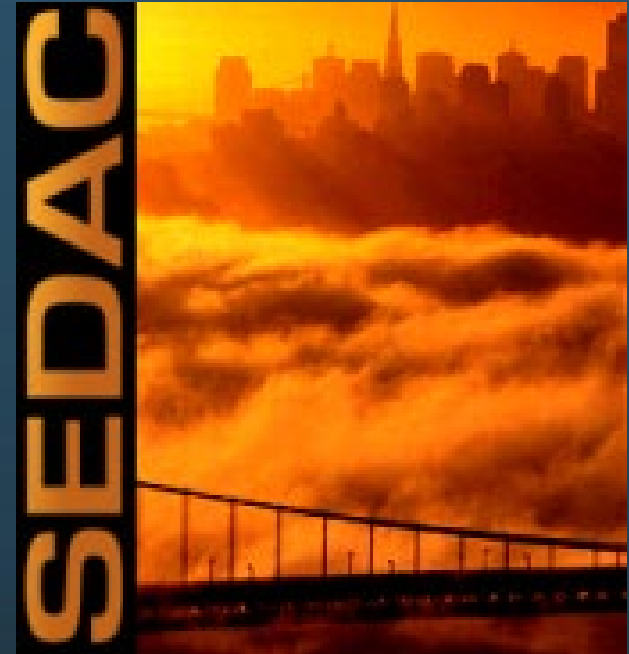


# NASA SEDAC Land Cover and Land Use Change products

Alex de Sherbinin, PhD  
Director, CIESIN, Columbia Climate School  
SEDAC Manager

LCLUC Science Team Meeting  
3 April 2024



# What is SEDAC?

- SEDAC is one of 12 NASA Distributed Active Archive Centers (DAACs) under the Earth Science Data and Information System (ESDIS)
- SEDAC has been managed by the Center for International Earth Science Information Network (CIESIN) at Columbia University since 1998
- CIESIN's offices are in the Geoscience Building on Columbia's Lamont Campus in Palisades NY
- SEDAC has a staff of social and natural scientists, GIS specialists, data scientists, data management experts, programmers, and systems engineers

 COLUMBIA CLIMATE SCHOOL  
CENTER FOR INTERNATIONAL EARTH SCIENCE  
INFORMATION NETWORK





# SEDAC's mission?

**SOCIOECONOMIC DATA AND APPLICATIONS CENTER (SEDAC)**  
A Data Center in NASA's Earth Observing System Data and Information System (EOSDIS) — Hosted by CIESIN at Columbia University

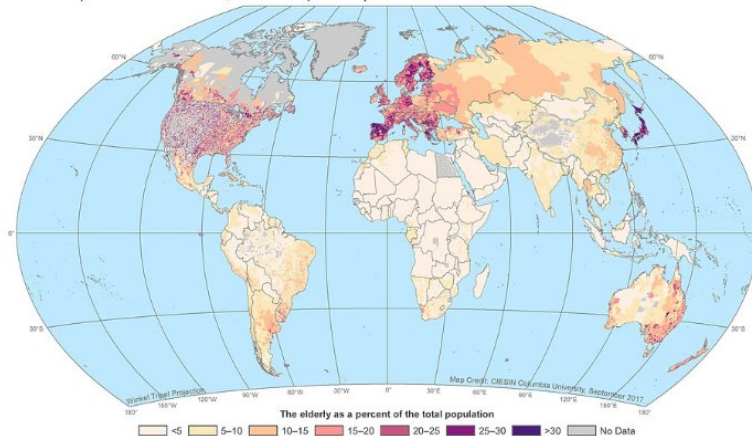
**In the Spotlight**  
Resource - Thematic Guide to Night-Time Light Remote Sensing

**Featured Data Sets**  
Global Estimated Net Migration Grids By Decade, v1 (1970-2000)  
Global Grid of Probabilities of Urban Expansion to 2030, v1 (2000-2030)

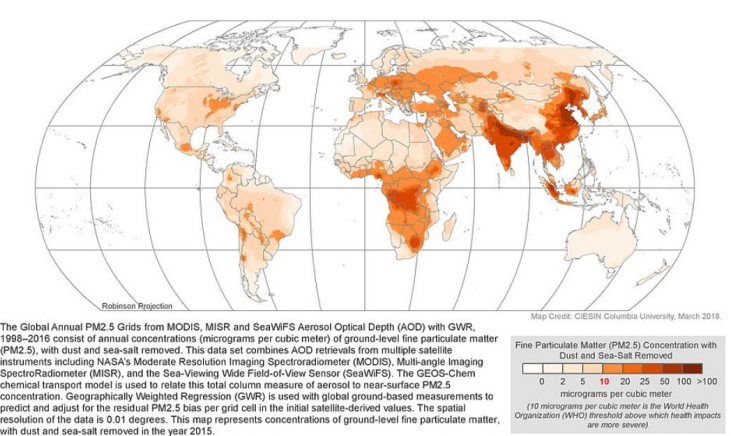
**News**  
Environmental Change and Migration Explored at World Bank Workshop  
Experts Gather in Geneva to Plan Remote Sensing Applications  
The World's Shared River Basins Are Under Stress

- SEDAC data provide the ground level context for NASA's remote sensing data
- Serve as a gateway/bridge between Earth and social sciences with focus on human-environment interactions
- Big emphasis on integration of RS & SE data
- Direct support to scientists, applied and operational users, decision makers, and policy communities
- Strong links to geospatial data community

**Basic Demographic Characteristics, v4.10, 2010: The Elderly (Ages 65 and Older)**  
Gridded Population of the World, Version 4 (GPWv4)



**Global Annual PM2.5 Grids from MODIS, MISR and SeaWiFS Aerosol Optical Depth (AOD) with GWR, 2015**  
Satellite-Derived Environmental Indicators



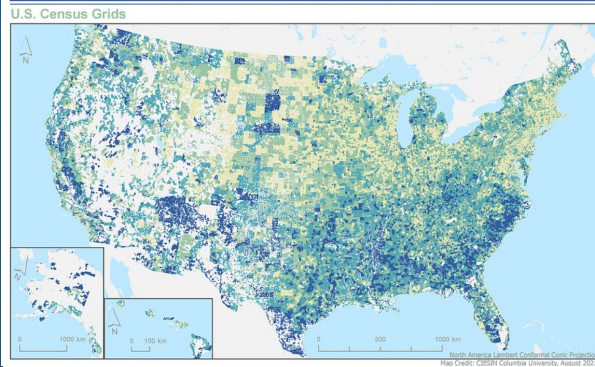


# SEDAC distributes many different data sets across a range of topics and application areas

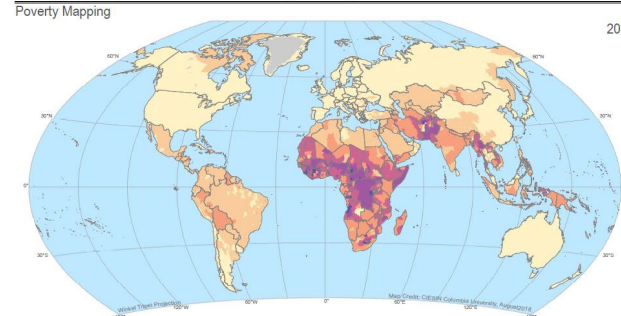
## Current SEDAC Mission Areas

- ▶ Population Land-Use and Emissions (PLUE)
- ▶ Mitigation, Vulnerability and Adaptation (MVA)
- ▶ Hazard Vulnerability Assessment (HVA)
- ▶ Poverty and Food Security (PFS)
- ▶ Environment and Sustainable Development (ESD)

U.S. Social Vulnerability Index Grids (2018): Overall Score



Global Subnational Infant Mortality Rates, Version 2

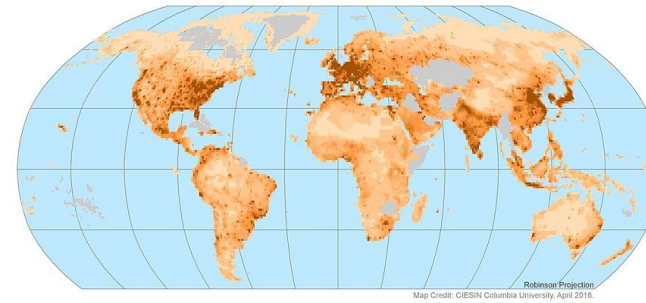


Global Subnational Infant Mortality Rates, Version 2 is part of the Poverty Mapping collection. This map displays infant mortality rate (IMR) estimates for 234 countries and territories, 143 of which include subnational units, at a spatial resolution of 30 arc-seconds (1-1 km) for the year 2015.

Data Source: Center for International Earth Science Information Network - CIESIN - Columbia University, 2016. Global Subnational Infant Mortality Rates, Version 2. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). <https://doi.org/10.7927/H4PN3J3J>

© 2016. The Trustees of Columbia University in the City of New York.

Global Gridded Geographically Based Economic Data (G-Econ), Version 4, GDP in PPP (2005)  
Spatial Economic Data

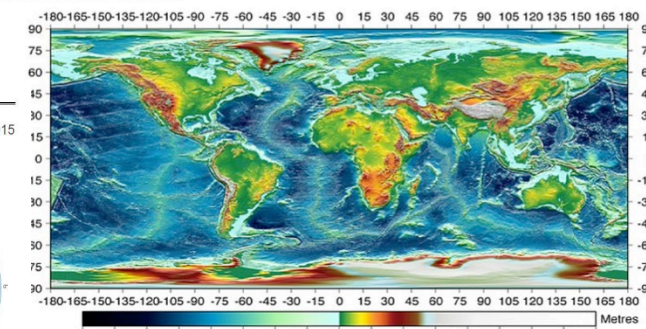


The Global Gridded Geographically Based Economic Data (G-Econ), Version 4 is part of the Spatial Economic Data Collection. The data derived from the Yale G-Econ project provides gridded economic data of Gross Domestic Product (GDP) in Purchasing Power Parity (PPP) at a spatial resolution of one degree for the years 1990, 1995, 2000, and 2005. The PPP is the exchange rate between a country's currency and U.S. dollars adjusted to reflect the actual cost in U.S. dollars of purchasing a standardized market basket of goods in that country using the country's currency. This map displays GDP in PPP where each grid cell represents billions of U.S. dollars for the year 2005.

