Documentation for
Gridded Population of the World, Version 4 (GPWv4)

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Center for International Earth Science Information Network (CIESIN)
Columbia University

Abstract

This document outlines the basic methodology used to construct the Gridded Population of the World, Version 4 (GPWv4) data collection and describes the data sets included in the collection. The Introduction briefly describes the input data, the purpose of the collection, the main characteristics of version 4, and lists the data sets in the collection. Details of the methodology and distributed data sets are covered in the Methodology and Data Set Description sections. Raster data are available as GeoTiffs, while vector data are available in shapefile, CSV, ESRI file geodatabase, and OGC GeoPackage (SQLite) formats. The sources of the input data used to produce the data sets in the collection are outlined in the Data Sources section, and the Map Gallery section points to the website where maps of the data sets can be found. Additional sections of this documentation describe limitations and use constraints.

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We appreciate feedback regarding this data set, such as suggestions, discovery of errors, difficulties in using the data, and format preferences.

Please address comments to SEDAC User Services
https://sedac.uservoice.com/knowledgebase/topics/110829-gpwv4

NASA Socioeconomic Data and Applications Center (SEDAC)
Center for International Earth Science Information Network (CIESIN)
Columbia University

Contents

I. Introduction

The Gridded Population of the World (GPW) models the distribution of the human population on a continuous raster surface. Since the release of the first version of this global population grid in 1995, the essential inputs to GPW have been population census tables and administrative boundaries. The purpose of GPW is to provide a spatially-disaggregated population layer that is compatible with data sets from social, economic, and Earth science disciplines, and remote sensing data. It provides globally consistent and spatially explicit data for use in research, policy-making, and communications

The fourth version of GPW (GPWv4) is a gridded data product of globally-integrated national population data from the 2010 round of Population and Housing Censuses. The gridded data sets are constructed from national or subnational input administrative units. GPWv4 is gridded with an output resolution of 30 arc-seconds, or ~1 km at the equator. Separate grids are available for population counts and population density, UN-adjusted population counts and population density, data quality indicators, and land and water areas. Additionally, a vector data set of the center point locations (centroids) for each of the input administrative units and a grid of national level numeric identifiers are included in the collection in order to share information about the input data layers.

Eight data sets within the GPWv4 collection can be downloaded from the GPWv4 web page (http://sedac.ciesin.columbia.edu/data/collection/gpw-v4/sets/browse):

1. Population Count, v4 (2000, 2005, 2010, 2015, 2020)
2. Population Density, v4 (2000, 2005, 2010, 2015, 2020)
3. UN-Adjusted Population Count, v4 (2000, 2005, 2010, 2015, 2020)
4. UN-Adjusted Population Density, v4 (2000, 2005, 2010, 2015, 2020)
5. Data Quality Indicators, v4 (2010)
6. Land and Water Area, v4 (2010)
7. Administrative Unit Center Points with Population Estimates, v4 (2000, 2005, 2010, 2015, 2020)
8. National Identifier Grid, v4 (2010)

In order to broaden the applicability of GPWv4, the data collection will be expanded in future releases to include global population grids of Basic Demographic Characteristics (age and sex) estimated for 2010 and urban/rural designations as defined by national statistics offices.

To be notified of the latest data releases, including GPWv4, and of related news that may interest you, please consider following SEDAC on

Twitter (http://www.twitter.com/ciesin) or
Facebook (https://www.facebook.com/socioeconomicdataandappsctr).

Detailed information for each data set can be found in Section III.

II. Data and Methodology

A detailed description of the methods for GPWv4 can be found at Doxsey-Whitfield *et al*. (2015). GPWv4 is a minimally-modeled gridded population data collection that incorporates census population data from the 2010 round of censuses. Population estimates are derived by extrapolating the raw census estimates to a series of target years and are provided for the years 2000, 2005, 2010, 2015, and 2020. Additionally, a set of estimates that have been nationally adjusted to data from the United Nations World Population Prospects 2015 Revision (UN, 2015) is included in the GPWv4 collection for each of the target years. The development of GPWv4 builds upon previous versions of the data collection (Tobler *et al*., 1997; Deichmann *et al*., 2001; Balk *et al*., 2006) and follows seven basic steps:

1. *Locate tabular population counts*

The two basic inputs of GPW are non-spatial population data (i.e., tabular counts of population listed by administrative area) and spatially-explicit administrative boundary data. Population input data were collected at the highest resolution available from the results of the 2010 round of censuses, scheduled to occur between 2005 and 2014. These were collected from hundreds of national statistics offices and other organizations. Where census results were unavailable or not yet released, official population estimates from national statistics offices were used. Appendix I lists the currency and type of data (census, population register, official estimates, etc.) used for each country. In some cases multiple levels of administrative data were used for a given country. For example, data for Paris, France were available at a higher resolution than for the rest of the country. Matching boundary data were also available, so the higher level administrative data for the city were merged with the lower level data. Appendix II lists the countries for which multiple administrative levels of census data were used.

