NPP Grassland: Tumugi, China, 1981-1990, R1

Get Data

Revision date: November 10, 2014

Summary:

This data set contains four ASCII files (.txt format). Three files contain monthly above- and below-ground biomass data, one data file for each cold meadow steppe studied from 1981 to 1990 at Tumugi, Xingan League, in eastern Inner Mongolia, China (approximately 46.10 N, 123.00 E, Elevation 191 m). The fourth file contains climate data recorded at a weather station located in the study area for the length of the study.

The Tumugi study sites consist of three different natural steppes dominated by *Filifolium sibiricum*, *Stipa baicalensis*, and *Leymus chinense*, respectively. Measurements of above- and below-ground live biomass were made monthly throughout the growing season (March to November) by clipping 1.0 m^2 quadrats and sampling 1.0 m^2 soil pits to a depth of 1.0 m, respectively. The study areas had been protected from grazing since 1976.

Above-ground net primary productivity (ANPP) was estimated at 155 g/m^2/year (average for the three steppes, based on peak above-ground living biomass). Peak live below-ground biomass was used to estimate below-ground net primary productivity (BNPP): 968 g/m^2/year for the *F. sibiricum* steppe; 983 g/m^2/year the *Stipa baicalensis* steppe; and 1,022 g/m^2/year for the *L. chinense* steppe.

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 1999.

Additional Documentation:

The Net Primary Productivity (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.html.

Data Citation:

Cite this data set as follows:

Xiao, X., and D. Ojima. 2014. NPP Grassland: Tumugi, China, 1981-1990, R1. 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/470

This data set was originally published as:
Xiao, X., and D. Ojima. 1999. NPP Grassland: Tumugi, China, 1981-1990. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A.

Table of Contents:

1. Data Set Overview:

Project: Net Primary Productivity (NPP)

Seasonal and interannual biomass dynamics of three meadow steppe grasslands were studied from 1981 to 1990 at Tumugi, Xingan League, in eastern Inner Mongolia, China. Measurements of above- and below-ground live biomass were made monthly throughout the growing season (March to November) by clipping 1.0-m^2 quadrats and sampling 1.0-m^2 soil pits to a depth of 1.0 m, respectively.

The Tumugi study site contains three different natural steppes (dominated by *Filifolium sibiricum*, *Stipa baicalensis*, and *Leymus chinense*, respectively). The study sites had been fenced to exclude grazing since 1976 and were used for long-term monitoring of productivity. The study areas (approximately 46.10 N, 123.00 E) are located about 60-km east of the city of Ulan Hot (approximately 300-km west of Harbin, China). They are representative of the meadow steppes which cover about 50,000 km^2 in Inner Mongolia and are widely distributed in the Euro-Asian steppe zone. This type of grassland is typically grazed by sheep and cattle at moderate grazing intensity.

The continental sub-humid climate of this area is dominated by monsoon rains from April to September. Net primary productivity is known to vary considerably both spatially and from year to year as a function of precipitation and temperature.

The NPP measurement presented here includes both above- and below-ground productivity, based on peak living biomass. Above-ground net primary productivity (ANPP) was estimated at 155 g/m^2/year (average of the three meadow steppe sites) (Scurlock and Olson, 2012; Xiao et al., 1996). Peak live below-ground biomass was used to estimate below-ground net primary productivity (BNPP), which varied between 969 g/m^2/year for the *F. sibiricum* steppe, 983 g/m^2/year for the *Stipa baicalensis* steppe, and 1,022 g/m^2/year for the *L. chinense* steppe (Table 1).

Table 1. Mean peak live above-ground biomass (ANPP) and mean peak live below-ground biomass (BNPP) estimates for three Chinese steppes based on field measurements, 1981-1990 (g/m^2/year dry matter weight)

Variable	*Filifolim sibiricum* steppe	*Stipa baicalensis* steppe	*Leymus chinense* steppe
ANPP	152	152	162
BNPP	969	983	1,022

Source: Xiao et al. (1996).

Note: Productivity values in gC/m^2/year are reported in Olson et al. (2013a; b) using a conversion factor of 0.45. ANPP values generally agree with the values given above; the differences are due to rounding. BNPP values do not agree with the values given above because different calculation methods were used.