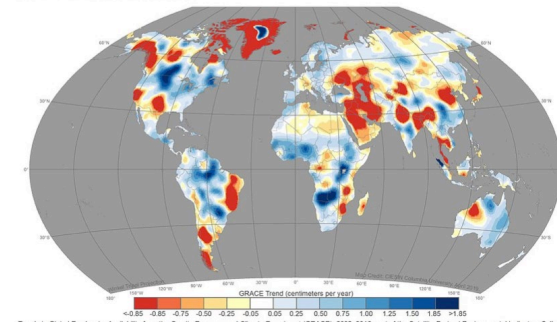
U.S. Dollars (Billions)	
No Data	0 156-0.469
< 0.016	0.469-0.939
0.016-0.023	0.939-1.564
0.023-0.156	1.564-4.693
	4.693-9.387
	9.387-15.644
	15.644-1,564.419

Altimeter Corrected Elevations (ACE2), (1994-2005)

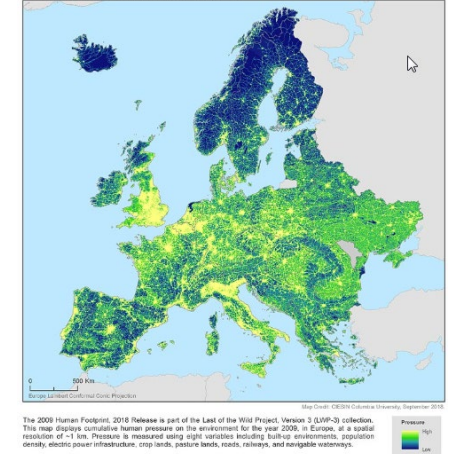
Digital Elevation Data Collection



Trends in Global Freshwater Availability from the Gravity Recovery and Climate Experiment (GRACE), 2002-2016  
Satellite-Derived Environmental Indicators

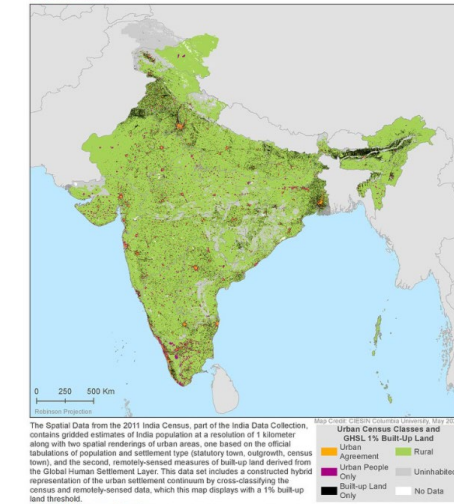


2009 Human Footprint, 2018 Release: Europe  
Last of the Wild Project, Version 3 (LWP-3)



The 2009 Human Footprint, 2018 Release is part of the Last of the Wild Project, Version 3 (LWP-3) collection. This map displays cumulative human pressure on the environment for the year 2009, in Europe, at a spatial resolution of 1 km. Pressure is measured using eight variables including built-up environments, population density, electric power infrastructure, crop lands, pasture lands, roads, railways, and navigable waterways.

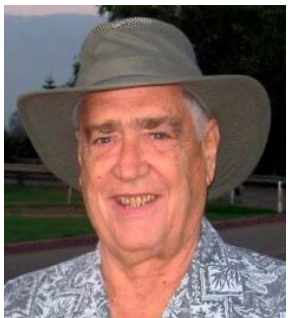
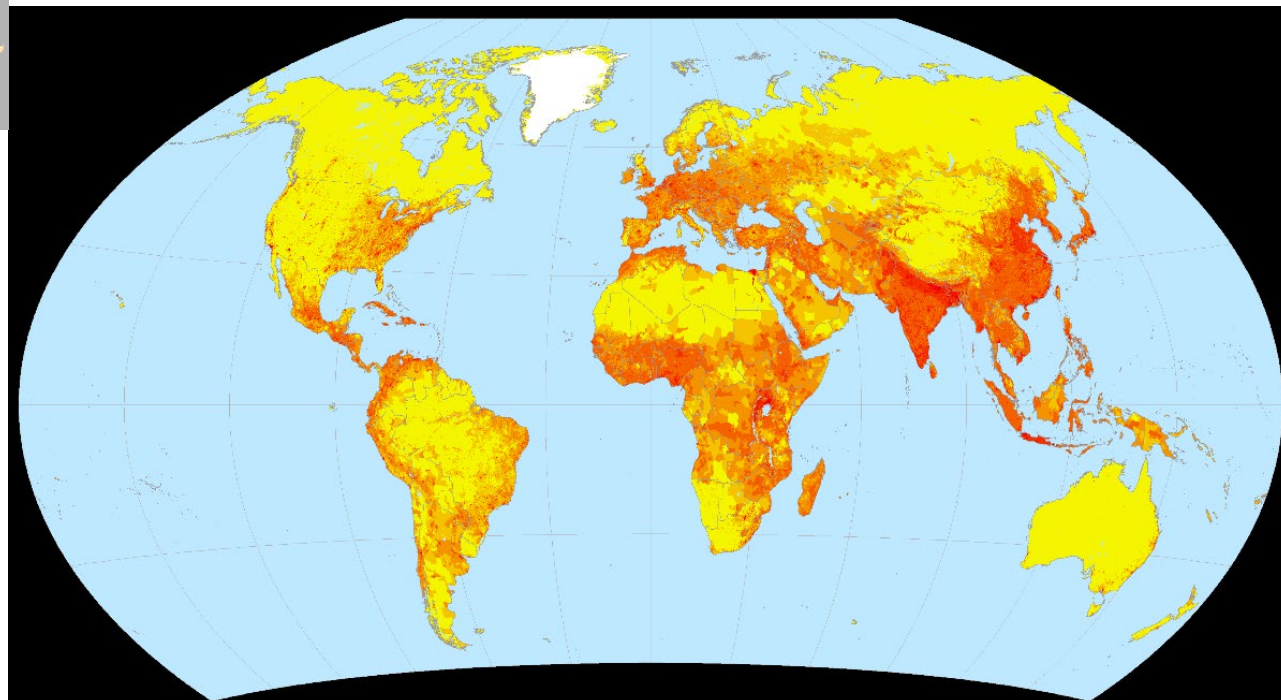
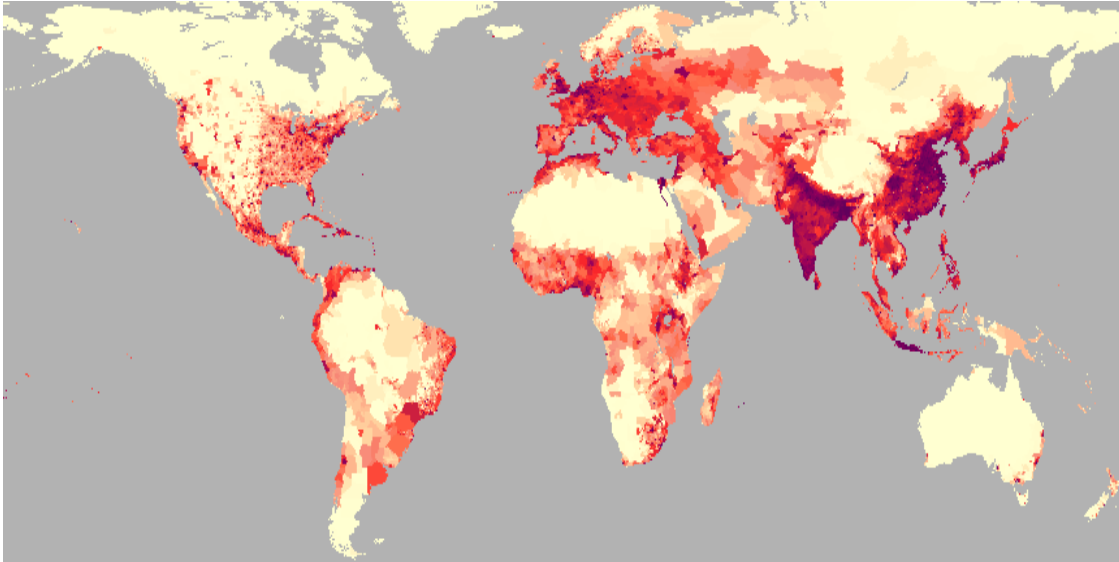
Spatial Data from the 2011 India Census: Urban Census Classes and GHSL 1% Built-Up Land  
India Data Collection





# SEDAC's flagship data product, Gridded Population of the World, has evolved significantly since 1995, building on improved data and tools

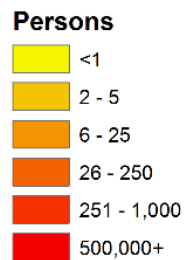
- ▶ GPWv1: total population on a 5 arc-minute grid, 19,000 admin units
- ▶ GPWv4: total pop, age, sex on a 30 arc-second grid, >12 million admin units
- ▶ GPWv5: under development



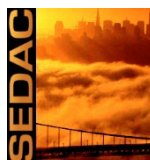
Waldo Tobler  
(deceased)



Uwe Deichmann



**EARTHDATA**  
OPEN ACCESS FOR OPEN SCIENCE



# Outline

- SEDAC LCLUC Data Sets
- SEDAC Urban and Settlements Data Sets
- SEDAC Data Use in LCLUC Analyses



Note: All maps in this presentation are under Creative Commons Attribution Only licenses:



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<https://creativecommons.org/licenses/by/4.0/>

The data are available as map services:

<https://sedac.ciesin.columbia.edu/maps/services>

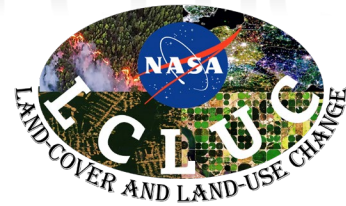
Web processing services for Gridded population of the World v4 are available at:

<https://sedac.ciesin.columbia.edu/data/collection/gpw-v4/population-estimation-service>

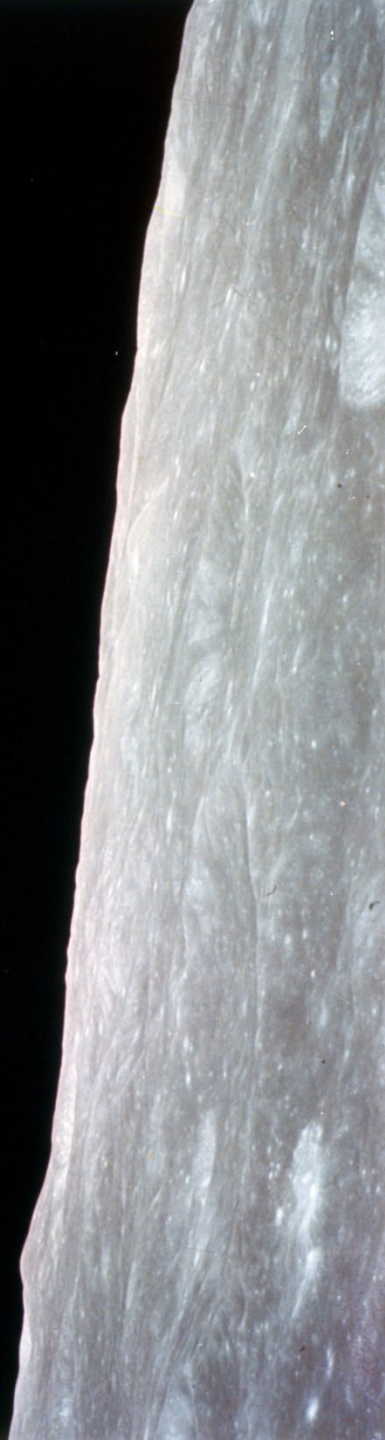
All DOIs available from the prefix: DOI: **10.7927/**