2. *Match population counts to geographic boundaries (census or administrative)*

Administrative boundary data were collected from a variety of national agencies (e.g. statistics offices, mapping agencies, planning agencies), as well as other organizations. Ideally, the boundaries are from the census. The population census counts or official estimates were then matched to digital geographic boundaries. Matching was based on the common identifying codes or the unit names used in the census. The source of population and boundary data used for each country can be downloaded in Microsoft Excel format by following the link to "Country-level Information and Sources" on the GPWv4 "Methods" web page: http://sedac.ciesin.columbia.edu/data/collection/gpw-v4/methods/method1.

3. *If needed, adjust boundaries to global framework*

A global framework of international boundaries was used to ensure consistent alignment between countries. The Global Administrative Areas version 2 (GADMv2; www.gadm.org) data set was selected as the framework as it is publicly available and

frequently used in the research community. The international boundaries of census geography data sets were adjusted to the GADMv2 framework, although in cases where the resolution of the census geography far exceeded the GADMv2 boundaries, the former were kept (*e.g.*, New Zealand, the United Kingdom, and the United States). Appendix III lists countries where the boundaries were not adjusted to GADMv2.

4. *Estimate population for target years*

Since countries conduct their censuses at different times, annualized growth rates were used to adjust census counts to the target year of 2010 to allow for global comparison. Growth rates were calculated for each administrative unit by matching the total population from the input data to those from a previous census enumeration or estimate. Annualized rates of change were calculated as follows:

$$r = \frac{\ln\left(\frac{P_2}{P_1}\right)}{t}$$

Population estimates were adjusted to target years as follows:

$$P_x = P_2 e^{rt}$$

where r is the annualized growth rate, P_1 and P_2 are the census population counts, P_x is the population estimate in the target year, and t is the number of years between population counts.

In cases where matching at the highest resolution was not possible between the two points in time, censuses were matched and growth rates were calculated at a coarser resolution (*e.g.*, state), and applied to each unit (*e.g.*, municipality) within that state. This occurred for a number of reasons: substantial reorganization of administrative units took place between the two enumeration periods making matching problematic; previous census data were not released to the same resolution as the current census data; or only coarser geographies were comparable, because high-resolution enumeration areas were newly created for each census. In some cases we adopted a hybrid approach, matching the highest resolution where possible and coarsening where needed. Appendix IV lists the countries for which a hybrid approach was used. The 2010 population estimates were then extrapolated to 2000, 2005, 2015, and 2020 using the calculated annualized growth rates.

5. *Adjust population to UN estimates*

National-level estimates for 2000, 2005, 2010, 2015, and 2020 were further adjusted to the estimates of the United Nation's *World Population Prospects (WPP): The 2015 Revision*, which often correct for over- or under-reporting in the nationally-reported figures (United Nations, 2015). For the years 2015 and 2020, the medium-variant UN projections were used.

Adjustment factors for matching national estimates to UN estimates were calculated as follows:

$$a = \frac{P_{UN} - P_x}{P_{UN}}$$

Adjustment factors were applied at the national level as follows:

$$P_{adj} = P_x * a$$

where a is the adjustment factor, P_x is the population estimate in the target year, P_{UN} is the UN national estimate, and P_{adj} is the adjusted estimate.

6. Transform to grids

To create the gridded population data set, the population estimates were distributed to a 30 arc-second (~1 km) grid using an areal-weighting method. This method, also known as uniform distribution or proportional allocation, does not make use of any other geographic data in order to spatially disaggregate the census population. Population was allocated into grid cells though the simple assumption that the population of a grid cell is the exclusive function of the land area within that pixel. For grid cells that intersect sub-national or national boundaries, population was allocated based on the proportion of the area of each unit located in the grid cell. A water mask was applied to the data to prevent lakes, rivers, and ice-covered areas from distorting the actual population density.

There are a number of more highly-modeled methods, including dasymetric modeling and smart interpolation (Hay *et al.*, 2005), that incorporate additional geographic data. These data are used to produce weight matrices for determining how to apportion population by pixel. Several global data products use ancillary data in their spatial modeling, incorporating remotely sensed data on land cover, urban extent, accessibility, or all of the above in order to delineate population surfaces (Bhaduri *et al.*, 2002; Balk *et al.*, 2006; Tatem *et al.*, 2007). GPWv4, however, uses the areal-weighting approach.

The main benefit of disaggregating demographic variables by areal-weighting is the maintenance of the fidelity of the input data. Census information modeled with this approach may be freely and easily incorporated into global analyses that make use of ancillary data sets that might be endogenous to more highly-modeled surfaces. The modeled census information are also suitable for use in dasymetric and other modeling approaches—the population counts or densities can be reallocated based on other layers. The main drawback of using areal-weighting as the disaggregation method is the variability of the precision of pixel-level estimates. The precision and accuracy of a given pixel is a direct function of the size of the input areal unit. In countries where the input units are quite large, the precision of individual pixels within that unit is degraded. There are clear implications of this for the data user. In order to produce the most accurate results, the data user must be aware of the size of the input areal units and select a study area that is larger than any given single unit. The size of the input units that contribute to individual pixels is available in the data quality indicators data set. The

second implication is that higher resolution input areal units increase the accuracy of pixel-level estimates in the areal-weighted data product (Tatem *et al.*, 2007).