2. Data Description:

Spatial Coverage

Site: Tumugi, China

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

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Elevation (m)
Tumugi, China	123.00	123.00	46.10	46.10	191

Spatial Resolution

Each study area contained 250-m x 40-m species plots. Each plot was divided into five 50-m x 40-m subplots for field sampling. Above-ground biomass was clipped from 1.0-m^2 quadrats. Below-ground biomass was extracted from 1.0-m^2 soil pits to a depth of 1.0 m.

Temporal Coverage

Biomass measurements were made on the *Leymus chinense* steppe from 1981/03/15 through 1990/11/15 and on the *Filifolium sibiricum* and *Stipa baicalensis* steppes from 1981/04/15 through 1990/11/15. Climate data are available from 1981/01/01 through 1990/12/31.

Temporal Resolution

Biomass measurements were made monthly. All biomass estimates are based on plant dry matter accumulation, expressed as g/m^2. Climate data are expressed as monthly and annual precipitation amounts (mm) and monthly and annual average maximum/minimum temperature (C). Monthly and annual climatic means are provided for the 1981-1990 period.

Data File Information

Table 2. Data files and descriptions

FILE NAME	TEMPORAL COVERAGE	FILE CONTENTS
tmg1_npp.txt	1981/04/15 - 1990/11/15	Above- and below ground biomass data for the

		ungrazed *Filifolium sibiricum* steppe at Tumugi, China
tmg2_npp.txt	1981/04/15 - 1990/11/15	Above- and below ground biomass data for the ungrazed *Stipa baicalensis* steppe at Tumugi, China
tmg3_npp.txt	1981/03/15 - 1990/11/15	Above- and below ground biomass data for the ungrazed *Leymus chinense* steppe at Tumugi, China
tmg_cli.txt	1981/01/01 - 1990/12/31	Monthly and annual climate data from the weather station at Tumugi, China

NPP Data. Biomass estimates for the Tumugi site are provided in three files, one for each steppe monitored (Table 2). The data sets are ASCII files (.txt format). The first 18 lines are metadata; data records begin on line 19. The variable values are delimited by semicolons. There are no missing values. All biomass units are in g/m^2 (dry matter weight).

COLUMN HEADING	DEFINITION	UNITS
Site	Site where data were gathered (code refers to site identification)	Text
Treatmt	Long term management of site (code refers to treatment described in metadata in data file)	
Year	Year in which data were collected	Numeric
Mn	Month in which data were collected	
Day	Day on which data were collected	
Jdate	Date in Julian year	
Tyear	Date in decimal year (year plus the Julian date divided by 365)	
AGbiomass	Monthly above-ground living biomass	g/m^2
BGbiomass	Monthly peak below-ground living biomass	

Note: All data values are from Xiao et al. (1996).

Sample NPP Data Record:

Sample NPP Data Record <**tmg1_npp.txt**>

```
tmg ;ungrazed1; 1981; 4; 15; 105; 1981.288; 2.40; 1009.66
tmg ;ungrazed1; 1981; 5; 15; 135; 1981.370; 20.56; 1033.07
tmg ;ungrazed1; 1981; 6; 15; 166; 1981.455; 35.01; 1027.14
tmg ;ungrazed1; 1981; 7; 15; 196; 1981.537; 50.07; 998.97
...
```

Sample NPP Data Record <**tmg2_npp.txt**>

```
tmg ;ungrazed2; 1981; 4; 15; 105; 1981.288; 2.46; 990.43
tmg ;ungrazed2; 1981; 5; 15; 135; 1981.370; 20.31; 1025.63
tmg ;ungrazed2; 1981; 6; 15; 166; 1981.455; 35.01; 1028.14
tmg ;ungrazed2; 1981; 7; 15; 196; 1981.537; 51.04; 1029.37
...
```

Sample NPP Data Record <**tmg3_npp.txt**>

```
tmg ;ungrazed3; 1981; 3; 15; 74; 1981.203; 3.16; 947.61
tmg ;ungrazed3; 1981; 4; 15; 105; 1981.288; 3.79; 933.07
tmg ;ungrazed3; 1981; 5; 15; 135; 1981.370; 19.43; 987.33
tmg ;ungrazed3; 1981; 6; 15; 166; 1981.455; 33.42; 1003.66
...
```

Climate Data. The climate data set is an ASCII file (.txt format). The first 18 lines are metadata; data records begin on line 19. The variable values are delimited by semicolons. There are no missing values.