**Consider disseminating your  
(particularly global & regional) data  
via SEDAC!**

# SEDAC LCLUC Data Sets

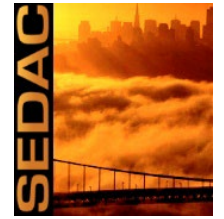


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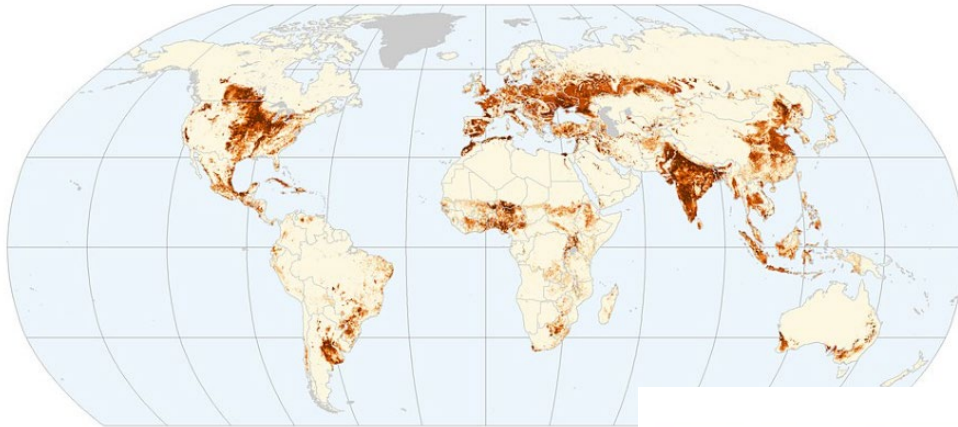


# Land-Use Data Sets



## Croplands, 2000: Global

Global Agricultural Lands

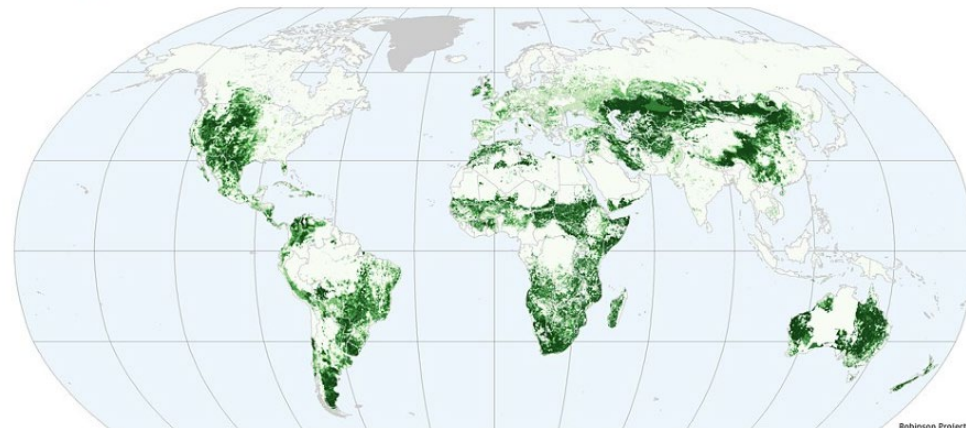


Global Croplands in 2000 map the proportion of each 5 minute (10km) grid cell land area that is under cropland. Dark shaded areas denote higher proportion of area under cropland. Data from Moderate Imaging Spectroradiometer (MODIS) land cover product and Satellite Pour l'Observation de la Terre (SPOT) VEGETATION's Global Land Cover 2000 product were combined with UN Food and Agriculture (FAO) agricultural statistics to generate the data set.

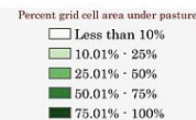
Center for International Earth Science Information Network  
 Earth Institute | Columbia University  
 Copyright 2012. The Trustees of Columbia University in the City of New York.  
 Data Source: Ramankutty, N., A.T. Evan, C. Monfreda, and J.A. Foley. 2019. Global Agricultural Lands. Croplands, 2000. Socioeconomic Data and Applications Center (SEDAC). <http://sedac.ciesin.columbia.edu/data/sets/aglands-croplands-2000>

## Pastures, 2000: Global

Global Agricultural Lands



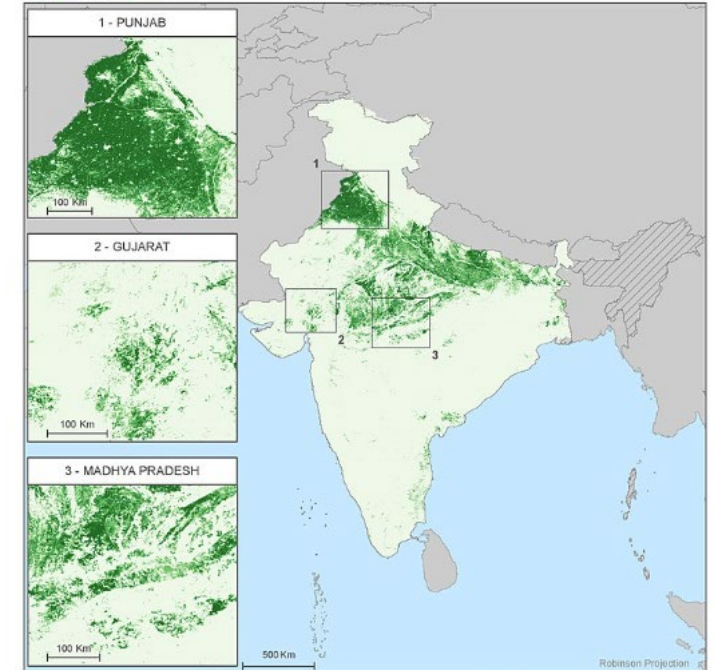
Global Pastures in 2000 map the proportion of each 5 minute (10km) grid cell land area that is under pasture. Dark shaded areas denote higher proportion of area under pasture. Data from Moderate Imaging Spectroradiometer (MODIS) land cover product and Satellite Pour l'Observation de la Terre (SPOT) VEGETATION's Global Land Cover 2000 product were combined with UN Food and Agriculture (FAO) agricultural statistics to generate the data set.



Center for International Earth Science Information Network  
 Earth Institute | Columbia University  
 Copyright 2012. The Trustees of Columbia University in the City of New York.  
 Data Source: Ramankutty, N., A.T. Evan, C. Monfreda, and J.A. Foley. 2019. Global Agricultural Lands. Pastures, 2000. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). <http://sedac.ciesin.columbia.edu/data/sets/aglands-pastures-2000>  
 Publication Date: 3/2012

## India Annual Winter Cropped Area, 2016

India Data Collection



India Annual Winter Cropped Area, 2001–2016, part of the India Data Collection, is a compilation of the extents of annual winter cropped area across India (except the Northeastern states) from 2001 to 2016. This data set utilizes NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) Enhanced Vegetation Index (EVI) time-series for winter growing season (October–March) to produce percent estimates per grid cell for winter cropped area. This map displays percent winter cropped area at a spatial resolution of 1 km for the year 2016.

Center for International Earth Science Information Network  
 Earth Institute | Columbia University  
 Data Source: Jain, M., P. Mondal, G. L. Gafford, G. Fiske, and R. S. DeFries. 2017. India Annual Winter Cropped Area, 2001–2016. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). <https://doi.org/10.7927/H47D2S3W>  
 © 2017. The Trustees of Columbia University in the City of New York.

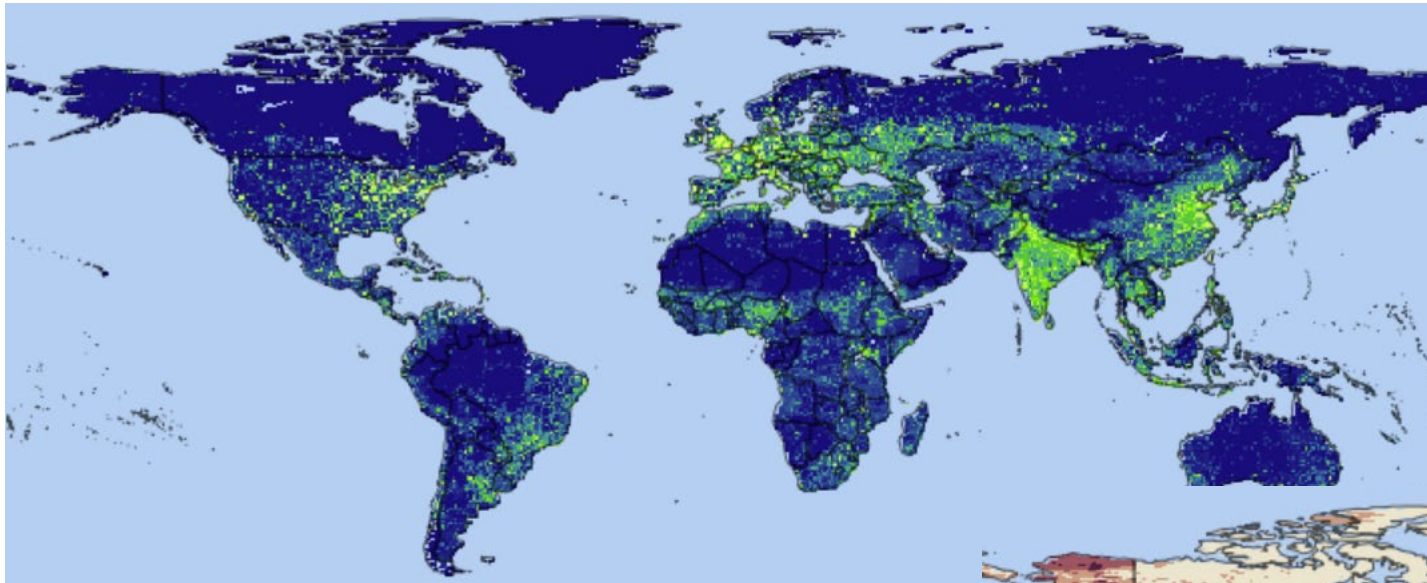
Ramankutty, N., et al.. 2010.  
 Global Agricultural Lands  
<https://sedac.ciesin.columbia.edu/data/collection/aglands>

Jain, M., et al. 2017. India Annual Winter Cropped Area, 2001-2016.  
<https://doi.org/10.7927/H47D2S3W>