Population grids for each of the target years, unadjusted and adjusted to the UN estimates, are available at the global level.

III. Data Set Descriptions

Data sets can be browsed at http://sedac.ciesin.columbia.edu/data/collection/gpw-v4/sets/browse.

1. Population Count, v4 (2000, 2005, 2010, 2015, 2020)

Data set description:
The population count grids consist of estimates of the number of persons per 30 arc-second (~1 km) grid cell for each of the five target years: 2000, 2005, 2010, 2015, and 2020, consistent with national censuses and population registers.

Data set web page:
http://sedac.ciesin.columbia.edu/data/set/gpw-v4-population-count

Data set format:
The files for this data set are available as global grids in GeoTiff format. Each downloadable is a compressed zip file, which contains: 1) the global GeoTiff for the year of estimate, 2) PDF documentation, 3) a Microsoft Excel file (.xlsx) with country-level information and sources, and 4) a text file (.txt) with a log of changes to the dataset by version.

Data set downloads:
gpw-v4-population-count-2000.zip
gpw-v4-population-count-2005.zip
gpw-v4-population-count-2010.zip
gpw-v4-population-count-2015.zip
gpw-v4-population-count-2020.zip

2. Population Density, v4 (2000, 2005, 2010, 2015, 2020)

Data set description:
The population density grids are derived by dividing the population count grid for a given target year by the land area grid. The grids represent persons per square kilometer for each of the five target years: 2000, 2005, 2010, 2015, and 2020.

Data set web page:
http://sedac.ciesin.columbia.edu/data/set/gpw-v4-population-density

Data set format:
The files for this data set are available as global grids in GeoTiff format. Each downloadable is a compressed zip file, which contains: 1) the global GeoTiff for the year of estimate, 2) PDF documentation, 3) a Microsoft Excel file (.xlsx) with country-level information and sources, and 4) a text file (.txt) with a log of changes to the dataset by version.

Data set downloads:
gpw-v4-population-density-2000.zip
gpw-v4-population-density-2005.zip
gpw-v4-population-density-2010.zip
gpw-v4-population-density-2015.zip
gpw-v4-population-density-2020.zip

3. UN-Adjusted Population Count, v4 (2000, 2005, 2010, 2015, 2020)

Data set description:
The UN-adjusted population count grids consist of estimates of the number of persons per 30 arc-second (~1 km) grid cell, adjusted to match the 2015 revision of the UN World Population Prospects national population estimates, for each of the five target years: 2000, 2005, 2010, 2015, and 2020.

Data set web page:
http://sedac.ciesin.columbia.edu/data/set/gpw-v4-population-count-adjusted-to-2015-unwpp-country-totals

Data set format:
The files for this data set are available as global grids in GeoTiff format. Each downloadable is a compressed zip file, which contains: 1) the global GeoTiff for the year of estimate, 2) PDF documentation, 3) a Microsoft Excel file (.xlsx) with country-level information and sources, and 4) a text file (.txt) with a log of changes to the dataset by version.
Data set downloads:
gpw-v4-population-count-adjusted-to-2015-unwpp-country-totals-2000.zip
gpw-v4-population-count-adjusted-to-2015-unwpp-country-totals-2005.zip
gpw-v4-population-count-adjusted-to-2015-unwpp-country-totals-2010.zip
gpw-v4-population-count-adjusted-to-2015-unwpp-country-totals-2015.zip
gpw-v4-population-count-adjusted-to-2015-unwpp-country-totals-2020.zip

4. UN-Adjusted Population Density, v4 (2000, 2005, 2010, 2015, 2020)

Data set description:
The UN-adjusted population density grids were derived by dividing the UN-adjusted population count grid for a given target year by the land area grid. The grids represent persons per square kilometer for each of the five target years: 2000, 2005, 2010, 2015, and 2020.

Data set web page:
http://sedac.ciesin.columbia.edu/data/set/gpw-v4-population-density-adjusted-to-2015-unwpp-country-totals

Data set format:
The files for this data set are available as global grids in GeoTiff format. Each downloadable is a compressed zip file, which contains: 1) the global GeoTiff for the year of estimate, 2) PDF documentation, 3) a Microsoft Excel file (.xlsx) with country-level information and sources, and 4) a text file (.txt) with a log of changes to the dataset by version.

