NPP Tropical Forest: San Eusebio, Venezuela, 1970-1971, R1

Get Data

Revision date: October 15, 2013

Summary:

This data set contains three ASCII data files (.txt format), one for net primary production (NPP) component data and two for climate data. The NPP studies were conducted in a tropical montane forest in the Sierra de Merida at San Eusebio (8.62 N 71.35 W) in northwestern Venezuela. The forest is mostly primary in character, with some selective logging having taken place in the past. Biomass, litterfall, and nutrient content of above- and below-ground vegetation and soil were determined in 1973-1974.

Standing stocks of biomass and nutrients are reported as the mean of 13 plots with contrasting soil types, slope, and relief. Litterfall is reported as the mean determined for 3 of these plots, measured bi-weekly over the course of one year. Root turnover was estimated by correlation with leaf litter turnover (13%), and woody turnover was estimated by assuming the system to be in steady-state. A minimum estimate of total NPP (1,497 g/m^2/year) may be obtained by summing total litterfall (697 g/m^2/year), woody turnover (480 g/m^2/year), and fine root turnover (320 g/m^2/year). The forest contains high mineral stores, accumulated especially in the woody compartment. N and P values are very high in the soil compartment.

Long-term climate data are available for Merida (8.60 N 71.18 W), about 30 km southeast of the study site. Mean annual temperature is 18.9 C and mean annual precipitation is 1,752 mm, giving a humid/sub-humid climate. Short-term weather observation recorded at the study site are also provided in the data set.

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 2001.

Figure 1. General overview of the San Eusebio tropical montane forest study area, Venezuela. (Photograph taken 1973-74 by Dr. H. W. Fassbender, Fachhochschule Hildesheim/Holzminden, Goettingen, Germany). (SES1-1.jpg)

Additional Documentation:

The Net Primary Productivity (NPP) data collection contains field measurements of biomass, estimated NPP, and climate data for terrestrial grassland, tropical 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:

Grimm, U., and H.W. Fassbender. 2013. NPP Tropical Forest: San Eusebio, Venezuela, 1973-1974, R1. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A.doi:10.3334/ORNLDAAC/480.

Grimm, U., and H.W. Fassbender. 1999. NPP Tropical Forest: San Eusebio, Venezuela, 1970-1971. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A.

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1. Data Set Overview:

Project: Net Primary Productivity (NPP)

Biomass, litterfall, and nutrient content of above- and below-ground vegetation and soil were determined in 1973-1974 for a tropical montane forest at San Eusebio, Venezuela, with the support of the German Research Society and the University of Los Andes, Venezuela. Some components of net primary productivity (NPP) were estimated.

The San Eusebio study site (8.62 N 71.35 W) is in the Sierra de Merida in northwestern Venezuela, about 30 km northwest of the city of Merida. The experimental site belongs to the Faculty of Forest Science at the University of Los Andes, Merida. The forest appeared to be mostly primary in character, with some selective logging having taken place in the past. The landscape is somewhat heterogeneous, so 13 sample plots (each 50 m x 50 m) were chosen to cover the full range of height and size of all species present. Trees <10 cm diameter were measured only within a circle of 15 m radius in the center of each plot, and the understory was measured within smaller quadrats (2 m x 2 m). Fine roots (< 5 mm) were determined inside these quadrats with the use of corers 20 cm in diameter. Coarse roots were determined by excavation for a total of 30 trees.

A minimum estimate of total net primary productivity (TNPP) is presented here as the sum of total litterfall + woody turnover (ANPP) and fine root turnover (BNPP) (Grimm and Fassbender (1981); Fassbender and Grimm (1981); Lamprecht (1977; Scurlock and Olson, 2003). ANPP, BNPP, and TNPP values for San Eusebio reported in Olson et al. (2012a, b) and Clark et al. (2001a, b) differ from the values presented herein due to different calculation methods (Table 1).