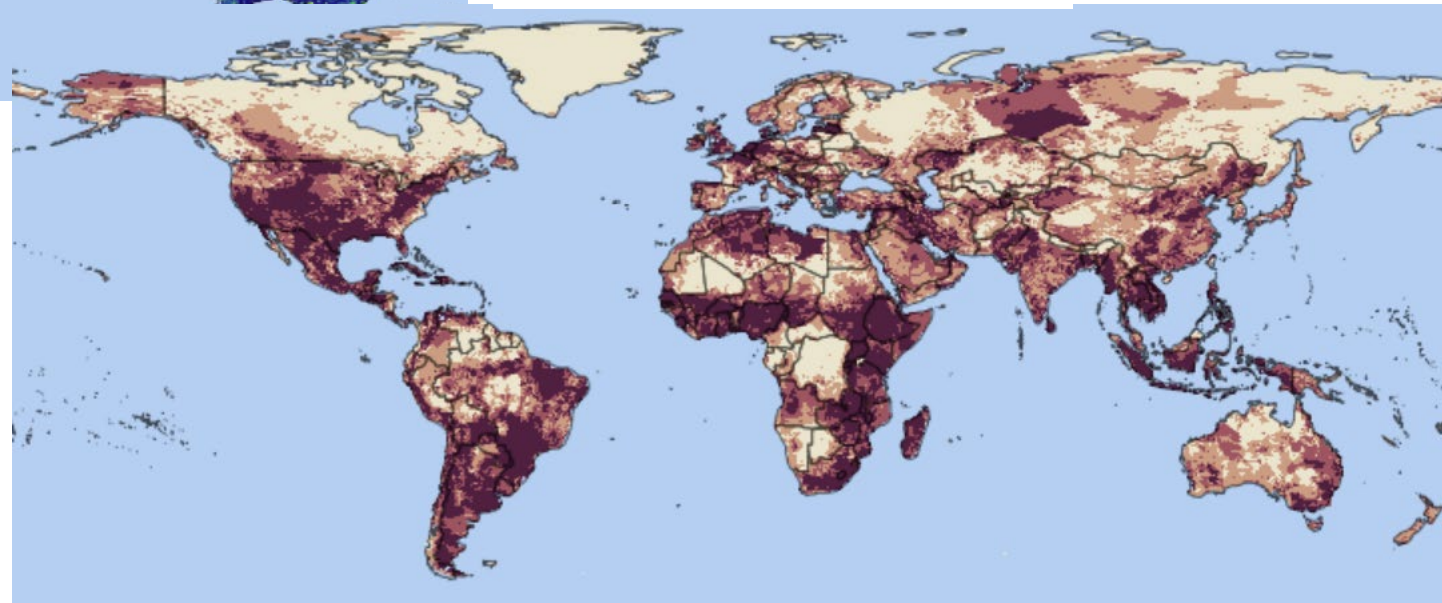
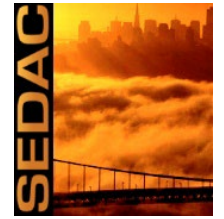
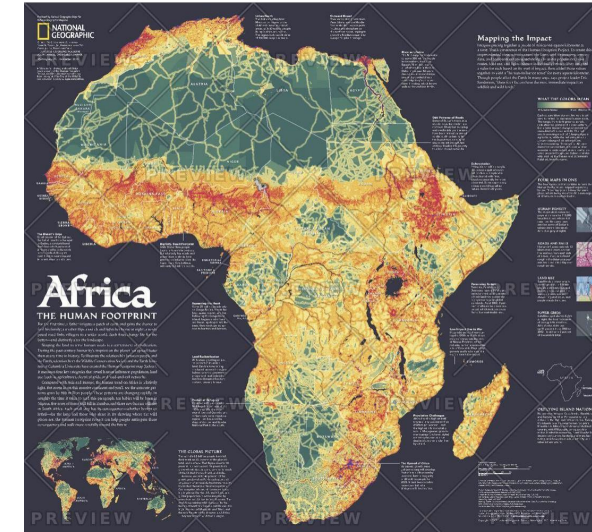


# Human Pressures on Land



Venter, O., et al. 2018. Last of the Wild Project, Version 3 <https://doi.org/10.7927/H46T0JQ4>

First version: WCS & CIESIN. 2002. Last of the Wild Project, Version 1, 2002

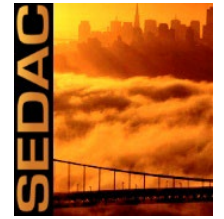


Oakleaf, J. R., et al. 2019. Development Threat Index. <https://doi.org/10.7927/61jv-th84>



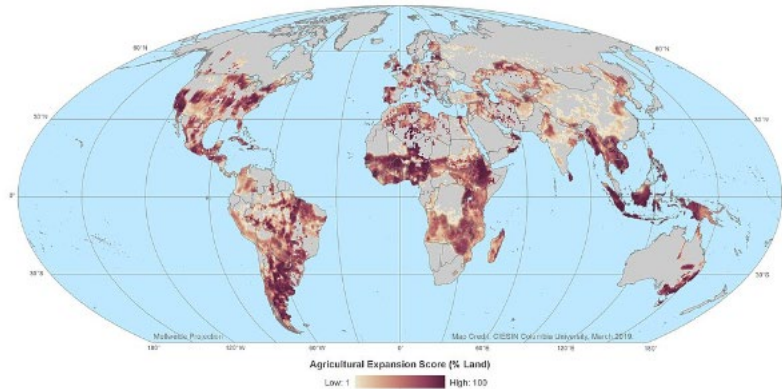


# Development Threat Index (components)



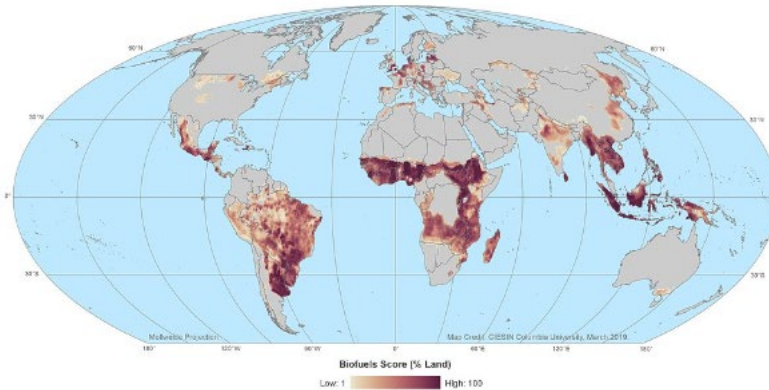
Development Threat Index, v1 (2015): Agricultural Expansion

Land Use Land Cover



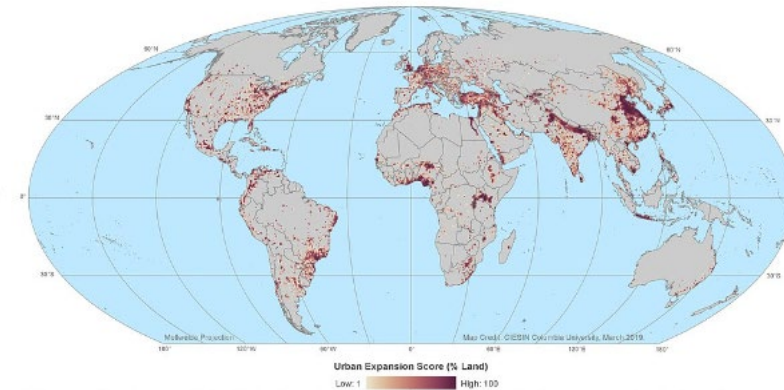
Development Threat Index, v1 (2015): Biofuels

Land Use Land Cover



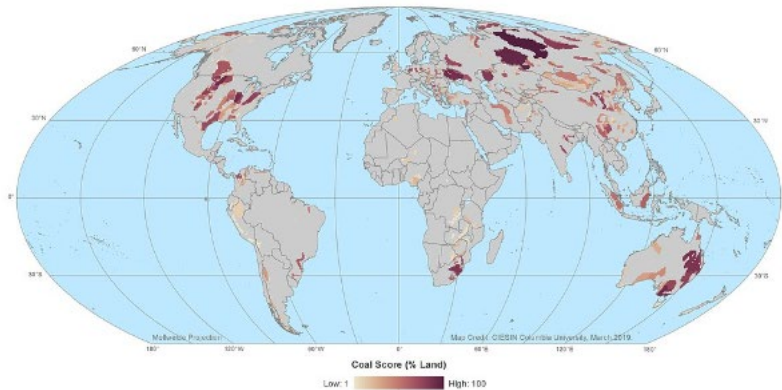
Development Threat Index, v1 (2015): Urban Expansion

Land Use Land Cover



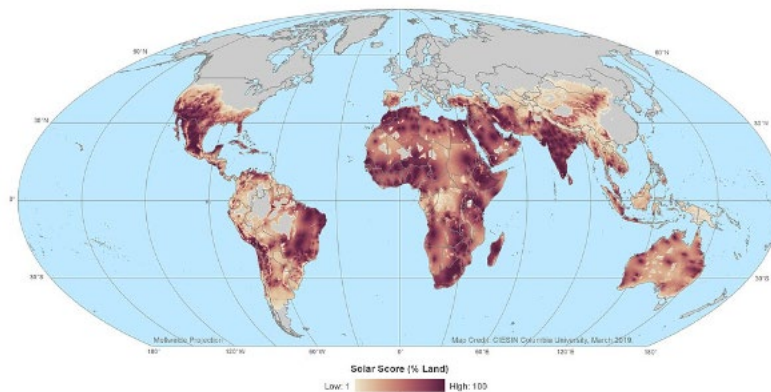
Development Threat Index, v1 (2015): Coal

Land Use Land Cover



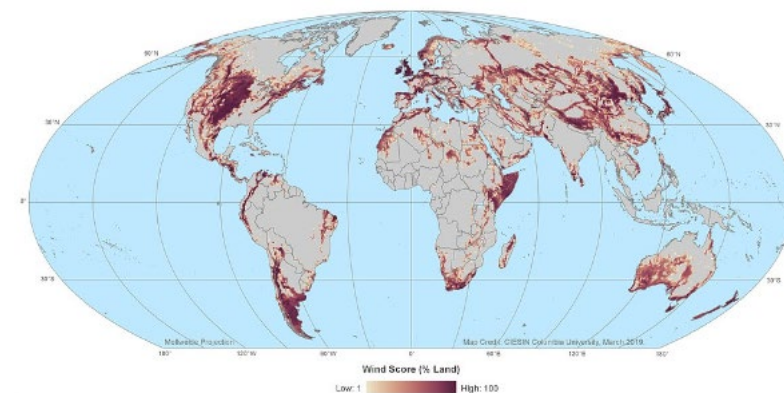
Development Threat Index, v1 (2015): Solar

Land Use Land Cover



Development Threat Index, v1 (2015): Wind

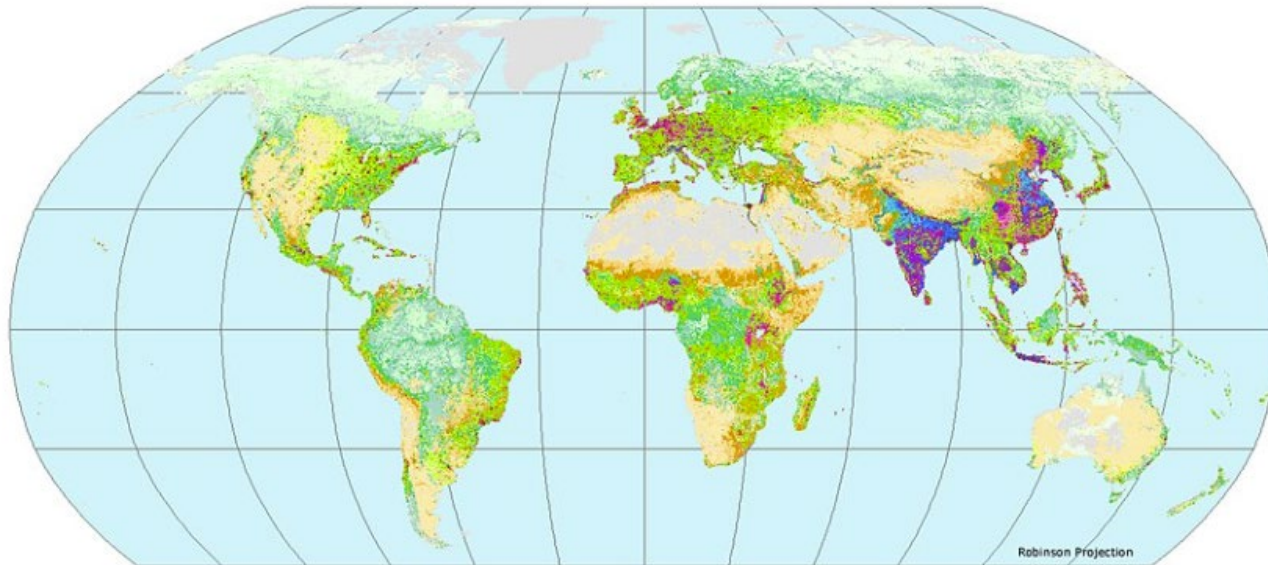
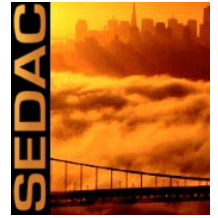
Land Use Land Cover



# Anthropogenic Biomes

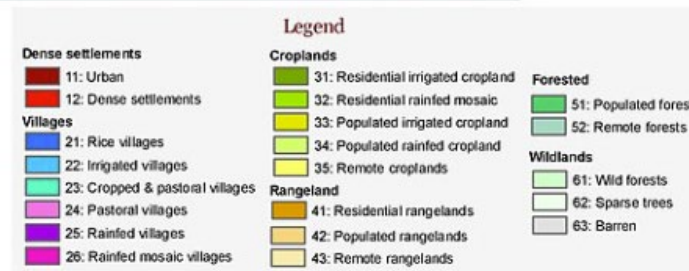
## Anthropogenic Biomes

Global



### Anthropogenic Biomes

Anthropogenic biomes represent heterogeneous landscape mosaics defined by population density, land use, biota, climate, terrain and geology. The 21 biomes are grouped into six major categories namely dense settlements, villages, croplands, rangeland, forested and wildlands.