Data set downloads:
gpw-v4-population-density-adjusted-to-2015-unwpp-country-totals-2000.zip
gpw-v4-population-density-adjusted-to-2015-unwpp-country-totals-2005.zip
gpw-v4-population-density-adjusted-to-2015-unwpp-country-totals-2010.zip
gpw-v4-population-density-adjusted-to-2015-unwpp-country-totals-2015.zip
gpw-v4-population-density-adjusted-to-2015-unwpp-country-totals-2020.zip

5. Data Quality Indicators, v4 (2010)

Data set description:
The Data Quality Indicators data set consists of data layers created 1) to provide additional information about the quality of input population data and 2) to provide context for the population count and density grids.

Census quality grids characterize national-level indicators provided by the census, which describe the statistical data quality.

The three layers created to provide additional information regarding the pixels labelled as 'NoData' or '0' in the population count and density grids are: a water mask and a data context grid. The water mask distinguishes between pixels that are completely water and/or ice (Total Water Pixels) and pixels that also contain land (Partial Water Pixels). Inland pixels with values of 'NoData' in the population count and density grids belong to Total Water Pixels. The data context grid categorizes pixels with a "0" population estimate in the population count and density grids, based on information included in the census documents. Pixels are categorized into 6 categories:

Data Context Value	Data Context Category
201	Park or protected area
202	Military district, airport zone, or other infrastructure
203	Not enumerated or not reported in census
204	No households
205	Uninhabited
206	Population not gridded

Pixels categorized as 'Population not gridded' belong to administrative units where the data could not be gridded due to a lack of information or data integration issues. The units are currently being researched; these will be updated in future releases.

The Mean Administrative Unit Area grid measures the mean unit size in square kilometers. The mean unit size grid provides a quantitative surface that indicates the size of the input unit(s) from which population count and density grids are derived.

Data set web page:
http://sedac.ciesin.columbia.edu/data/set/gpw-v4-data-quality-indicators

Data set format:
The files for this data set are available as global grids in GeoTiff format. Each downloadable is a compressed zip file, which contains: 1) the global GeoTiff for the year of estimate, 2) PDF documentation, 3) a Microsoft Excel file (.xlsx) with country-level information and sources, and 4) a text file (.txt) with a log of changes to the dataset by version.
Data set downloads:
gpw-v4-data-quality-indicators-data-context.zip
gpw-v4-data-quality-indicators-water-mask.zip
gpw-v4-data-quality-indicators-mean-administrative-unit-area.zip

6. Land and Water Area, v4 (2010)

Data set description:
The total area of a surface represented by a given pixel in a uniform grid varies with latitude. In order to capture this spatial variation, surface areas were calculated using a locally-specified Mollweide Projection (EPSG:54009) on the input administrative vector units.

The land and water area grids represent different portions of the calculated surface area. The land area grid represents the land area (without permanent ice or water) of a pixel in square kilometers and was used to calculate the population density grids. The water area grid measures the water area (including permanent ice and water) of a pixel in square kilometers. The land area plus the water area of a pixel equal the total surface area of that pixel.

Data set web page:
http://sedac.ciesin.columbia.edu/data/set/gpw-v4-land-water-area

Data set format:
The files for this data set are available as global grids in GeoTiff format. Each downloadable is a compressed zip file, which contains: 1) the global GeoTiff for the year of estimate, 2) PDF documentation, 3) a Microsoft Excel file (.xlsx) with country-level information and sources, and 4) a text file (.txt) with a log of changes to the dataset by version.

Data set downloads:
gpw-v4-land-water-area-land.zip
gpw-v4-land-water-area-water.zip

7. Administrative Unit Center Points with Population Estimates, v4 (2000, 2005, 2010, 2015, 2020)

Data set description:
This data set provides a vector (point) version of the ~12.5 million input administrative units used in GPWv4. It consists of estimates of UN-adjusted population estimates and densities for the years 2000, 2005, 2010, 2015, and 2020 by administrative unit center point (centroid). Specifically, the population data were adjusted to the 2015 Revision of the UN World Population Prospects. Additionally, the administrative unit names, the unit area, and the data context of the unit are included. The data are stored in geographic coordinates of decimal degrees based on the World Geodetic System spheroid of 1984 (WGS84).

The field names and descriptions of the data set are described here:

Field Name	Field Name Description
ADMINID	unique (numeric) id[a]
ISOALPHA	3-letter country/state code
COUNTRYNM	English country/state name
NAME1	first administrative level name[b]
NAME2	second administrative level name[b]
NAME3	third administrative level name[b]
NAME4	fourth administrative level name[b]
NAME5	fifth administrative level name[b]
NAME6	sixth administrative level name[b]
CENTROID_X	longitude of the administrative unit center point in decimal degrees
CENTROID_Y	latitude of the administrative unit center point in decimal degrees
INSIDE_X	longitude of the administrative unit inside center point in decimal degrees[c]
INSIDE_Y	latitude of the administrative unit inside center point in decimal degrees[c]
TOTAL_A_KM	total area of the administrative unit in square km
WATER_A_KM	water area of the administrative unit in square km
LAND_A_KM	land area of the administrative unit in square km; this area field is used to calculate population density
UN_2000_E	UN-adjusted population estimates 2000
UN_2005_E	UN-adjusted population estimates, 2005
UN_2010_E	UN-adjusted population estimates, 2010
UN_2015_E	UN-adjusted population estimates, 2015
UN_2020_E	UN-adjusted population estimates, 2020