Table 1. ANPP, BNPP, and TNPP values reported by various published data sources

File Name or Description	Data Source(s)	Sub-Site	ANPP	BNPP	TNPP
			$gC/m^2/year$		
ses_npp.txt	Grimm and Fassbender (1981); Fassbender and Grimm (1981); Lamprecht (1977)[1]	ses meanof3 (average of 3 sub-sites; see text for details)	589	160	749
NPP_Multibiome_EnvReview_Table_A1_R1.csv	Scurlock and Olson (2012) based on Grimm and Fassbender (1981); Fassbender and Grimm (1981); Lamprecht (1977)	ses (average of 3 sub-sites)	589	160	749
GPPDI_ClassA_NPP_162_R2.csv	Olson et al. (2012a, b); Clark et al.	Class A 49 (MI 48)	606	423	1,029

EMDI_ClassA_NPP_81_R2.csv	(2001a)[2] Grimm and Fassbender (1981); Fassbender and Grimm (1981)	Class A 49	606	423	1,029
Table 1 in Clark et al. (2001a)	Clark et al. (2001a)[2] based on Grimm and Fassbender (1981); Fassbender and Grimm (1981)	San Eusebio(average of 3 sub-sites)	610	120-730 (av 425)	730-1,330 (av 1,030)
tropfornpp.csv	Clark et al. (2001b)[3] based on Grimm and Fassbender (1981); Fassbender and Grimm (1981)	Venezuela-San Eusebio	464	NA	NA

Notes: NA = Not available. MI = Measurement ID number. The differences in NPP values reported in this table are mainly due to differences in calculation methods, as explained in these notes. Please consult original references for details. Revised data sets (R1, R2, etc) are accompanied by ORNL DAAC Data Set Change Information files. Please see the corresponding documentation for reasons why the data values were revised. [1]For this table, NPP data from the original data source were converted from grams of dry weight per meter square per year to grams of carbon per meter square per year using a conversion factor of 0.5. The NPP estimates are based on field measurement of total litterfall accumulation, wood mortality, and root turnover. [2]Clark et al. (2001a) used a different approach to calculate net primary production values. ANPP was calculated by summing reported above-ground biomass increment + reported fine litterfall + estimated losses to consumers + estimated VOC emissions. BNPP was calculated by summing 0.2 x estimated ANPP for a low BNPP estimate + 1.2 x estimated ANPP for a high BNPP estimate. TNPP was calculated as the range between the low and high values of ANPP + BNPP. Average BNPP and TNPP estimates were also calculated. See Clark et al. (2001a) for a discussion of calculation methods, including how unmeasured components of ANPP were estimated and the basis for setting bounds on BNPP. [3]ANPP estimate is the sum of litterfall + branch fall + above-ground biomass increment.

2. Data Description:

Spatial Coverage

Site: San Eusebio, Venezuela

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

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Elevation (m)
San Eusebio, Venezuela	-71.35	-71.35	8.62	8.62	2,000-2,500

Site Information

The study site is located in a humid tropical montane forest (modified Bailey ecosystem #M420). The stands of the forest reserve are considered primary. The landscape is quite heterogeneous. The major forest species include *Podocarpus rospigliosii*, *P. oleifilius*, *Graffenrieda latifolia*, *Myrcia fallax*, *Eschweilera monosperma*, and *Beilschmiedia sulcata*. Bamboo plants are found in areas with open canopies. There are a large number of epiphytes in the forest stands, especially bromeliads and orchids.

Climate data are available from weather stations in the primary forest and in a clearing at San Eusebio (elevation 2,300 m) as well as from nearby Merida (8.60 N 71.18 W elevation 1,479 m).

Figure 2. View near one of the research plots, San Eusebio tropical forest study site, Venezuela. (N.B. damage to photograph bottom center: taken 1973-74 by Dr. H. W. Fassbender, Fachhochschule Hildesheim/Holzminden, Goettingen, Germany). (SES3-1.jpg)

Figure 3. Crown of *Podocarpus rospigliosi* at the San Eusebio tropical forest study site, Venezuela. (Photograph taken 1973-74 by Dr. H. W. Fassbender, Fachhochschule Hildesheim/Holzminden, Goettingen, Germany). (SES4-1.jpg)

Spatial Resolution

The study plots were 50 x 50 m. Inventory subplots were 4 m^2 in size, litter collectors were 1 m^2, and decomposition frames were 40 x 40 cm.