**Version 1:** Ellis, E.C., and N. Ramankutty. 2008. Anthropogenic Biomes of the World, Version 1.

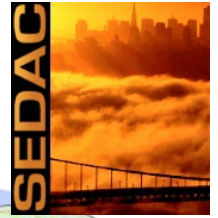
<https://doi.org/10.7927/H4H12ZXD>

**Version 2:** Ellis, E.C., K.K. Goldewijk, S. Siebert, D. Lightman, and N. Ramankutty. 2014. Anthropogenic Biomes of the World, Version 2:

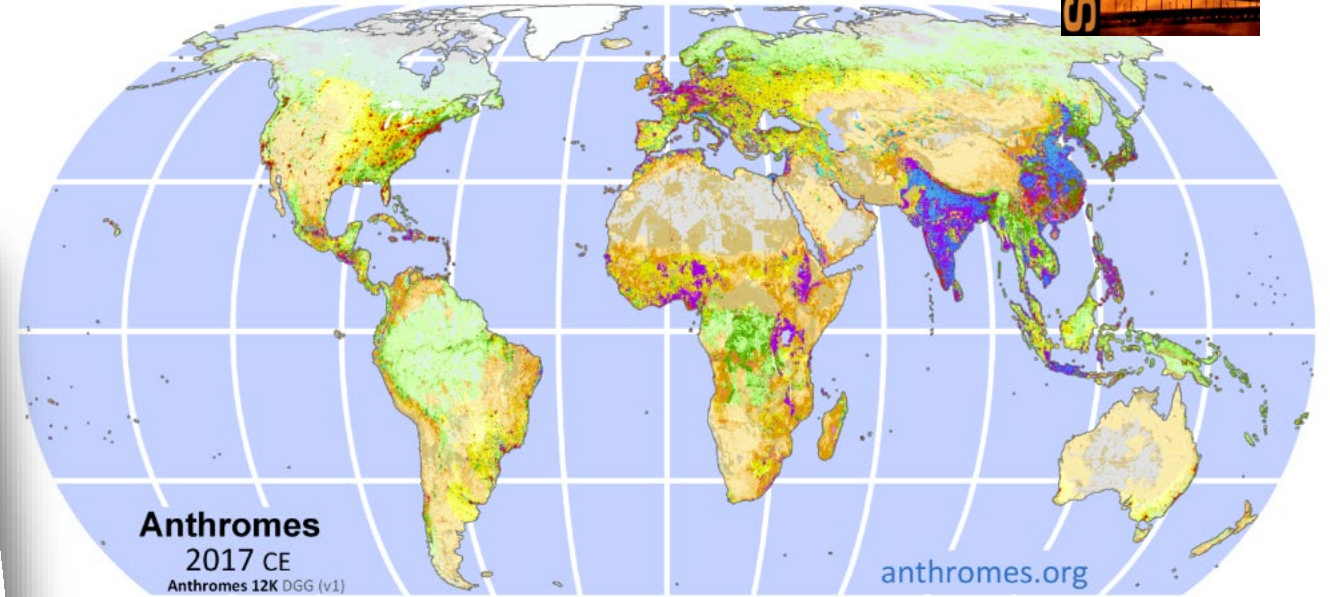
<https://doi.org/10.7927/H4D798B9>



# Coming Soon! Anthropogenic Biomes



Converted from Discrete Global Grid to WGS1984 Geographic Projection



PHILOSOPHICAL  
TRANSACTIONS B

royalsocietypublishing.org/journal/rstb



Opinion piece



Cite this article: Ellis EC. 2023 The Anthropocene condition: evolving through social–ecological transformations. *Phil. Trans. R. Soc. B* 379: 20220255. <https://doi.org/10.1098/rstb.2022.0255>

## The Anthropocene condition: evolving through social–ecological transformations

Erle C. Ellis<sup>1,2,3</sup>

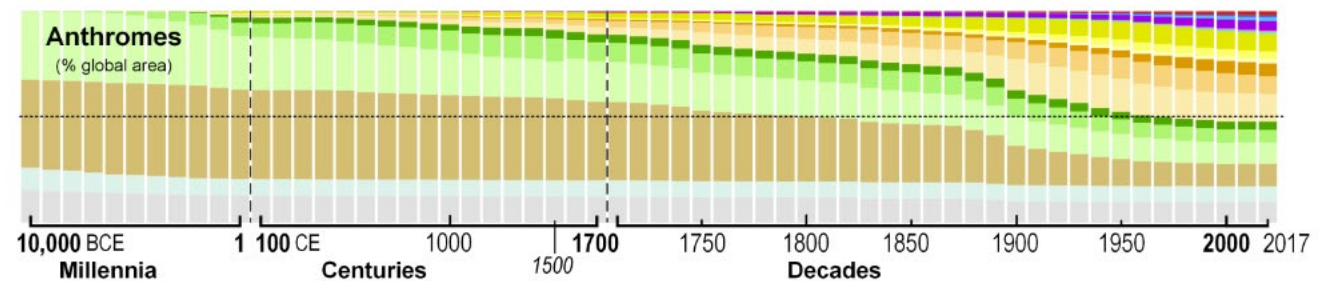
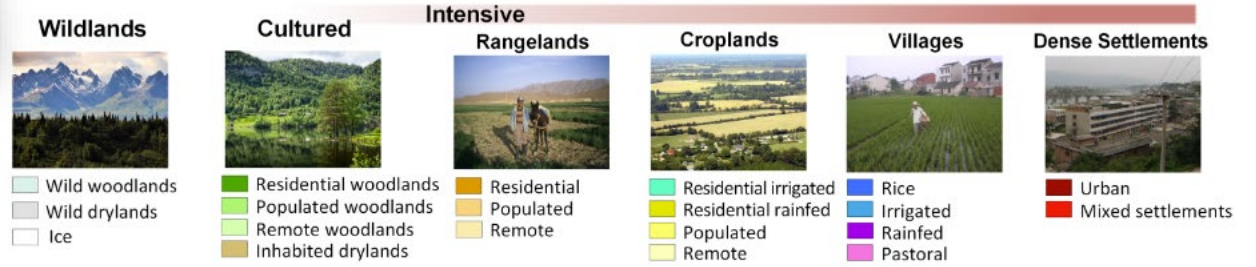
<sup>1</sup>Department of Geography & Environmental Systems, University of Maryland, Baltimore County, Baltimore, MD 21250, USA

<sup>2</sup>Oxford Martin School, University of Oxford, 34 Broad St, Oxford OX1 3BD, UK

<sup>3</sup>Leverhulme Centre for Nature Recovery, Environmental Change Institute, School of Geography & Environment, University of Oxford, South Parks Road, Oxford OX1 3QY, UK

© ECE, 0000-0002-2006-3362

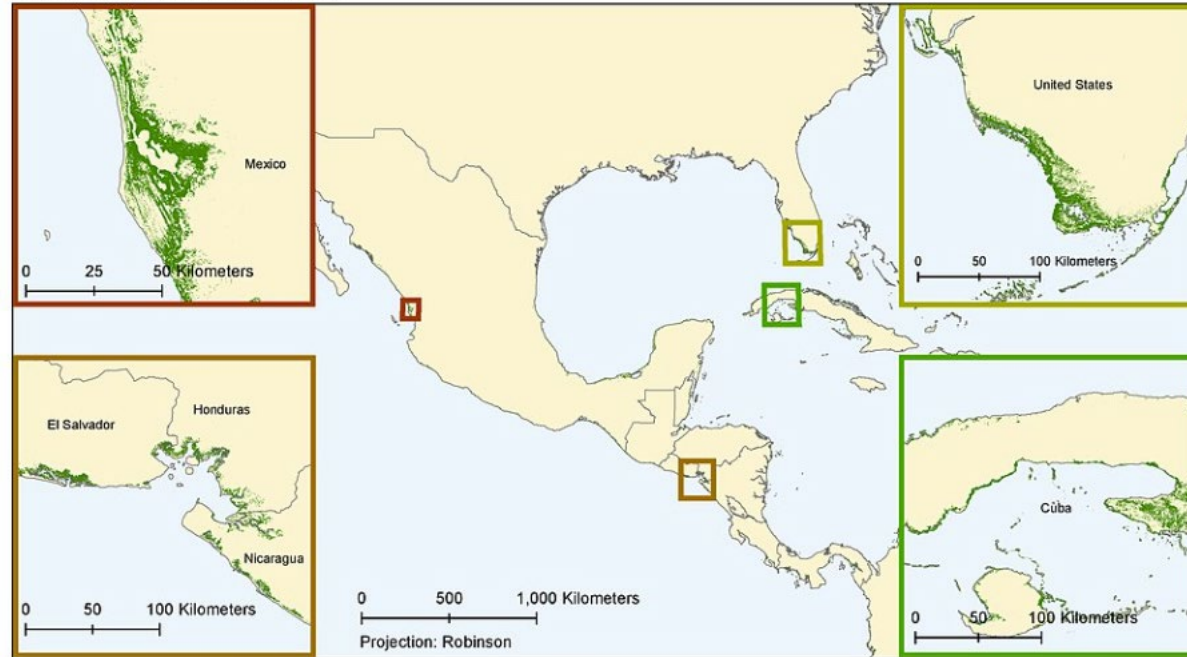
Anthropogenic planetary disruptions, from climate change to biodiversity loss, are unprecedented challenges for human societies. Some societies, social groups, cultural practices, technologies and institutions are already disintegrating or disappearing as a result. However, this coupling of



# Other Land Related Data

## Global Mangrove Forests Distribution, 2000: Central America

Land Use and Land Cover (LULC)



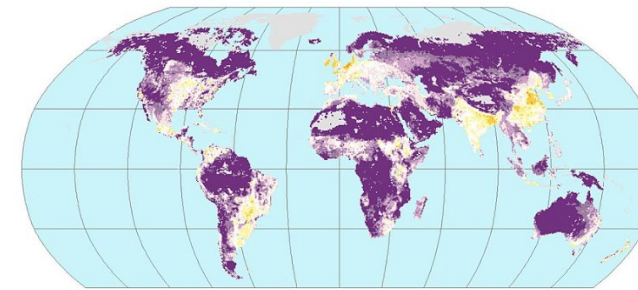
Global distribution of Mangrove forests circa 2000. Grid cell values are 1 where there is mangrove and 0 where there is no mangrove. Data values are derived by digital image classification of Landsat Thematic Mapper (TM) data acquired around the year 2000.