UN_2000_DS	UN-adjusted population density, 2000
UN_2005_DS	UN-adjusted population density, 2005
UN_2010_DS	UN-adjusted population density, 2010
UN_2015_DS	UN-adjusted population density, 2015
UN_2020_DS	UN-adjusted population density, 2020
CONTEXT	data context value [d]
CONTEXT_NM	data context category [d]
WATER_CODE	unit type code (L=Land unit, IW=Inland Water unit)

[a] For USA:

ADMINID = 2 & 2-digit state code & state-specific unique ID
2-digit state code from: www.census.gov/geo/reference/ansi_statetables.html

For countries other than USA:

ADMINID = 1 & 3-digit ISO code & country-specific unique ID
3-digit ISO from: http://unstats.un.org/unsd/methods/m49/m49alpha.htm

[b] Many countries are only available at coarser (first or second) administrative levels. A value of N.A. in the data indicates that a name is not available for that level.

[c] There are two types of centroids. True centroids use the representative center of an input feature; however, this feature may fall outside of its input feature (e.g., the true centroid of a units with two islands will lie at a point in between the islands). The inside centroid is a centroid that has been forced to be inside the polygon boundary. In this data set, the shapefile uses the true centroids as the point locations. However, the coordinates of both the true centroids (CENTROID_X and CENTROID_Y) and the inside centroids (INSIDE_X and INSIDE_Y) have been included as attributes.

[d] These fields refer to the data context layer in the Data Quality Indicators, v4 (2010) data set. For the full list of values for these fields, please see the details for this data set.

Data set web page:
http://sedac.ciesin.columbia.edu/data/set/gpw-v4-admin-unit-center-points-population-estimates

Data set format:
The files for this data set are available to download at the global and national levels. Global versions of the data set are available in ESRI file geodatabase, OCG GeoPackage (SQLite), and CSV formats. Please note that due to the large number of input units used in GPWv4 (~12.5 million), these files require computers and software that can read large amounts of data into memory to work with this global data. As an alternative, the data is also provided at the national level using shapefiles and CSV files. In this download format, data are split by country (and by state for the United States). Each downloadable is a compressed zip file, which contains 1) either the ESRI file geodatabase, the OGC

GeoPackage (SQLite) file, the shapefiles or the CSVs, 2) PDF documentation, 3) a Microsoft Excel file (.xlsx) with country-level information and sources, and 4) a text file (.txt) with a log of changes to the dataset by version.

Data set downloads:
gpw-v4-admin-unit-center-points-population-estimates-gdb-global.zip
gpw-v4-admin-unit-center-points-population-estimates-sqlite-global.zip
gpw-v4-admin-unit-center-points-population-estimates-csv-global.zip
gpw-v4-admin-unit-center-points-population-estimates-shp-national.zip
gpw-v4-admin-unit-center-points-population-estimates-csv-national.zip

8. National Identifier Grid, v4 (2010)

Data set description:
The National Identifier Grid is a raster representation of nation-states in GPWv4 for use in aggregating population data. It is derived from the input census units to create a raster surface where pixels (cells) that cover the same census data source - most often a country or territory - have the same value. Note that these data are not official representations of country boundaries; rather, they represent the area covered by the statistical data as provided. In cases where multiple countries overlapped a given pixel (e.g. on national borders), the pixels were assigned the country code of the input dataset which made up the majority of their land area.

Data set web page:
http://.sedac.ciesin.columbia.edu/data/set/gpw-v4-national-identifier-grid

Data set format:
The file for this data set is available as a global grid in GeoTiff format. The downloadable is a compressed zip file, which contains 1) the global GeoTiff for the data layer, 2) PDF documentation, 3) a Microsoft Excel file (.xlsx) with country-level information and sources, and 4) a text file (.txt) with a log of changes to the dataset by version.

Data set downloads:
gpw-v4-national-identifier-grid.zip

IV. Data Sources

Census and boundary data

The source of population and boundary data used for each country can be downloaded in Microsoft Excel format by following the link to “Country-level Information and Sources” on the GPWv4 “Methods” web page:
http://sedac.ciesin.columbia.edu/data/collection/gpw-v4/methods/method1.

Global framework boundaries

A global framework of international boundaries was used to ensure consistent alignment between countries. The Global Administrative Areas version 2 (GADMv2; www.gadm.org) data set was selected as the global framework. Countries not adjusted to this framework are listed in Appendix II.