COLUMN HEADINGS	DEFINITION
Site	Unique 3-character code for each site based on the first three consonants in the site name (e.g., tmg for Tumugi)
Temp	Indicates whether the values in that row are either long-term (i.e, mulit-year) or annual data for the specified parameter. For multi-year, the values are: mean=mean values (monthly and annual) calculated for the years of data as noted in the documentation

(Temporal)	numb=number of years of data included in a reported mean value stdv=standard deviation of a mean value Annual data: 19XX=monthly and annual parameter values for the specified year (e.g., 1972)
Parm	Parameter, indicates the meteorological data reported in that row. prec-total precipitation for the month or year tmax=maximum temperature for the month or year reported in degrees C tmin=minimum temperature for the month or year reported in degrees C

Description of specific Temp and Parm data values:

Long-term data:

site;mean;prec;
Multi-year mean of total precipitation for each month [Jan, Feb, Mar, …, Dec] and mean of total annual precipitation across all years [Year] (mm)

site;mean;tmax;
Multi-year mean of maximum temperature for each month [Jan, Feb, Mar, …, Dec] and mean of annual maximum temperature across all years [Year] (C)

site;mean;tmin;
Multi-year mean of minimum temperature for each month [Jan, Feb, Mar, …, Dec] and mean of annual minimum temperature across all years [Year] (C)

… site; numb and stdv; repeat for prec, tmax, and tmin;

Annual data:

site;19XX;prec;
Total precipitation for each month [Jan, Feb, Mar,.....Dec] and total precipitation for the year 19XX [Year] (mm)

site;19XX;tmax;
Maximum temperature for each month [Jan, Feb, Mar,.....Dec] and maximum for the year 19XX [Year] (C)

site;19XX;tmin;
Minimum temperature for each month [Jan, Feb, Mar,.....Dec] and minimum for the year 19XX [Year] (C)

… site;19XX;(prec, tmax, and tmin); repeat for reported years.

Annual data missing value note: If a monthly parm value is missing, the parm value for [Year] is also set to missing (-999.9).

Sample Climate Data Record

tmg ;mean;prec; 1.3; 2.1; 4.8; 16.7; 25.5; 62.7; 152.5; 90.0; 39.8; 11.9; 1.3; 2.4; 410.9;
tmg ;mean;tmax; -10.17; -5.61; 3.87; 15.37; 22.61; 27.07; 28.41; 27.81; 21.08; 12.89; 0.86; -6.28; 28.82;
tmg ;mean;tmin; -24.58; -19.77; -11.09; -1.19; 5.94; 12.54; 16.90; 14.16; 7.09; -2.00; -12.76; -19.94; -24.58;
tmg ;numb;prec; 10; 10; 10; 10; 10; 10; 10; 10; 10; 10; 10; 10; 10;
tmg ;numb;tmax; 10; 10; 10; 10; 10; 10; 10; 10; 10; 10; 10; 10; 10;
tmg ;numb;tmin; 10; 10; 10; 10; 10; 10; 10; 10; 10; 10; 10; 10; 10;
tmg ;stdv;prec; 2.1; 1.9; 3.1; 20.3; 17.2; 43.2; 59.3; 46.4; 21.1; 15.4; 2.3; 2.4; 101.0;
tmg ;stdv;tmax; 2.79; 2.4; 2.99; 2.18; 1.96; 0.93; 1.14; 1.96; 0.9; 1.87; 2.16; 2.67; 1.34;
tmg ;stdv;tmin; 2.98; 2.32; 2.34; 1.44; 1.09; 2.00; 1.78; 2.54; 0.87; 1.44; 1.72; 1.57; 2.98;
tmg ;1981;prec; 0.0; 5.0; 6.3; 8.4; 23.6; 42.0; 194.5; 94.7; 31.9; 5.7; 0.0; 0.10; 412.2;
tmg ;1981;tmax; -8.50; -6.50; 3.00; 18.20; 21.40; 27.40; 30.10; 25.50; 21.30; 10.70; -2.80; -0.40; 30.10;
tmg ;1981;tmin; -22.90; -22.20; -11.20; 0.80; 6.80; 11.50; 19.30; 14.10; 6.40; -0.30; -15.70; -19.40; -22.90;
...
Where,
Temp (temporal) - specific year or long-term statistic:
- mean = mean based on all years
- numb = number of years
- stdv = standard deviation based on all years