Map Credit: CIESIN Columbia University, November 2013

Giri, C., et al. 2005. Global Mangrove Forests Distribution, 2000. <https://doi.org/10.7927/H4J67DW8>.

## Global Nitrogen Fertilizer Application

Global Fertilizer and Manure, Version 1



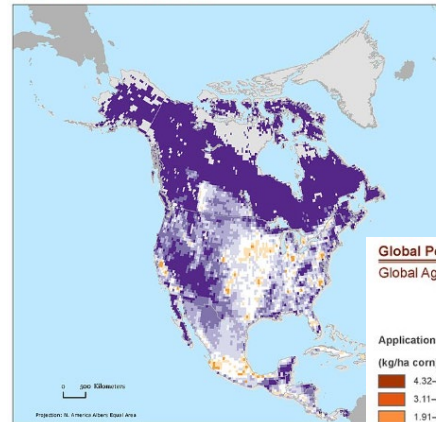
Amount of nitrogen fertilizer applied averaged over all crops within the 0.5 deg grid cell. Grid cell values are expressed in kilograms per hectare (kg/ha) ranging from 0 to 370. The data values were computed by fusing global maps of harvested areas for 175 crops with national information on fertilizer use for each crop.

Kg/ha of Nitrogen Fertilizer applied per grid cell:



## North America Nitrogen in Manure Production

Global Fertilizer and Manure, Version 1



Amount of nitrogen in manure produced within the 0.5 degree grid cell. Grid cell values are expressed in kilograms per hectare (kg/ha) ranging from 0 to 370. The data values were derived based on the national report of the manure produced by the total number of livestock located within each grid cell.

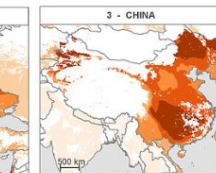
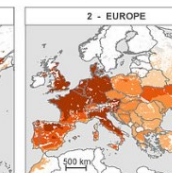
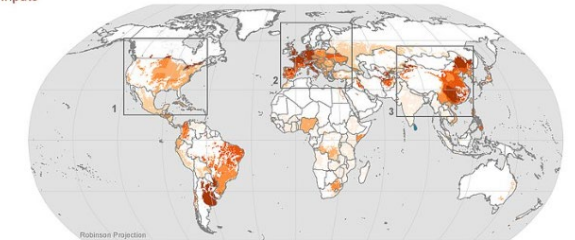
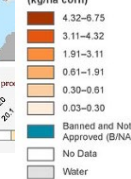
Kg/ha of Nitrogen Manure prod



## Global Pesticide Grids (PEST-CHEMGRIDS), v1.01, 2015: Application Rate of Glyphosate on Corn, High Estimate

Global Agricultural Inputs

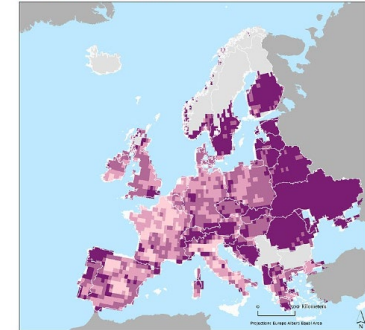
Application Rate (kg/ha corn)



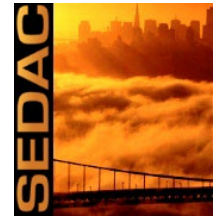
Map Credit: CIESIN Columbia University, September 2010

## Europe Phosphorus Fertilizer Application

Global Fertilizer and Manure, Version 1

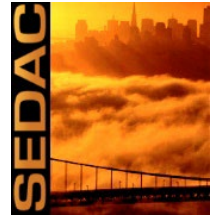


Amount of phosphorus fertilizer applied averaged over all crops within the 0.5 deg grid cell. Grid cell values are expressed in kilograms per hectare (kg/ha) ranging from 0 to 200. The data values were computed by fusing global maps of harvested areas for 175 crops with national information on fertilizer use for each crop.





# Data rescue!



## Millennium Ecosystem Assessment (MA)

**Collection Overview** MA Rapid Land Cover Change, v1 (1901–2015)

Data Sets (6)  
 MA Rapid Land Cover Change, v1 (1901–2015)

Set Overview Data Download Documentation Metadata

Downloads

Data:

View Recommended Citation(s)

The data in a zip file are available in the following formats [here](#) [871 KB].

- Agriculture - Cropland: Grid (.adf)
- Deforestation - Forest: Grid (.adf)
- Desertification: Grid (.adf)
- Fire: Grid (.adf)
- Urbanization - Cities: Shapefile (.shp)

<https://sedac.ciesin.columbia.edu/data/collection/ma>



**DATA DISTRIBUTION CENTRE**

IPCC Site DDC Home About the DDC Guidance on the use of data Socio-Economic Data Linked datasets Definitions of terms How the site is arranged

Advanced search

Location: DDC Home > Guidelines > Socio-Economic Data

INTERGOVERNMENTAL PANEL ON climate change

Help Site map IPCC web sites

**Socio-Economic Data and Scenarios**

Welcome to the Socio-economic section of the Data Distribution Centre (DDC) of the Intergovernmental Panel on Climate Change (IPCC). These pages of the DDC provide access to baseline and scenario data related to population, economic development, technology and natural resources for use in climate impact assessments. This information, along with environmental data and scenarios also held by the DDC, is important for characterizing the vulnerability and adaptive capacity of social and economic systems in relation to climate change in different regions. For many exposed systems, the impacts of climate change could be strongly moderated by future socio-economic and technological developments, so these need to be taken into account in any assessment.

<https://sedac.ciesin.columbia.edu/ddc/>

**MA Climate and Land Cover, v1 (1901–2000)**  
 Millennium Ecosystem Assessment (MA)

Overview To preserve access to the original climate and land cover data used by the Millennium Ecosystem Assessment (MA) and other related research.

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Documents

**MA Ecosystems, v1 (2000)**  
 Millennium Ecosystem Assessment (MA)

Overview To preserve access to the original ecosystems data used by the Millennium Ecosystem Assessment (MA) and other related research.

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**MA Population, v1 (1990–2002)**  
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Overview To preserve access to the original population data used by the Millennium Ecosystem Assessment (MA) and other related research.

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**MA Rapid Land Cover Change, v1 (1901–2015)**  
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**MA Biodiversity, v1 (1950–2001)**  
 Millennium Ecosystem Assessment (MA)

Overview To preserve access to the original biodiversity data used by the Millennium Ecosystem Assessment (MA) and other related research.

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Documents

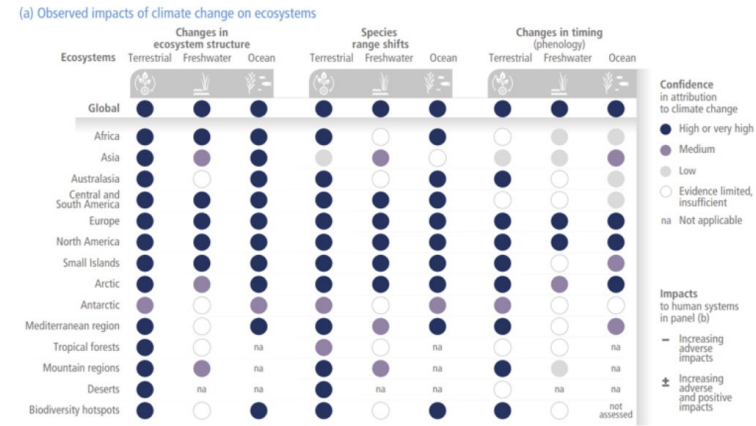
**MA Scenarios, v1 (1995–2100)**  
 Millennium Ecosystem Assessment (MA)

Overview To preserve access to the original set of socioeconomic and natural resource scenarios used by the Millennium Ecosystem Assessment (MA) and other related research.

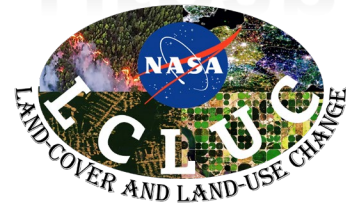
Download

Documents

### Impacts of climate change are observed in many ecosystems and human systems worldwide



# SEDAC Urban Data Sets

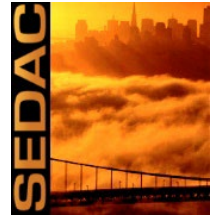


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# Global Human Settlement Layer: Built Up (GHS-BUILT), 1975-2014

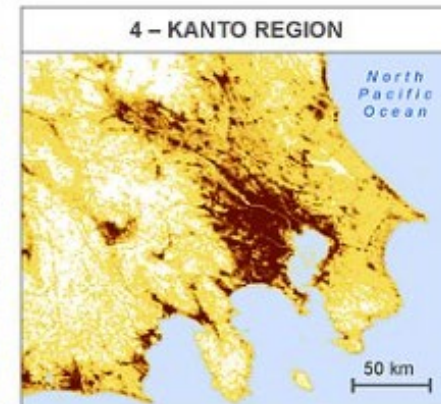
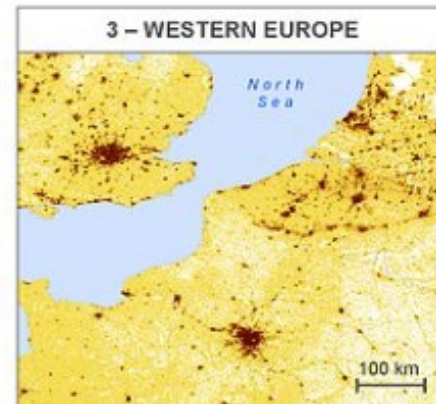
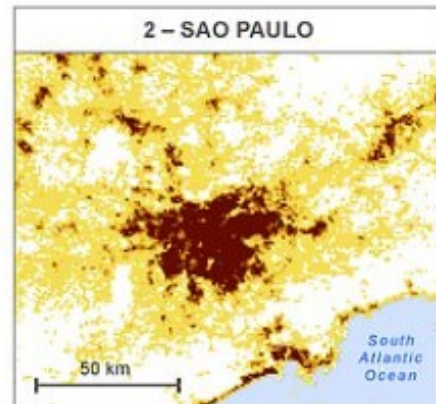
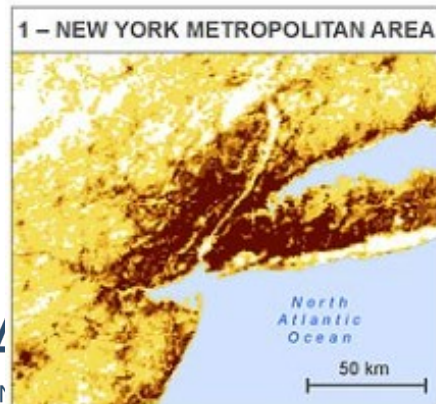
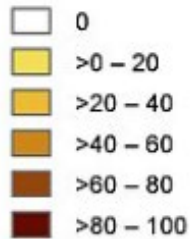