UN population estimates

National-level population estimates for 2000, 2005, 2010, 2015, and 2020 were adjusted to the estimates of the United Nation's *World Population Prospects: The 2015 Revision* (United Nations, 2015). The medium-variant projections were used for these calculations.

Water mask

The water mask was used to exclude areas of water and permanent ice from the population density calculations. It was derived from four sources:

1. Shuttle Radar Topography Mission (SRTM) Water Body Data Files (United States Geological Survey, 2003)
2. Digital Chart of the World drainage network (ESRI, 2006)
3. Global Lakes and Wetlands Database, Levels 1 (large lakes and reservoirs) and 2 (rivers, small lakes, and reservoirs (Lehner and Döll, 2004)
4. Water features included in the boundary data for a given country

V. Map Gallery

Global maps of all the data sets can be found at http://sedac.ciesin.columbia.edu/data/collection/gpw-v4/maps/gallery/search.

VI. Acknowledgments

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VII. Disclaimer

CIESIN follows procedures designed to ensure that data disseminated by CIESIN are of reasonable quality. If, despite these procedures, users encounter apparent errors or misstatements in the data, they should contact SEDAC User Services at https://sedac.uservoice.com/knowledgebase/topics/110829-gpwv4. Neither CIESIN nor NASA verifies or guarantees the accuracy, reliability, or completeness of any data provided. CIESIN provides this data without warranty of any kind whatsoever, either

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VIII. Use Constraints

IX. Recommended Citations

Scientific Publication:

Doxsey-Whitfield, E., K. MacManus, S.B. Adamo, L. Pistolesi, J. Squires, O. Borkovska and S.R. Baptista. 2015. Taking Advantage of the Improved Availability of Census Data: A First Look at the Gridded Population of the World, Version 4. Papers in Applied Geography 1(3): 1-9. http://dx.doi.org/10.1080/23754931.2015.1014272.

Data Sets:

Gridded Population of the World, Version 4 (GPWv4): Administrative Unit Center Points with Population Estimates

Center for International Earth Science Information Network - CIESIN - Columbia University. 2016. Gridded Population of the World, Version 4 (GPWv4): Administrative Unit Center Points with Population Estimates. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H4F47M2C. Accessed DAY MONTH YEAR.

Gridded Population of the World, Version 4 (GPWv4): Data Quality Indicators

Center for International Earth Science Information Network - CIESIN - Columbia University. 2016. Gridded Population of the World, Version 4 (GPWv4): Data Quality Indicators. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H49C6VBN. Accessed DAY MONTH YEAR.

Gridded Population of the World, Version 4 (GPWv4): Land and Water Area

Center for International Earth Science Information Network - CIESIN - Columbia University. 2016. Gridded Population of the World, Version 4 (GPWv4): Land and Water Area. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H45M63M9. Accessed DAY MONTH YEAR.

Gridded Population of the World, Version 4 (GPWv4): National Identifier Grid

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XI. Documentation Copyright and License

XII. Appendices

Appendix I: Currency and Type of Population Data used in GPWv4

Country or Territory Name	Population Year	Type of Population Data
Afghanistan	2011	Population Estimate/Projection
Åland Islands	2010	Population Register
Albania	2011	Final Census
Algeria	2008	Final Census
American Samoa	2010	Final Census
Andorra	2010	Population Register
Angola	2014	Preliminary/Provisional Census
Anguilla	2011	Preliminary/Provisional Census
Antigua and Barbuda	2011	Final Census
Argentina	2010	Final Census
Armenia	2011	Final Census
Aruba	2010	Final Census
Australia	2011	Final Census
Austria	2012	Population Register
Azerbaijan	2009	Final Census
Bahamas	2010	Final Census
Bahrain	2010	Final Census
Bangladesh	2011	Final Census
Barbados	2010	Final Census
Belarus	2009	Final Census
Belgium	2014	Population Register
Belize	2010	Final Census
Benin	2013	Preliminary/Provisional Census
Bermuda	2010	Final Census
Bhutan	2005	Final Census
Bolivia (Plurinational State of)	2012	Final Census
Bonaire Saint Eustatius and Saba	2010	Population Register
Bosnia and Herzegovina	2013	Preliminary/Provisional Census
Botswana	2011	Final Census
Brazil	2010	Final Census
British Virgin Islands	2001	Final Census
Brunei Darussalam	2011	Preliminary/Provisional Census
Bulgaria	2011	Final Census
Burkina Faso	2006	Final Census
Burundi	2008	Final Census
Cambodia	2008	Final Census
Cameroon	2005	Final Census
Canada	2011	Final Census
Cape Verde	2010	Final Census
Cayman Islands	2010	Final Census
Central African Republic	2012	Population Estimate/Projection
Chad	2009	Final Census
Chile	2010	Population Estimate/Projection
China	2010	Final Census
China Hong Kong Special Administrative Region	2011	Final Census
China Macao Special Administrative Region	2011	Final Census

