NPP Grassland: Consistent Worldwide Site Estimates, 1954-1990, R1

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Revision date: April 22, 2015

Summary:

This data set contains one data file in comma-separated format (.csv). The data file contains information for the 28 grassland sites that were used in developing and validating an algorithm to estimate below-ground net primary productivity (BNPP). The site characteristics in the data files include data source, treatment (number of data files available per site for different grazing and burning treatments), mean annual precipitation, mean annual temperature, latitude, and longitude. The total number of treatments was 52.

Any estimate of BNPP requires an accounting of total root biomass, the percentage of living biomass, and annual turnover of live roots. In this study, the investigators derived a relationship using peak above-ground biomass and mean annual temperature to predict below-ground biomass (r2 = 0.54; P=0.01). The percentage of live material was 0.6, based on published values. Three different functions were used to describe root turnover: constant; a direct function of above-ground biomass; and positive exponential relationship with mean annual temperature.

Revision Notes: Only the documentation for this data set has been modified. The data files have been checked for accuracy and are identical to those originally published in 1996.

Additional Documentation

The NPP data collection contains field measurements of biomass, estimated NPP, and climate data for terrestrial grassland, tropical forest, temperate forest, boreal forest, and tundra sites worldwide. Data were compiled from the published literature for intensively studied and well-documented individual field sites and from a number of previously compiled multi-site, multi-biome data sets of georeferenced NPP estimates. The principal compilation effort (Olson et al., 2001) was sponsored by the NASA Terrestrial Ecology Program. For more information, please visit the NPP web site at http://daac.ornl.gov/NPP/npp_home.shtml.

Data Citation:

Cite this data set as follows:

Gill, R.A., R.H. Kelly, W.J. Parton, K.A. Day, R.B. Jackson, J.A. Morgan, J.M.O. Scurlock, L.L. Tieszen, J.R. Vande Castle, D.S. Ojima, and X.S. Zhang. 2015. NPP Grassland: Consistent Worldwide Site Estimates, 1954-1990, R1. Data set. Available on-line [http://daac.ornl.gov] from the Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/613

Table of Contents:

1. Data Set Overview:

Project: Net Primary Productivity (NPP)

This study developed an algorithm for estimating below-ground NPP in grasslands and tested root turnover functions that might be used to describe root dynamics in grasslands. BNPP is often a missing components of total system NPP. The work was conducted as part of the Worldwide NPP Working groups supported by the U.S. National Center for Ecological Analysis and Synthesis, a Center funded by NSF (Grant #DEB-94-21535), the University of California at Santa Barbara, and the State of California.

In many grasslands, above-ground net primary productivity (ANPP) is commonly estimated by measuring peak above-ground biomass. Estimates of below-ground net primary productivity (BNPP), and consequently, total net primary productivity (TNPP), are more difficult to calculate. This study addressed one of the three main objectives of the Global Primary Productivity Data Initiative (GPPDI) for grassland systems - to develop simple models or algorithms to estimate missing components of total system NPP.

Any estimate of BNPP requires an accounting of total root biomass, the percentage of living biomass, and annual turnover of live roots. In this study, the investigators derived a relationship using above-ground peak biomass and mean annual temperature as predictors of below-ground biomass ($r2 = 0.54$; $P=0.01$). The percentage of live material was 0.6, based on published values. Three different functions were used to describe root turnover: constant; a direct function of above-ground biomass; or as a positive exponential relationship with mean annual temperature.

The various models were tested against a large database of global grassland NPP estimates based on field measurements. The constant turnover and direct function models were approximately equally descriptive ($r2=0.31$ and 0.37), while the exponential function had a stronger correlation with the measured values ($r2=0.40$) and had a better fit than the other two models at the productive end of the BNPP gradient. When applied to extensive field data assembled from two grassland sites with reliable estimates of TNPP (Shortgrass Steppe and Konza Prairie Research Natural Area), the direct function was most effective, especially at lower productivity sites.

Some caveats are provided for the model's use in systems that lie at the extremes of the grassland gradient. The investigators (Gill et al., 2002) stress that there are large uncertainties associated with measured and modeled estimates of BNPP.

2. Data Description:

Spatial Coverage

Site: Global

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

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Global	-180	180	-90	90

Spatial Resolution

Many of the studies evaluated by Gill et al. (2002) employed the same spatial resolution for field measurements of biomass. Please see individual NPP grassland site data set documentation archived at ORNL DAAC and/or published literature for details. The reported and modeled data are expressed as g biomass/m^2.

Temporal Coverage

The field measurements data in the NPP studies investigated span the period 1954/01/01 - 1990/12/31.

Temporal Resolution

BNPP data used in algorithm development and validation were below-ground biomass measurements taken at the approximate time of peak above-ground biomass, since this is the most widespread analog for above-ground NPP. Below-ground biomass was converted to BNPP using estimates of the percentage of live material and root turnover rate.

Data File Information

The data are provided in one comma-separated file (.csv). The first seven lines are metadata; the data record begins on line eight. There are no missing values.

Table 2. Data file descriptions

FILE NAME	FILE CONTENTS

grass_table.csv	Characteristics of grassland sites used in BNPP algorithm development

3. Data Application and Derivation:

This study developed an algorithm for estimating below-ground NPP in grasslands and tested root turnover functions that might be used to describe root dynamics in grasslands. BNPP is often a missing components of total system NPP. The investigators used a method that requires estimating below-ground biomass when those data are unavailable, and then converting that biomass number to BNPP using a turnover coefficient.

