calculating nutrient resorption efficiencies. Using this global database of nutrient contents in green and senesced leaves, resorption efficiencies can be computed across plant types and climates, while accounting for mass loss during senescence. Investigators used the data to compare the relationship between mean nutrient resorption efficiency and climate variables (mean annual temperature (MAT) and mean annual precipitation (MAP)). The mean nutrient resorption efficiency for each nutrient for the data set as a whole and for each plant growth type and climate group were separately calculated using a regression analysis (Vergutz et al., 2012).

Vergutz et al., (2012), analyzed 28 ecosystem and biogeochemical models and found wide variation in nutrient resorption efficiency values used in the models. Ecosystem models tend to neglect phosphorus dynamics and do not consider other nutrients, but these nutrient resorption parameters are important for the accuracy of such models. This study has highlighted specific limitations in current resorption parameterizations to help identify improvements for future biogeochemical and land surface models.

4. Quality Assessment:

See original source articles for quality assessment information.

5. Data Acquisition Materials and Methods:

Data were obtained from published studies that reported or provided sufficient information to calculate mean values of carbon and N, P, K, Ca, and Mg nutrient mass per unit dry mass in mature green and senesced leaves and reported nutrient content on a leaf-mass basis (Vergutz et al., 2012). Using Web of Science and Google Scholar search engines, investigators identified studies on nutrient contents in green and senesced leaves with search terms such as “resorption,” nutrient reabsorption,” “nutrient use efficiency,” and “leaf mass loss.”

Data were compiled from 86 studies conducted in 31 countries and resulted in approximately 1,000 data points for both green and senesced leaves from woody and non-woody vegetation. The leaf data were collected from studies taking place from 1970-2009. The data came from major plant types including woody (lianas, shrubs, and trees) and non-woody species, grouped in six growth types: ferns, forbs, gramminoids, conifers, evergreen woody angiosperms, and deciduous woody angiosperms (Vergutz et al., 2012).

Data were compiled on leaf nutrient concentrations from terrestrial plants in every continent except Antarctica, with the majority of the data from Europe and North America. Investigators noted that most of the data for senesced leaves came from newly fallen leaves, with the fewest data from litter-trap studies. Only unfertilized controls from fertilized systems, including annual crops, were included in the data set. Overall, 171 data points were available for carbon concentrations in leaves, with 948 available for nitrogen, 699 for phosphorus, 207 for potassium, 150 for calcium, 115 for magnesium, and 191 for the leaf mass-loss calculations (Vergutz et al., 2012).

Mean annual temperature (MAT) data was obtained for each site and ranged from -8° to 31.6°C, mean annual precipitation (MAP) for each site ranged from 125 to 550 mm/yr, and elevation across sites ranged from 0 to 3520 m above sea level. Based on climatic features, study locations were grouped according to Köppen Climate Classification which organized data into five climatic regions: topical/megathermal, dry, temperate/mesothermal, continental/microthermal, and polar (McKnight and Hess 2000, Kottek et al. 2006).

6. Data Access:

This data is 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
Telephone: +1 (865) 241-3952

7. References:

Kottek, M., J. Grieser, C. Beck, B. Rudolf, and F. Rubel. 2006. World map of the Koppen- Greiger climate classification updated. Meteorologist Zeitschrift 15:259-263.

McKnight, T. L., and D. Hess. 2000. Climate zones and types: the Koppen system. Physical geography: a landscape appreciation. Prentice Hall, Upper Saddle River, New Jersey, USA.

Vergutz, L., Manzoni, S., Porporato, A., Novais, R. F., and Jackson, R. B. 2012. Global resorption efficiencies and concentrations of carbon and nutrients in leaves of terrestrial plants, Ecological Monographs 82:2, 205-220. doi: 10.1890/11-0416.1