Temporal Coverage

Biomass measurements were made in 1974. Litter was collected from December 1973 through November 1974. Decomposition was studied from December 1973 through January 1975 (data not included in this data set but reported in Fassbender and Grimm, 1981). Climate data are available from 1915/01/01 through 1996/12/31.

Temporal Resolution

Biomass measurements were made once. Litter was collected bi-weekly. Decomposition rates were calculated monthly. Biomass and NPP estimates are expressed as g/m^2 and g/m^2/year (dry matter weight), respectively.

Climate data are expressed as monthly and annual precipitation amounts (mm) and monthly and annual average temperature (C). Six and seven year mean precipitation records are reported. Monthly and annual mean precipitation are available from a weather station located at the San Eusebio study site. Monthly and annual mean maximum/minimum temperatures measured in the primary forest and in a clearing are also available. Monthly and annual climatic means are provided for the 1921-1996 period for precipitation and 1915-1993 for average temperature from the Merida weather station near San Eusebio.

Data File Information

Table 2. Data files in this data set archive

FILE NAME	FILE SIZE	TEMPORAL COVERAGE	FILE CONTENTS
ses_npp.txt	8.9 KB	1973/12/01-1974/11/30	Biomass, NPP, and nutrient data for tropical montane forest at San Eusebio, Venezuela

ses1_cli.txt	4 KB	Mean of 6 years (dates not specified) 1963/01/01-1964/12/31	Mean precipitation data from weather station at San Eusebio, Venezuela
		Mean of 7 years (1963-1964; 1970-1974)	
		1973/11/01-1974/12/31	Precipitation, and maximum/minimum temperature data for primary forest and nearby clearing at San Eusebio, Venezuela
ses2_cli.txt	19.4 KB	1921/01/01-1996/12/31	Mean monthly and annual precipitation data from Merida weather station near San Eusebio, Venezuela.
		1915/01/01-1993/12/31	Mean monthly and annual average temperature data from Merida weather station near San Eusebio, Venezuela.

NPP Data. NPP estimates for the San Eusebio site are provided in one file (Table 2). The data set is an ASCII file (.txt format). The variable values are delimited by semi-colons. The first 18 lines are metadata; data records begin on line 19. The value -999.9 is used to denote missing values. Biomass and NPP estimates are based on plant dry matter accumulation, expressed as g/m^2 and g/m^2/year, respectively.

Table 3. Column headings in NPP file

COLUMN HEADINGS	DEFINITION	UNITS
Site	Site where data were gathered (code refers to site identification)	Text
Treatmt	Code refers to treatment of data when calculating results	Text
Year	Year in which data were collected	Numeric
Month	Month in which data were collected	
Day	Day on which data were collected	
parameter	Parameters measured (see definitions in Table 3)	Text
amount	Data values	Numeric
units	Unit of measure	Text
References/Comments	Reference to primary and secondary data sources and/or explanatory comments	Text

Table 4. Parameter definitions in NPP file

PARAMETER	DEFINITION	UNITS	SOURCE
trunks	Stem biomass	g/m^2	Table 2[1]
branches	Branch biomass		
leaves	Leaf biomass		
climbers+others	Biomass of lianas and other vegetation (small trees < 10 cm diameter, epiphytes, bromeliads, orchids, and bamboos)		
AGbiomass	Above-ground live biomass	g/m^2	Table 1[1]
Stdead	Standing dead wood		Table 1[1]
AGTotmatter	Total above-ground biomass (sum of above)		by addition
	Litter biomass (recently accumulated)		