The algorithm allows the estimation of below-ground NPP when field observation is impractical, due to cost or when estimates are to be made over large areas. In addition, it may be possible to estimate below-ground NPP based on above-ground NPP measurements made in years past, making it possible to estimate historic changes in total NPP.

4. Quality Assessment:

The NPP algorithm was tested against the Osnabrück database of above- and below-ground grassland productivity (Esser, 2013; Esser et al., 1997) . The efficacy of the three turnover estimates was tested in two ways: (1) through a comparison of modeled results with the Osnabrück database and (2) through direct comparison of model output and values reported for the shortgrass Steppe (SGS) and Konza Prairie Research Natural Area (KNZ), two sites (in the USA) in the Long-term Ecological Research (LTER) Network with reliable below-ground NPP measurements.

Sources of Error

There are large uncertainties associated with measured and modeled estimates of BNPP.

5. Data Acquisition Materials and Methods:

Site Information

Data from 28 grassland study sites were used in developing and validating an algorithm to estimate BNPP. Table 1 contains characteristics of grassland sites included in the NCEAS Grasslands NPP data set.

MAP = mean annual precipitation; MAT = mean annual temperature; Treatments = number of data sets available per site for different grazing and burning treatments (N.B. no irrigation or fertilization); Total number of treatments = 52.

Table 1. Site characteristics

Site	Treatments	MAP (mm)	MAT (C)	Latitude	Longitude
Data source: Oak Ridge National Laboratory Distributed Active Archive Center (ORNL DAAC)					
Calabozo, Venezuela	3	1306	28.3	8.93	-67.42
Charleville, Queensland, Australia	2	483	20.7	-26.4	146.27
Klong Hoi Khong, Thailand	2	1541	28	6.33	100.93
Lamto, Ivory Coast	1	1165	28.6	6.22	-5.03
Matador, Saskatchewan, Canada	1	350	2.4	50.7	-107.72
Matopos, Zimbabwe	1	603	18.8	-20.26	28.37
Nairobi, Kenya	2	677	20.1	-1.33	36.83
Kursk, Russia	1	583	5.2	51.67	36.5
Otradnoe, Russia	2	485	4.2	60.83	30.25
Shortandy, Kazakhstan	1	350	1.6	51.67	71
Tumugi, Inner Mongolia, China	1	411	2.1	46.1	123
Tuva, Russia	1	285	-4.3	51.83	94.42
Montecillo, Mexico	2	580	14.3	19.46	-98.91
Osage, Oklahoma, USA	2	916	14.3	36.95	-96.55
Bridger, Montana, USA	2	349	8.7	45.78	-110.78
Dickinson, Nebraska, USA	2	422	4.8	46.9	-102.82
Hays, Kansas, USA	1	586	12	38.87	-99.38
Jornada, New Mexico, USA	2	262	14.4	32.6	-106.85
Data source: Queensland Department of Natural Resources, Australia (DNR)					

Roma (Euthella), Queensland, Australia	2	540	20.4	-26.48	148.68
Roma (DPI Research Station), Queensland, Australia	1	553	20.5	-26.58	148.77
Roma (Roselea), Queensland, Australia	2	541	20.4	-26.76	148.82
Crows Nest, Queensland, Australia	1	848	17.5	-27.03	152.02
Grandchester, Qld, Australia	1	917	18.5	-27.75	152.45
Calliope (Galloway Plains), Queensland, Australia	3	797	21.2	-24.16	150.95
Biloela (Callide Range), Queensland, Australia	1	797	21.2	-24.19	150.69
Parkhurst, Queensland, Australia	1	812	22.4	-23.3	150.51
Bowen (Ida Creek), Queensland, Australia	1	816	23.4	-20.27	148.12
Normanton (Milgarra), Queensland, Australia	1	653	27.3	-18.12	140.88
Julia Creek (Toorak), Queensland, Australia	1	403	25.2	-20.98	141.8
Tambo (Lisnalee), Queensland, Australia	1	473	20.4	-25.08	146.5
Clermont (Epping Forest Nat. Pk.), Queensland, Australia	1	500	23.1	-22.37	146.69
Gayndah (Brian Pastures Res. Stn.), Queensland, Australia	6	666	20.6	-25.67	151.75

Methods

Algorithm development and validation methodologies are described by Gill et al. (2002). NPP data for 23 treatments at 16 sites in the core NPP database compiled at the U.S. Oak Ridge National Laboratory (Scurlock et al., 1999) were used for algorithm development. A selection of above- and below-ground NPP data from the Osnabrück data set (Esser, 2013; Esser et al., 1997) and Australian pasture data provided by K. A. Day (unpublished data) were used *post facto* to test the relationships.

Multiple pairwise regressions were used to determine the relationship between environmental factors and below-ground biomass and to use environmental and above-ground plant characteristics to determine below-ground NPP. Once the variables most strongly related to below-ground biomass were determined, a multiple regression was run to describe most fully the relationship. Below-ground biomass was then converted to BNPP using estimates of the percentage of live material and root turnover rate. The resulting relationship was then tested against the Osnabrück database. In addition, a site level test of the complete BNPP algorithm was conducted for two sites with extensive NPP measurements, the SGS and KNZ LTER sites.

6. Data Access:

This data set is available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

Data Archive:

Web Site: http://daac.ornl.gov

Contact for Data Center Access Information:

E-mail: uso@daac.ornl.gov
Telephone: +1 (865) 241-3952

7. References:

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Additional Sources of Information:

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