Parm (parameter):
- prec = precipitation for month or year (mm)
- tmax = mean maximum temperature for month or year (C)
- tmin = mean minimum temperature for month or year (C)

3. Data Application and Derivation:

The accumulation of biomass, or NPP, is the net gain of carbon by photosynthesis that remains after plant respiration. While there are many fates for this carbon, this data set accounts for above- and below-ground peak living biomass. These biomass values were used to estimate ANPP and BNPP, respectively.

Few field ecological studies have focused on the long-term dynamics of net primary production of grasslands in the Inner Mongolia region of China. Information on interannual variation in net primary production of these grasslands is essential to determine the stocking rate of livestock for rangeland ecosystem management and to project the response of grassland ecosystems to CO_2-induced global climate change. This study is part of a larger project studying climate and soil texture controls of spatial-temporal variations in grassland ecosystems in Inner Mongolia from patch to regional scales.

Monthly grassland biomass dynamics data for the Tumugi sites are provided for comparison with models and estimation of NPP. In Xiao et al. (1996), the CENTURY v3 model output variables such as above-ground live biomass, below-ground live biomass, and soil organic carbon level at the top 20 cm of soil were selected to compare with the observed data. Three techniques were used for testing the CENTURY model: (1) linear regression of the observed data versus simulation results, (2) comparison of CENTURY model predictions with empirical regression model based on climate variables, and (3) graph comparison of CENTURY model predictions with observed Tumugi data. Simulated data agreed reasonably well with the observed data.

Climate data are provided for use in driving ecosystem/NPP models. In this study, the actual weather data for 1981-1990 was used as input to the CENTURY v3 model under no grazing conditions (after equilibrium was reached using long-term average climate data). The climatic variables were also used in linear regression analysis to establish the quantitative relationship between climatic variables and peak live above-ground biomass.

4. Quality Assessment:

Information not available.

Sources of Error

Information not available.

5. Data Acquisition Materials and Methods:

Site Information

The field study sites are three different types of natural meadow grasslands (steppe) located at Tumugi, Xingan League, in eastern Inner Mongolia, China. They include a *Filifolium sibiricum* steppe, a *Stipa baicalensis* steppe, and a *Leymus chinense* steppe. The grasslands are classified as modified Bailey ecoregion cold desert steppe (#333). The species rich steppes are dominated by C_3 plants and are representative of the meadow steppe ecosystems which are widely distributed in the Euro-asian steppe zone. The three study sites were fenced in 1976 to exclude livestock grazing and serve as long-term monitoring of NPP in ungrazed grassland.

Soil type is chernozem / dark chestnut mollisol (sand/silt/clay 0.43/0.22/0.35). A calcium layer exists usually under 60 cm deep. There are slight differences in soil depth and texture at the top 20 cm among the three study sites. These differences are described in Xiao et al. (1996). Elevation of the study sites averages 191 m.

The climate at Tumugi is continental sub-humid and is dominated by monsoon rains. Winter is usually cold and dry, whereas summer is warm and wet. Precipitation is concentrated in April-September. Nonfrost period lasts about 132 days. Plants initiate growth in early April and become senescent in mid-October.

Methods

In the fenced sites of *F. sibiricum* steppe, *S. baicalensis* steppe, and *L. chinense* steppe, field sampling was conducted at the 15th day of each month from March 1981 to November 1990. Each of three sites was divided into five 50-m x 40-m subplots for field observations. One 1.0-m^2 quadrat was randomly placed within each of the five subplots at each sampling date. Plant species, density, cover, height, and phenological phase were recorded. Above-ground biomass was measured by harvest technique. Plant material was clipped to the ground surface and litter was collected by hand. Clipped material was separated into live biomass and standing dead.