litter		g/m^2	Table 2[1]
orglayer	Surface organic matter biomass (decomposed)	g/m^2	Table 2[1]
litter+orglayer	Total organic mulch layer (litter + surface organic matter)	g/m^2	Table 1[1]
fineroots	Fine root biomass (< 5 cm)	g/m^2	Table 2[1]
largeroots	Large root biomass (> 5 cm)	g/m^2	Table 2[1]
Totroots	Total root biomass (fine + large roots)	g/m^2	Table 1[1]
Soilorgmatter	Soil organic matter biomass (0-20 cm depth)	g/m^2	Table 2[1]
Soilorgmatter	Soil organic matter biomass (0-120 cm depth)	g/m^2	Table 1[1]
trunks-N	Nitrogen concentration in stems	g/m^2	Table 1[1]
branches-N	Nitrogen concentration in branches		
leaves-N	Nitrogen concentration in leaves		
Stdead-N	Nitrogen concentration in standing dead wood		
litter-N	Nitrogen concentration in litter layer		
orglayer-N	Nitrogen concentration in decomposed organic layer		
litter+orglayer-N	Nitrogen concentration in mulch layer (litter + decomposed)		
fineroots-N	Nitrogen concentration in fine roots		
largeroots-N	Nitrogen concentration in large roots		
Totroots-N	Nitrogen concentration in total roots (fine + large)		
Soilorgmatter-N	Nitrogen concentration in mineral soil (0-20 cm depth)		
Soilorgmatter-N	Nitrogen concentration in mineral soil (0-120 cm depth)		
trunks-P	Phosphorus concentration in stems	g/m^2	Table 1[1]
branches-P	Phosphorus concentration in branches		
leaves-P	Phosphorus concentration in leaves		
Stdead-P	Phosphorus concentration in standing dead wood		
litter-P	Phosphorus concentration in litter layer		
orglayer-P	Phosphorus concentration in decomposed organic layer		
	Phosphorus concentration in mulch layer (litter + decomposed)		

litter+orglayer-P			
fineroots-P	Phosphorus concentration in fine roots		
largeroots-P	Phosphorus concentration in large roots		
Totroots-P	Phosphorus concentration in total roots (fine + large)		
Soilorgmatter-P	Phosphorus concentration in mineral soil (0-20 cm depth)		
Soilorgmatter-P	Phosphorus concentration in mineral soil (0-120 cm depth)		
trunks-N	Proportion of nitrogen in stem compartment	percent	Table 3[1]
branches-N	Proportion of nitrogen in branch compartment		
leaves-N	Proportion of nitrogen in leaf compartment		
trunks-P	Proportion of phosphorus in stem compartment		
branches-P	Proportion of phosphorus in branch compartment		
leaves-P	Proportion of phosphorus in leaf compartment		
leaflittfall	Annual leaf litterfall	g/m^2/year	Table 1[2]
woodlittfall	Annual branch litterfall		
otherlittfall	Annual flower, fruit, and epiphyte litterfall		
Totlittfall	Annual total litterfall		
wood_mortality	Wood mortality rate	g/m^2/year	Table 4[2, 3]
root_turnover	Root production biomass (turnover rate)	g/m^2/year	Table 4[2, 3]
Totlittfall	Monthly total litterfall	g/m^2/mo	Table 1[2]
leaflittfall	Monthly leaf litterfall		
woodlittfall	Monthly branch litterfall		
otherlittfall	Monthly flower, fruit, and epiphyte litterfall		

Notes: [1]Grimm and Fassbender (1981). [2]Fassbender and Grimm (1981). [3]Lamprecht (1977).

Sample NPP Data Record

```
Site; Treatmt; Year; Month; Day; parameter; amount; units; Reference/ comments

ses; meanof13; 1974; -999.9; -999.9; trunks; 26970; g/m2; All data from
ses; meanof13; 1974; -999.9; -999.9; branches; 4330; g/m2; Grimm and Fassbender (1981) - paper I;
ses; meanof13; 1974; -999.9; -999.9; leaves; 460; g/m2; Fassbender and Grimm (1981) - paper II ...
```

Climate Data. The climate data are provided in two ASCII files (.txt format) (Table 1). The first 23 lines of <ses1_cli.txt> are metadata; data records begin on line 24. The first 18 lines of <ses2_cli.txt> are metadata; data records begin on line 19. The variable values are delimited by semi-colons. The value -999.9 is

used to denote missing values.