## Global Human Settlement Built-Up Grid (GHS-BUILT), 2014

Global Human Settlement Layer (GHSL)



Percentage of Building Footprint

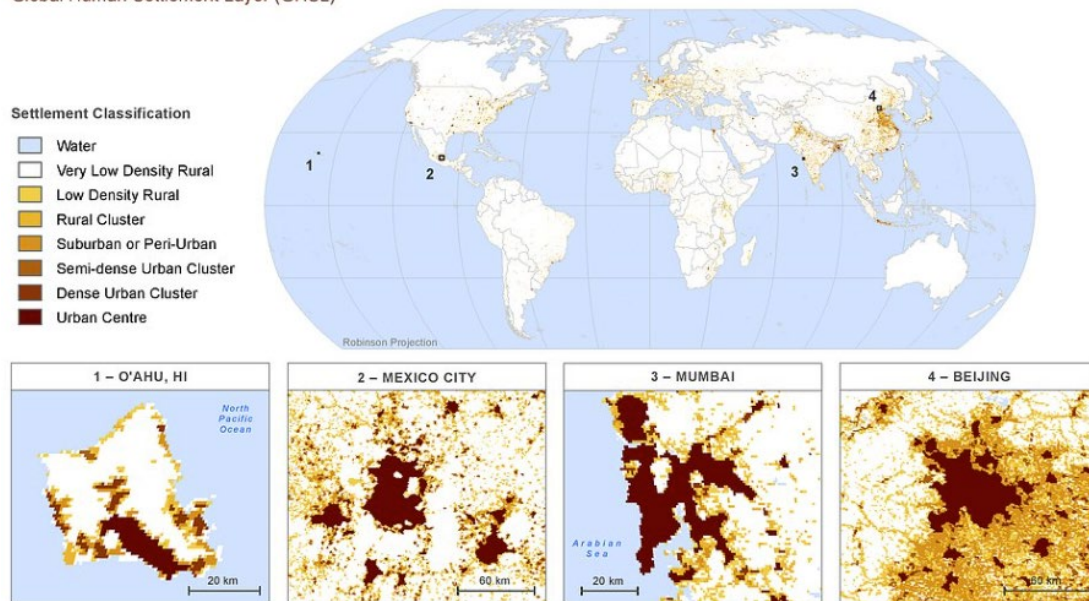


# Global Human Settlement Layer: Settlement Model (SMOD) and Urban Centres Database (UCDB)



## Global Human Settlement Degree of Urbanization Settlement Model Grid (GHS-SMOD), 2015

Global Human Settlement Layer (GHSL)



The Global Human Settlement Layer: Population and Built-Up Estimates, and Degree of Urbanization Settlement Model Grid data set is part of the Global Human Settlement Layer (GHSL) collection. This map displays the GHS-SMOD 2015 raster layer, which provides data on settlement typologies, expressed as an integer assigned to each settlement classification per grid cell for the year 2015.

JRC & CIESIN. 2021. Global Human Settlement Layer: Population and Built-Up Estimates, and Degree of Urbanization Settlement Model Grid.

<https://doi.org/10.7927/h4154f0w>



Urban Centre name: Washington, D.C. [USA]

Get a link to share this visualisation:

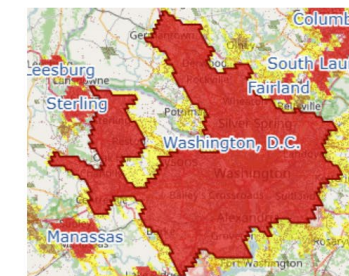
[Link to share](#)

[Data for this Urban Centre](#) (MS Excel format)

Characteristics	Geography	Socio-Economic	Environment	Exposure and hazard	SDG
-----------------	-----------	----------------	-------------	---------------------	-----

Name of the Urban Centre: Washington, D.C. (USA)  
 Resident population in 2015: 3 368 613 inhabitants  
 Surface in 2015 (km<sup>2</sup>): 1550  
 Average Population Density in 2015 (inhabitants/km<sup>2</sup>): 2 173  
 Geographical coordinates (centroid): Lat.: 38.9228, Lon.: -77.1420  
 Country: United States  
 Number of countries crossed: 1 country  
 Countries crossed (ISO codes): USA  
 UN region: Northern America  
 UN subregion: Northern America  
 UN income class: High-income Countries (HIC)  
 UN development class: More Developed Regions (MDR)

Map of Washington, D.C. [USA]



JRC. 2019. Urban Centres Database.

<https://ghsl.jrc.ec.europa.eu/ucdb2018visual.php>





# New! Global Urban Points and Polygons Dataset (GUPPD), v1

*Soon to be released!*

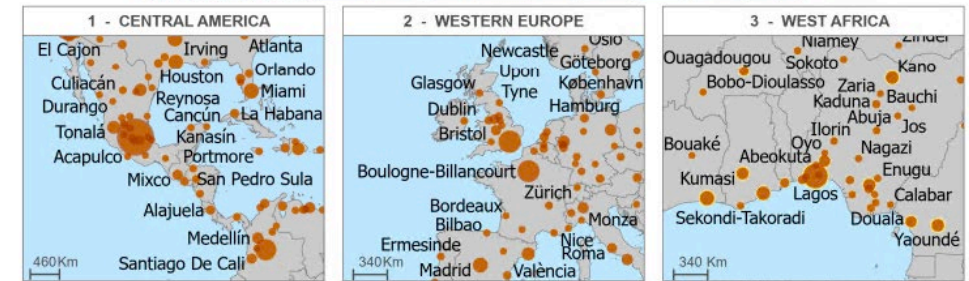
A global dataset of 123,058 urban settlements with place names and population for the years 1975-2030 in five year increments. It includes a hierarchy of settlements, from urban center (level 30), dense urban cluster (level 23), to semi-dense urban cluster (level 22). GUPPD uses open data sources to check and validate the names that JRC assigned to its UCDB polygons and to label the newly added settlements.

- Key inputs: GHS-SMOD, Global Urban Centres Database, GHS-POP R2023

## Global Urban Polygons and Points Dataset (GUPPD), Version 1

Urban Spatial

Population Year



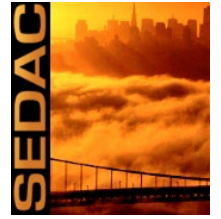
Global Urban Points and Polygons Dataset (GUPPD), Version 1 is a part of the Urban Spatial Data collection. This map represents the population growth of settlements with a baseline population greater than 500,000 between 2015 and 2030. GUPPD is a vector data set that provides settlement names, total area, and population data for GHS-SMOD levels 22, 23 and 30 polygons.

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Center for International Earth Science Information Network - CIESIN - Columbia University, and Joint Research Centre - JRC - European Commission. 2023. Global Urban Polygons and Points Dataset (GUPPD), Version 1. Palisades, New York: NASA Socioeconomic Data and Applications Center (SEDAC). <https://doi.org/10.7927/IJLKMNOP>

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# Derived product: Global High Resolution Daily Extreme Urban Heat Exposure (UHE-Daily), v1 (1983–2016)

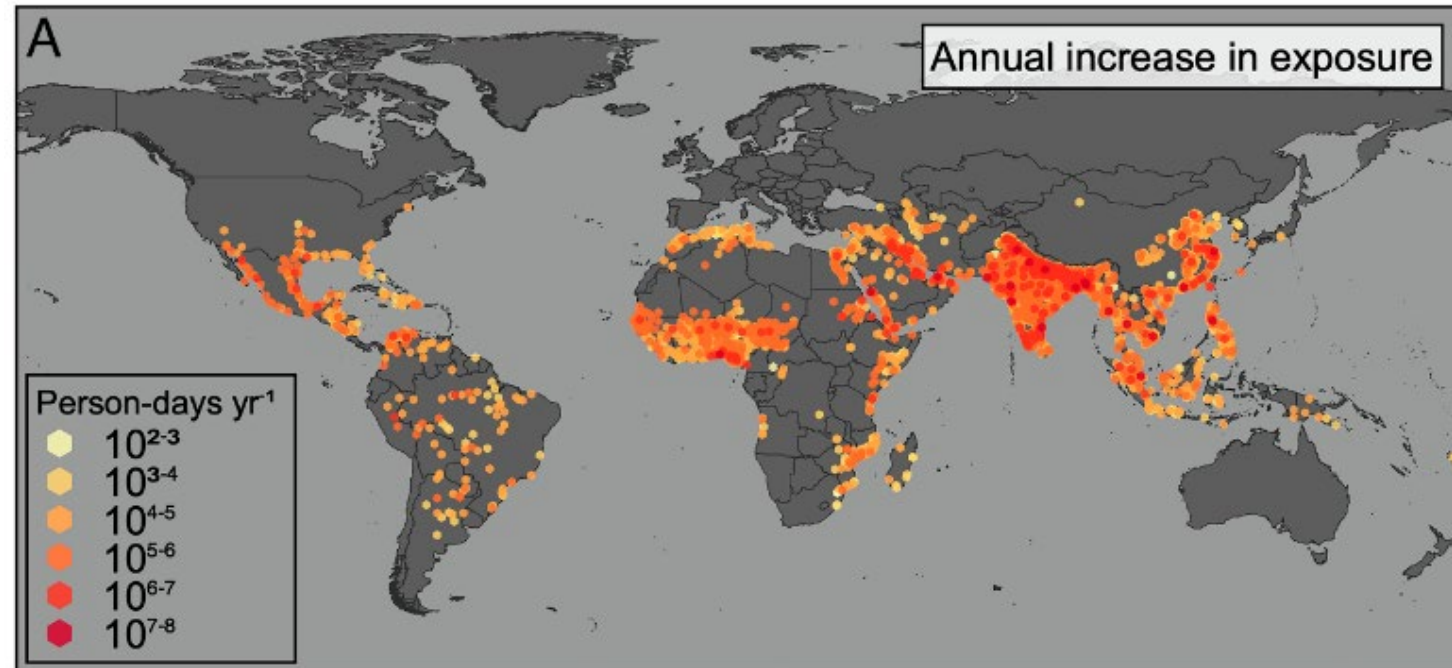


<https://doi.org/10.7927/fq7g-ny13>

High-resolution, longitudinal global record of geolocated urban extreme heat events and urban population exposure estimates for more than 10,000 urban settlements worldwide for 1983–2016.

- Five combined temperature-humidity thresholds: two-day or longer periods where the daily maximum Heat Index (Hlmax) > 40.6 °C; one-day or longer periods where Hlmax > 46.1 °C; and one day or longer periods where the daily maximum Wet Bulb Globe Temperature (WBGTmax) > 28 °C, 30 °C, and 32 °C.