Below-ground standing biomass was sampled from 1.0 m^3 of soil cores. In the laboratory, root materials were sorted by hand from soil and washed using a 0.5-mm sieve. Live and dead roots were visually separated out, using the criteria of attachment to individual plants, color (green), and flexibility. Most of roots were distributed within surface to 40 or 50-cm depth.

Clipped above- and below ground plant materials were oven-dried at 65 degrees C in the laboratory and weighed as dry matter weight (g/m^2).

Peak live above-ground biomass (PLAB) was used as a crude estimate of ANPP. Linear regression analysis was applied to establish the quantitative relationship between climatic variables and PLAB of each steppe. Peak live below-ground biomass (PLBB) was used to estimate BNPP.

The process-based ecosystem model CENTURY (version 3) (Parton et al., 1993) was used to simulate dynamics of plant biomass and soil organic matter in the three meadow steppe ecosystems. The CENTURY model has been tested using observed data from 11 temperate and tropical grassland sites in the world (Parton et al., 1993) and from a typical steppe of Inner Mongolia (unpublished data). Field data from this study was used to validate CENTURY model output for the three meadow steppe ecosystems.

Climate data

The climate data accompanying this NPP data set was compiled from a weather station at Tumugi for the period 1981-1990 and include daily observations of Tmax, Tmin, and precip amount.

For a given month, the maximum value of the daily Tmax for that month and the minimum value of the Tmin for that month is provided. For the year, the maximum value of the monthly Tmax is the annual Tmax and for the year the minimum value of the monthly Tmin values is the annual Tmin. Daily precipitation amount is summed to yield a monthly precipitation amount and the monthly precipitation is summed to provide an annual precipitation amount.

The multi-year mean monthly Tmax is the average of the Tmax values for that month for each year of the record. For example the mean monthly Tmax for April is the mean of each April's Tmax for the observation period of record. Mean monthly Tmin and Mean monthly precip amount are calculated similarly.

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:

Olson, R.J., K.R. Johnson, D.L. Zheng, and J.M.O. Scurlock. 2001. Global and Regional Ecosystem Modeling: Databases of Model Drivers and Validation Measurements. ORNL Technical Memorandum TM-2001/196. Oak Ridge National Laboratory, Oak Ridge, Tennessee, U.S.A.

Parton, W.J., J.M.O. Scurlock, D.S. Ojima, T.G. Gilmanov, R.J. Scholes, D.S. Schimel, T. Kirchner, J.C. Menaut, T. Seastedt, and E. Garcia Moya. 1993. Observations and modeling of biomass and soil organic matter dynamics for the grassland biome worldwide. Global Biogeochemical Cycles 7(4): 785-809.

Xiao, X.M., D. Chen, Y.M. Peng, X.Y. Cui, and D.S. Ojima. 1996. Observation and modeling of plant biomass of meadow steppe in Tumugi, Xingan League, Inner Mongolia, China. Vegetatio 127(2): 191-201.

Additional Sources of Information:

Olson, R.J., J.M.O. Scurlock, S.D. Prince, D.L. Zheng, and K.R. Johnson (eds.). 2013a. NPP Multi-Biome: Global Primary Production Data Initiative Products, R2. Data set. Available on-line [http://daac.ornl.gov] from the Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, USA. doi:10.3334/ORNLDAAC/617

Olson, R.J., J.M.O. Scurlock, S.D. Prince, D.L. Zheng, and K.R. Johnson (eds.). 2013b. NPP Multi-Biome: NPP and Driver Data for Ecosystem Model-Data Intercomparison, R2. Data set. Available on-line [http://daac.ornl.gov] from the Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, USA. doi:10.3334/ORNLDAAC/615

Scurlock, J.M.O., and R.J. Olson. 2002. Terrestrial net primary productivity - A brief history and a new worldwide database. Environ. Rev. 10(2): 91-109. doi:10.1139/a02-002

Scurlock, J.M.O., and R.J. Olson. 2012. NPP Multi-Biome: Grassland, Boreal Forest, and Tropical Forest Sites, 1939-1996, R1. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, USA. doi:10.3334/ORNLDAAC/653

Scurlock, J.M.O., K. Johnson, and R.J. Olson. 2002. Estimating net primary productivity from grassland biomass dynamics measurements. Global Change Biology 8(8): 736-753. DOI: 10.1046/j.1365-2486.2002.00512.x