Sample Climate Data Record <ses1_cli.txt>

```
Site;Temp;Parm; Jan; Feb; Mar; Apr; May; Jun; Jul; Aug; Sep; Oct; Nov; Dec; Year

ses ;men6;prec; 55.0; 30.2; 54.3; 210.1; 189.9; 135.6; 148.0; 171.2; 170.7; 147.6; 104.1; 34.6; 1453.3
ses ;men7;prec; 50.7; 32.9; 60.5; 187.4; 191.0; 123.0; 155.7; 175.0; 208.6; 149.0; 122.9; 45.2; 1501.9
ses ;max7;prec; 95.7; 63.9; 80.4; 312.6; 252.1; 270.4; 236.1; 260.7; 321.2; 264.0; 228.9; 146.7; 1589.7
ses ;min7;prec; 0.0; 10.2; 11.0; 96.1; 137.3; 42.7; 88.0; 110.6; 107.9; 98.4; 43.7; 0.5; 1371.9
ses ;var7;prec; 36.0; 21.8; 16.4; 15.4; 11.1; 21.5; 12.4; 11.1; 14.4; 18.2; 18.1; 44.2; 2.1
ses ;err7;prec; 13.6; 8.2; 6.2; 5.8; 4.2; 8.1; 4.7; 4.2; 5.4; 6.9; 6.9; 16.7; 0.8
ses ;1973;prec; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; 106.0; 229.0; 77.9; -999.9
ses ;1973;tmx1; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; 14.8; 13.8; 12.7; -999.9
ses ;1973;tmx2; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; 18.7; 17.5; 16.9; -999.9
ses ;1973;tmn1; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; 9.5; 9.9; 7.9; -999.9
ses ;1973;tmn2; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; 9.3; 10.0; 8.0; -999.9 ...

Where,
Temp (temporal) - specific year or long-term statistic:
  mean = mean based on all years
   men6 = mean over 6 year period (dates not specified)
   men7 = mean over 7 year period (1963-1974; 1970-1974)
   max7 = maximum over 7 year period (1963-1974; 1970-1974)
   min7 = mean over 7 year period (1963-1974; 1970-1974)
   var7 = coefficient of variation (%) over 7 years (1963-1964, 1970-1974)
   err7 = error (%) over 7 years (1963-1964, 1970-1974)
Parm (parameter):
  prec = precipitation for month or year (mm)
  tmax = mean maximum temperature for month or year, measured in primary forest (C)
  tmax = mean maximum temperature for month or year, measured in clearing (C)
  tmin = mean minimum temperature for month or year, measured in primary forest (C)
  tmin = mean minimum temperature for month or year, measured in clearing (C)
```

