GLOBAL DISTRIBUTION OF ROOT NUTRIENT CONCENTRATIONS IN TERRESTRIAL ECOSYSTEMS

Summary:

Nutrient measurements for fine roots were compiled from 56 published studies providing information on 372 different combinations of species, root diameter, rooting depths, and soils at a variety of locations. The compilation was used to examine dynamics of 14 nutrients, including translocation properties of roots of varying size and status.

Fine roots are an important source and sink for nutrients in terrestrial biogeochemistry. The data collected come from 56 published studies that give information on fine root (less than 5-mm diameter) nutrient concentrations, root diameters, and retranslocation of nutrients. These studies include diverse vegetation and biomes, including grass, shrub, and tree functional types from temperate, tropical, boreal and tundra systems. The preponderance of data comes from experiments with temperate and coniferous trees. Study sites were a mixture of natural and manipulated ecosystems, including old growth, secondary growth, old fields, and tundra systems. Data from fertilized, potted or greenhouse experiments were excluded. Data are available by diameter class. This listing builds on the database of Jackson et al (1996, 1997). Please see Gordon and Jackson (2000) for more information.

The following hypotheses were examined (Gordon and Jackson 2000) for fine root nutrients by analyzing these data: (1) that there is an inverse relationship of fine root nutrient concentrations with root diameter, and (2) that retranslocation of nutrients out of fine roots is minimal. Nutrient concentrations of roots less than or equal to 5 mm in diameter were analyzed as a function of root diameter and root status (live, dead, and undifferentiated), including a comparison for coniferous and broad-leaved trees. From the results, mean N concentrations in live and dead fine roots were identical and may imply little retranslocation of root N with senescence, but conflicting evidence from C:N ratios highlights the need for further research (Gordon and Jackson 2000). These results have practical implications for various ecological methods and for the representation of roots in biogeochemical models.

A PDF copy of the Gordon and Jackson (2000) paper is available at http://www.biology.duke.edu/jackson/Ecol99.htm.

This data set builds on the initial root data compiled by R. B. Jackson in the mid-1990s (see Jackson et al. 1996; Jackson et al. 1997). The expanded and updated data set (Gordon and Jackson 2000) contains nutrient concentrations for approximately 372 site-pit-depths from 56 papers. In addition, the initial Jackson data set has been expanded for studies with root turnover rates (data for 341 site-vegetation combinations for approximately 188 sites from 152 papers in Gill and Jackson 2000) and rooting depth (data for approximately 298 sites with 565 profiles in Schenk and Jackson 2002). The three recent papers include most of the data contained in the initial root data set; however, some observations may have been excluded because of more stringent selection criteria. Many of the source papers provided data for the three recent rooting papers and users are encouraged to review all three data sets.

Related Arvhived Data Sets:

- Global Distribution of Fine Root Biomass in Terrestrial Ecoystems
- Global Distribution of Root Profiles in Terrestrial Ecosystems
- Global Distribution of Root Turnover in Terrestrial Ecosystems

Data Citation:

Cite this data set as follows:

Gordon, W. S., and R. B. Jackson. 2003. Global Distribution of Root Nutrient Concentrations in Terrestrial Ecosystems. Data set. Available on-line [http://www.daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A. doi:10.3334/ORNLDAAC/659.

References:

Gill, R., and R. B. Jackson. 2000. Global patterns of root turnover for terrestrial ecosystems. New Phytologist 81:275-280.

Gordon, W. S., and R. B. Jackson. 2000. Nutrient concentrations in fine roots. Ecology 81:1:275-280.

Jackson, R. B., H. A. Mooney, and E.-D. Schulze. 1997. A global budget for fine root biomass, surface area, and nutrient contents. Proceedings of the National Academy of Sciences, U.S.A. 94:7362-7366

Jackson, R. B., J. Canadell, J. R. Ehleringer, H. A. Mooney, O. E. Sala, and E.-D. Schulze. 1996. A global analysis of root distributions for terrestrial biomes. Oecologia 108:389-411.

Schenk, H. J., and R. B. Jackson. 2002. The global biogeography of roots. Ecological Monographs 72(3):311-328.

Data Format:

The Oak Ridge National Laboratory Distributed Active Archive Center (ORNL DAAC) for Biogeochemistry Dynamics organized and formatted these data for long-term archive. The data and companion references were downloaded in html format from http://www.esapubs.org/archive/ecol/E081/002/default.htm. The HTML data file was converted

to a tab-delimited text file with most all cells filled. Information and data that were not available in the source paper are represented as "N/A" or -999 for numeric columns. Cells containing "ND" indicate that the nutrient was not detected. An asterisk (*) in the Flag column indicates that some of the nutrient values were calculated from data presented in the respective paper.