Colombia	2005	Final Census
Comoros	2013	Population Estimate/Projection
Congo	2007	Final Census
Cook Islands	2011	Final Census
Costa Rica	2011	Final Census
Côte d'Ivoire	2014	Preliminary/Provisional Census
Croatia	2011	Final Census
Cuba	2012	Final Census
Curaçao	2011	Final Census
Cyprus	2011	Final Census
Czech Republic	2011	Final Census
Democratic People's Republic of Korea	2008	Final Census
Democratic Republic of the Congo	2008	Population Estimate/Projection
Denmark	2010	Population Register
Djibouti	2009	Final Census
Dominica	2011	Preliminary/Provisional Census
Dominican Republic	2010	Final Census
Ecuador	2010	Final Census
Egypt	2006	Final Census
El Salvador	2007	Final Census
Equatorial Guinea	2001	Final Census
Eritrea	2012	Population Estimate/Projection
Estonia	2011	Final Census
Ethiopia	2007	Final Census
Faeroe Islands	2010	Population Register
Falkland Islands (Malvinas)	2012	Final Census
Fiji	2007	Final Census
Finland	2011	Population Register
France	2009	Final Census
French Guiana	2009	Population Register
French Polynesia	2007	Final Census
Gabon	2003	Final Census
Gambia	2013	Preliminary/Provisional Census
Georgia	2011	Population Register
Germany	2011	Population Register
Ghana	2010	Final Census
Gibraltar	2012	Final Census
Greece	2011	Final Census
Greenland	2010	Population Register
Grenada	2011	Preliminary/Provisional Census
Guadeloupe	2009	Population Register
Guam	2010	Final Census
Guatemala	2010	Population Estimate/Projection
Guernsey	2010, 2013	Population Estimate/Projection
Guinea	2014	Preliminary/Provisional Census
Guinea-Bissau	2009	Final Census
Guyana	2002	Final Census
Haiti	2003	Final Census
Holy See	2013	Population Estimate/Projection
Honduras	2010	Population Estimate/Projection
Hungary	2011	Final Census
Iceland	2010	Population Register
India	2011	Final Census

Indonesia	2010	Final Census
Iran (Islamic Republic of)	2011	Final Census
Iraq	2003, 2011	Population Estimate/Projection
Ireland	2011	Final Census
Isle of Man	2011	Final Census
Israel	2008	Population Register
Italy	2011	Final Census
Jamaica	2011	Preliminary/Provisional Census
Japan	2010	Final Census
Jersey	2011	Final Census
Jordan	2004	Final Census
Kazakhstan	2009	Final Census
Kenya	2009	Final Census
Kiribati	2010	Final Census
Kosovo	2011	Final Census
Kuwait	2005	Final Census
Kyrgyzstan	2009	Final Census
Lao People's Democratic Republic	2005	Final Census
Latvia	2011	Final Census
Lebanon	2002	Population Estimate/Projection
Lesotho	2006	Final Census
Liberia	2008	Final Census
Libya	2006	Final Census
Liechtenstein	2010	Final Census
Lithuania	2011	Final Census
Luxembourg	2011	Final Census
Madagascar	2010	Population Estimate/Projection
Malawi	2008	Final Census
Malaysia	2010	Final Census
Maldives	2006	Final Census
Mali	2009	Final Census
Malta	2011	Final Census
Marshall Islands	2011	Final Census
Martinique	2009	Population Register
Mauritania	2013	Final Census
Mauritius	2011	Final Census
Mayotte	2012	Final Census
Mexico	2010	Final Census
Micronesia (Federated States of)	2010	Final Census
Monaco	2008	Population Estimate/Projection
Mongolia	2010	Final Census
Montenegro	2011	Final Census
Montserrat	2011	Final Census
Morocco	2004	Final Census
Mozambique	2007	Final Census
Myanmar	2014	Preliminary/Provisional Census
Namibia	2011	Final Census
Nauru	2011	Final Census
Nepal	2011	Final Census
Netherlands	2011	Population Register
New Caledonia	2009	Final Census
New Zealand	2013	Final Census
Nicaragua	2005	Final Census