Sample Climate Data Record <ses2_cli.txt>

```
Site;Temp;Parm; Jan; Feb; Mar; Apr; May; Jun; Jul; Aug; Sep; Oct; Nov; Dec; Year

mrd ;mean;prec; 48.0; 46.3; 62.8; 169.2; 247.2; 163.5; 120.9; 142.3; 195.4; 265.1; 203.9; 85.7; 1752.0
mrd ;mean;tavg; 17.8; 18.5; 19.0; 19.4; 19.6; 19.3; 19.2; 19.5; 19.5; 19.1; 18.7; 18.2; 18.9
mrd ;numb;prec; 73; 71; 71; 72; 71; 72; 74; 73; 74; 73; 72; 74; 70
mrd ;numb;tavg; 66; 65; 66; 66; 66; 67; 67; 67; 67; 66; 67; 67; 60
mrd ;stdv;prec; 37.7; 39.4; 45.6; 82.4; 84.0; 61.1; 43.6; 61.3; 67.9; 85.6; 89.3; 51.3; 276.6
mrd ;stdv;tavg; 1.0; 0.8; 0.9; 0.8; 0.7; 0.6; 0.6; 0.5; 0.5; 0.6; 0.6; 0.8; 0.5
mrd ;1921;prec; 155.0; 33.0; 197.0; 160.0; 377.0; 89.0; 116.0; 146.0; 122.0; 338.0; 147.0; 68.0; 1948.0
mrd ;1922;prec; 89.0; 100.0; 183.0; 98.0; 387.0; 219.0; 87.0; 166.0; 217.0; 251.0; 273.0; 224.0; 2294.0
mrd ;1923;prec; 33.0; 32.0; 58.0; 91.0; 84.0; 207.0; 78.0; 113.0; 120.0; 330.0; 91.0; 31.0; 1268.0 ...

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)
  tavg = average 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 total litterfall, woody turnover, and fine root turnover. These are considered the major components of NPP.

The biomass dynamics data for the San Eusebio site are provided for comparison with models and estimation of NPP. Climate data are provided for use in driving ecosystem/NPP models.

4. Quality Assessment:

Data for biomass, litter production, and nutrient content of litter at San Eusebio were compared to values for other tropical montane forests (Table 4, Grimm and Fassbender, 1981; Table 2, Fassbender and Grimm, 1981).

Sources of Error

Information not available.

5. Data Acquisition Materials and Methods:

The organic matter and stored elements (N, P, K, Ca, Mg, Fe, Mn, Al, and Na) were measured in 13 stands of a montane forest ecosystem in the Sierra de Merida, northwestern Venezuela,

The 13 study plots were 50 x 50 m in size. All living and dead trees > 10 cm in diameter were measured; smaller trees were mapped in a radius 15 m from center of the plot. Subplots were 2 x 2 m with 12 replications distributed radially from the center of the plot. Fine roots (< 5 cm diameter) were sampled to 20 cm depth.

Eighty-six trees representing the 33 most important species were felled. Volume was calculated based on height and diameter. Dry weight was calculated. Branches, leaves and epiphytes were weighed separately and two aliquots were collected in bags for plastic in a drying oven at 105 C for 24 hours. Large roots (> 5 cm diameter) of 30 trees were sampled, dried, and weighed. Samples were prepared for chemical analysis. The results are presented as the mean of the 13 plots.

In each of the 13 plots, soil organic matter was sampled in 0.25 m^2 subplots to depths of 0-20, 20-40, 40-60, 60-90, and 90-120 cm. Soil samples were dried and analyzed as for vegetation above.

Litter production (tree stands, each 12 collectors; sampling every two weeks) and litter decomposition (samples of leaves and branches exposed to environment, collection every two months) were also studied. Three of the 13 plots were selected for studying litter production and decomposition. Litter collectors, 1 m^2 in size, were emptied bi-weekly. Samples were separated into leaves, branches, fruits, flowers and epiphytes (bromeliads and orchids) compartments and dried at 105 C for 24 hours. Monthly average dry weight was determined. The results are presented as the mean of the 3 plots.

Litter decomposition was studied using a 40 x 40 wooden frame with 1 cm mesh containing leaf and branch samples. Samples were examined bi-monthly for 7 sampling dates to determine decomposition rate. Samples were dried and analyzed as for vegetation above. Decomposition data are reported in the literature (Fassbender and Grimm, 1981).

Figure 4. One of the research plots clear-cut for biomass determination at the San Eusebio tropical forest study site, Venezuela. (A profile of the natural forest may be seen in the background. Photograph taken 1973-74 by Dr. H. W. Fassbender, Fachhochschule Hildesheim/Holzminden, Goettingen, Germany). (SES2-1.jpg)

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:

Grimm, U., and H. W. Fassbender. 1981. Ciclos bioquimicos en un ecosistema forestal de los Andes Occidentales de Venezuela. I. Inventario de las reservas organicas y minerales (N, P, K, Ca, Mg, Fe, Al, Na). Turrialba 31: 27-37.

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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.

Additional Sources of Information:

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