Data File: Root_nutrients_Appendix_A.txt

Site characteristics and nutrient concentrations, n=372 rows.

Variables	Descriptions and Units
Authors	Author and year of publication
Latitude	Latitude [degrees, minutes, and seconds]
Longitude	Longitude [degrees, minutes, and seconds]
Biome	Biome: Agriculture Tropical grassland, Boreal forest, Coniferous forest, crop, Deciduous forest, Evergreen forest, Forest, Subtropical wet forest, Taiga, Temperate, Temperate coniferous forest, Temperate deciduous & coniferous, Temperate deciduous forest, Temperate grassland, Tropical deciduous forest, Tropical evergreen forest, Tropical forest, Tropical rain forest, Tropical savanna, or Tundra
Location	Country or state if in the U.S.A.
Annual PPT	Precipitation [mm]
Functional Type	Tree, grass, shrub, savanna or various other types
Species	Common name, e.g., oak, pine, grass
Comments	Fertilized, unfertilized, climate conditions, potted, logged, etc.
Land	Description that may include stand age, type of area, research group, or other identification
Root Type	Coarse or fine, and live, dead or total
Diameter	Root diameter [mm]
Depth	Depth of soil sample [m]
Soil	Soil description, e.g., haplic podzol, umbric luvisol, acid
Flag	Asterisk ("*") indicates that some of the values were calculated from data presented in the paper
C	Carbon concentration [g][kg^-1]
Lignin	Lignin concentration [g][kg^-1]
N	Nitrogen concentration [g][kg^-1]
P	Phosphorus concentration [g][kg^-1]
K	Potassium concentration [g][kg^-1]
Ca	Calcium concentration [g][kg^-1]
Mg	Magnesium concentration [g][kg^-1]
S	Sulfur concentration [g][kg^-1]
Na	Manganese concentration [g][kg^-1]
Fe	Iron concentration [g][kg^-1]
Al	Aluminum concentration [g][kg^-1]
Zn	Zinc concentration [g][kg^-1]
Cu	Copper concentration [g][kg^-1]
Si	Silicon concentration [g][kg^-1]

Example Data Records:

Authors Latitude Longitude Biome Location Annual ppt (mm) Functional Type Species Treatment Land Root Type Diameter (mm) Depth Description (m if number) Soil Flag C Lignin N P K Ca Mg S Na Mn Fe Al Zn Cu Si
Adams and Hutchinson 1992 45 22' N 79 21' W Temperate deciduous forest "Canada, Ontario, Huntsville " 709 tree sugar maple healthy N/A "fine, live" < 2 0-0.1 podzol -999 -999 -999 0.1 0.11 0.62 0.15 0.18 -999 -999 -999 -999 -999 -999 -999
Adams and Hutchinson 1992 45 43' N 79 37' W Temperate deciduous forest "Canada, Ontario, Sundridge " 763 tree sugar maple healthy N/A "fine, live" < 2 0-0.1 podzol -999 -999 -999 0.132 0.57 0.5 0.2 0.21 -999 -999 -999 -999 -999 -999 -999 -999
Ahlstrom et al. 1988 60 41' N 16 30' E Temperate coniferous forest "Sweden, central " 609 tree "herb, & grass" liquid fertl 130 yr Scots pine stand "live, fine" < 2 30 cm ingrowth cores podzol -999 -999 1.5 0.22 0.13 0.17 0.12 0.11 -999 -999 -999 0.72 -999 -999 -999

Companion File: Root_nutrients_Appendix_B_References.txt (also in .pdf and .rtf formats)

References - 56 citations

Example Data Records:

Appendix B

Data sources cited in the Appendix A data table from Wendy S. Gordon and Robert B. Jackson. 2000. Nutrient concentrations in fine roots. Ecology 81: 275-280.

Appendix B downloaded from Ecological Archives E081-002-A2

Adams, C. M., and T. C. Hutchinson. 1992. Fine-root growth and chemical composition in declining Central Ontario sugar maple stands. Canadian Journal of Forest Research 22:1489-1503.

Ahlstrom, K., H. Persson, and I. Borjesson. 1988. Fertilization in a mature Scots pine (Pinus sylvestris L.) stand - effects on fine roots. Plant and Soil 106:179-190.

Arthur, M. A., and T. J. Fahey. 1992. Biomass and nutrients in an Engelmann spruce - subalpine fir forest in north central Colorado: pools, annual production, and internal cycling. Canadian Journal of Forest Research 22:315-325.

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