Niger	2012	Final Census
Nigeria	2006	Final Census
Niue	2011	Final Census
Norfolk Island	2011	Final Census
Northern Mariana Islands	2010	Final Census
Norway	2011	Population Register
Oman	2010	Final Census
Pakistan	1998	Final Census
Palau	2005	Final Census
Panama	2010	Final Census
Papua New Guinea	2011	Final Census
Paraguay	2010	Population Estimate/Projection
Peru	2007	Final Census
Philippines	2010	Final Census
Pitcairn	2008	Final Census
Poland	2011	Final Census
Portugal	2011	Final Census
Puerto Rico	2010	Final Census
Qatar	2010	Final Census
Republic of Korea	2010	Final Census
Republic of Moldova	2004	Final Census
Réunion	2009	Population Register
Romania	2011	Final Census
Russian Federation	2010	Final Census
Rwanda	2012	Final Census
Saint Helena	2008, 2014	Final Census and Population Register
Saint Kitts and Nevis	2001	Final Census
Saint Lucia	2010	Preliminary/Provisional Census
Saint Pierre and Miquelon	2009	Final Census
Saint Vincent and the Grenadines	2012	Preliminary/Provisional Census
Saint-Barthelemy	2009	Population Register
Saint-Martin (French part)	2009	Population Register
San Marino	2010	Preliminary/Provisional Census
Sao Tome and Principe	2012	Final Census
Saudi Arabia	2010	Preliminary/Provisional Census
Senegal	2013	Preliminary/Provisional Census
Serbia	2011	Final Census
Seychelles	2010	Final Census
Sierra Leone	2004	Final Census
Singapore	2010	Final Census
Sint Maarten (Dutch part)	2011	Final Census
Slovakia	2011	Final Census
Slovenia	2010	Final Census
Solomon Islands	2009	Final Census
Somalia	2005	Population Estimate/Projection
South Africa	2011	Final Census
South Sudan	2008	Final Census
Spain	2011	Final Census
Sri Lanka	2012	Preliminary/Provisional Census
State of Palestine	2007	Preliminary/Provisional Census
Sudan	2008	Final Census
Suriname	2012	Final Census
Svalbard and Jan Mayen Islands	2010	Population Register

Swaziland	2007	Final Census
Sweden	2010	Population Register
Switzerland	2010	Final Census
Syrian Arab Republic	2004	Final Census
Taiwan	2010	Final Census
Tajikistan	2010	Final Census
Thailand	2010	Preliminary/Provisional Census
The former Yugoslav Republic of Macedonia	2010	Population Estimate/Projection
Timor-Leste	2010	Final Census
Togo	2010	Final Census
Tokelau	2011	Final Census
Tonga	2011	Final Census
Trinidad and Tobago	2011	Final Census
Tunisia	2014	Final Census
Turkey	2010	Population Register
Turkmenistan	2005	Population Estimate/Projection
Turks and Caicos Islands	2012	Final Census
Tuvalu	2012	Final Census
Uganda	2010	Population Estimate/Projection
Ukraine	2013	Population Estimate/Projection
United Arab Emirates	2005	Final Census
United Kingdom of Great Britain and Northern Ireland	2011	Final Census
United Republic of Tanzania	2012	Final Census
United States of America	2010	Final Census
United States Virgin Islands	2010	Final Census
Uruguay	2011	Final Census
Uzbekistan	2013	Population Register
Vanuatu	2009	Final Census
Venezuela (Bolivarian Republic of)	2011	Final Census
Viet Nam	2009	Final Census
Wallis and Futuna Islands	2008	Final Census
Western Sahara	2004	Final Census
Western Samoa	2011	Final Census
Yemen	2004	Final Census
Zambia	2010	Final Census
Zimbabwe	2012	Final Census

Appendix II: Countries with Multiple Levels of Census Data Inputs

The following countries were processed using multiple levels of census data inputs (levels in parentheses):

Armenia (1, 2), France (4, 5), Luxembourg (3, 4), Mali (3, 4), Russia (2, 3), United Kingdom of Great Britain and Northern Ireland (3, 4, 6).

Appendix III: Countries Not Adjusted to the Global Boundary Framework

The following countries were not adjusted to the global boundary framework:

Argentina, Australia, Bangladesh, Brazil, Canada, China, Egypt, Faeroe Islands, Fiji, French Polynesia, Greece, Greenland, India, Indonesia, Ireland, Italy, Japan, Kenya, Malawi, Malaysia, Marshall Islands, Mexico, Mozambique, Myanmar, New Zealand, Nigeria, Palau, Philippines, Portugal, Puerto Rico, Saint Helena, Saudi Arabia, Solomon Islands, South Africa, South Sudan, Sri Lanka, Sudan, Taiwan, Turkey, United Kingdom of Great Britain and Northern Ireland, United States of America, and Venezuela.

Appendix IV: Countries for Which Growth Rates Were Calculated at Multiple Levels

Estimates for the following countries were produced using growth rates calculated at two or more administrative levels (levels in parentheses):

Armenia (1, 2), Burundi (1, 2), Colombia (1, 2), Cook Islands (1, 2, 3), Curaçao (0, 1), Cyprus (1, 2), Dominican Republic (2, 3, 4), Faeroe Islands (2, 3), France (4, 5), Iran (Islamic Republic of) (1, 2), Luxembourg (3, 4), Malawi (1, 2), Malaysia (1, 2), Maldives (1, 2), Mauritania (2, 3), Mauritius (1, 2), Mozambique (2, 3), Oman (1, 2), Philippines (1, 2), Poland (3, 4), Republic of Korea (0, 2), Singapore (1, 2), State of Palestine (1, 2), Turkey (1, 2), United Kingdom of Great Britain and Northern Ireland (2, 3), United Republic of Tanzania (1, 2), Zambia (0, 3).