Source: Tuholske, C., K. Caylor, C. Funk, A. Verdin, S. Sweeney, K. Grace, P. Peterson, and T. Evans. 2021. Global Urban Population Exposure to Extreme Heat. *Proceedings of the National Academy of Sciences* 118(41), e2024792118. <https://doi.org/10.1073/pnas.2024792118>

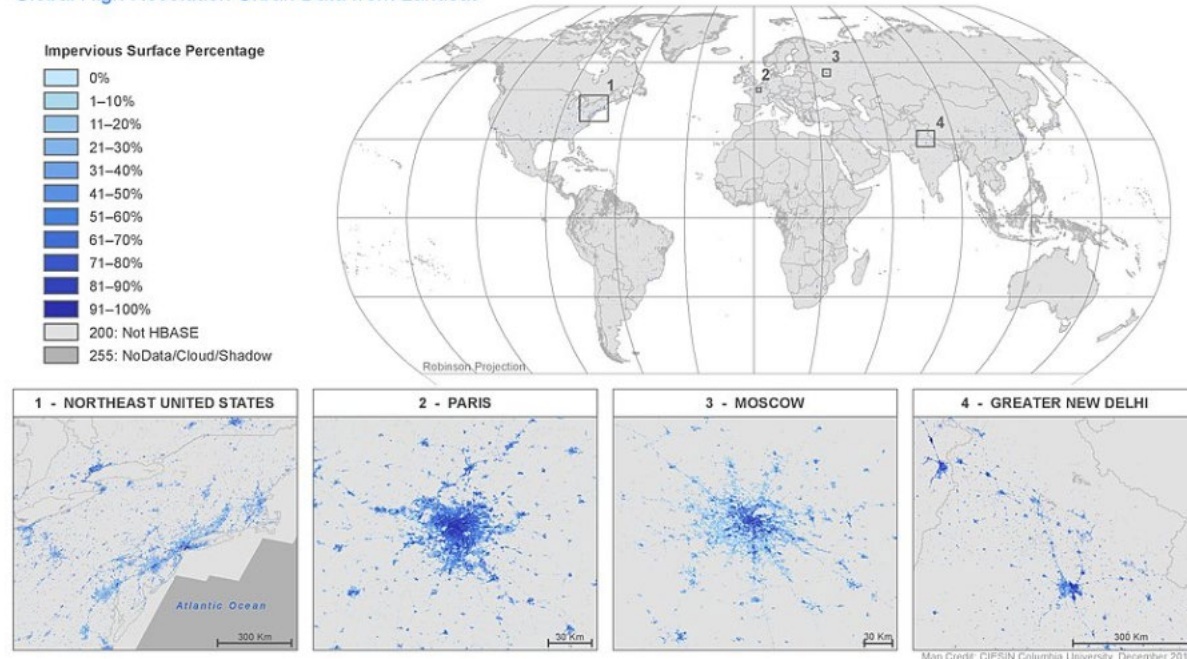




# GMIS and HBASE

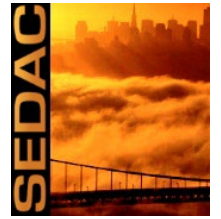
## Global Man-made Impervious Surface (GMIS) Dataset From Landsat, 2010: Impervious Surface Percentage

Global High Resolution Urban Data from Landsat



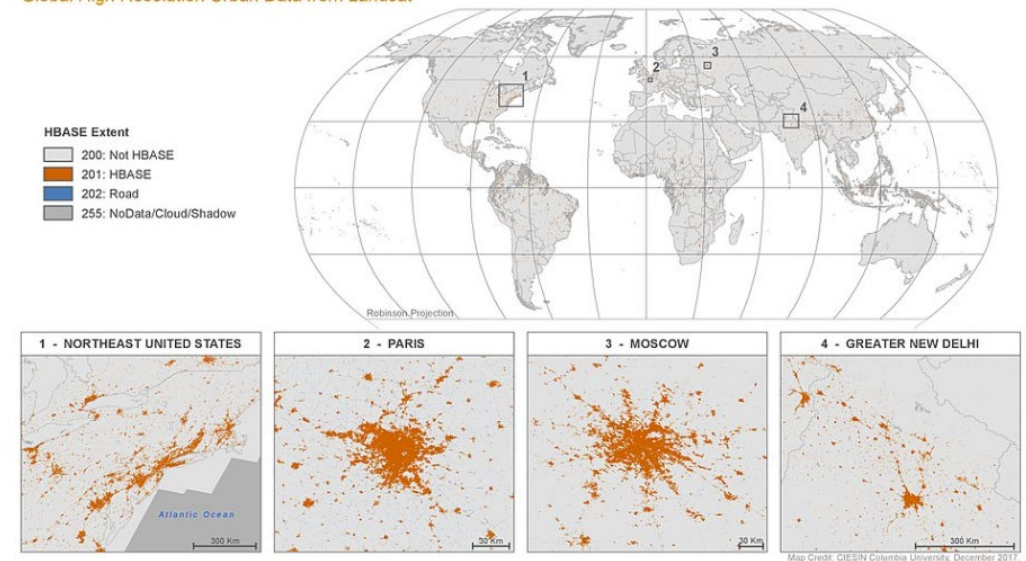
Brown de Colstoun, E. C., et al. 2017. Global Man-made Impervious Surface (GMIS) Dataset From Landsat..

<https://doi.org/10.7927/H4P55KKF>.



## Global Human Built-up And Settlement Extent (HBASE) Dataset From Landsat, 2010: HBASE Extent

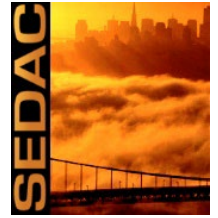
Global High Resolution Urban Data from Landsat



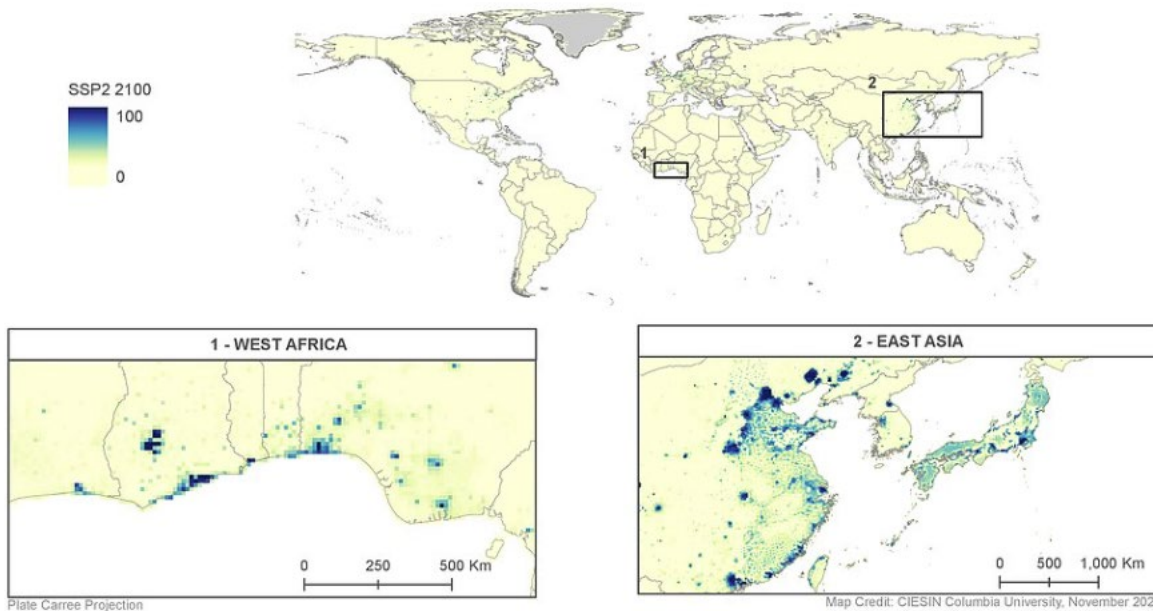
Wang, P., et al. 2017. Global Human Built-up And Settlement Extent (HBASE) Dataset From Landsat.

<https://doi.org/10.7927/H4DN434S>.

# Urban Expansion Projections



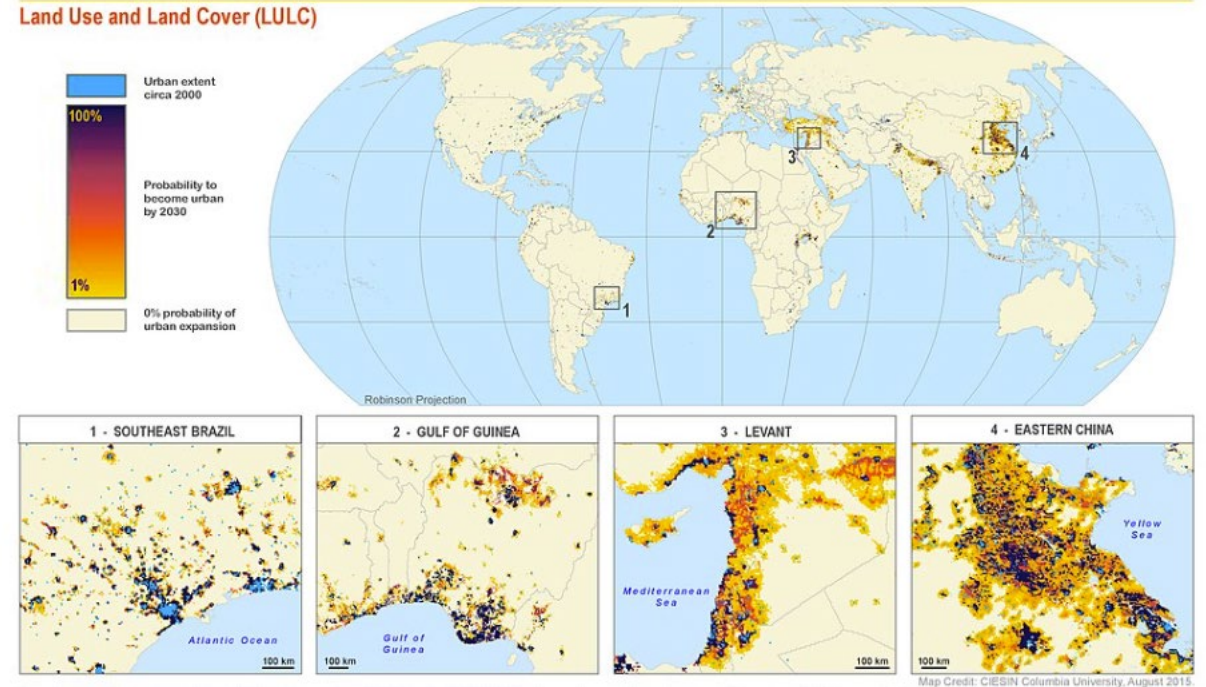
**Global One-Eighth Degree Urban Land Extent Projection Grids by SSP Scenarios (2100): SSP2 Shared Socioeconomic Pathways (SSPs)**



Gao, J. and B. C. O'Neill. 2021. Global One-Eighth Degree Urban Land Extent Projection Grids by SSP Scenarios, 2000-2100. <https://doi.org/10.7927/nj0x-8y67>.



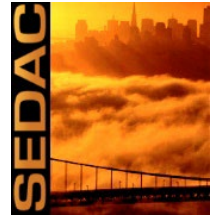
**Global Grid of Probabilities of Urban Expansion to 2030 Land Use and Land Cover (LULC)**



Seto, K., et al. 2016. Global Grid of Probabilities of Urban Expansion to 2030. <https://doi.org/10.7927/H4Z899CG>.

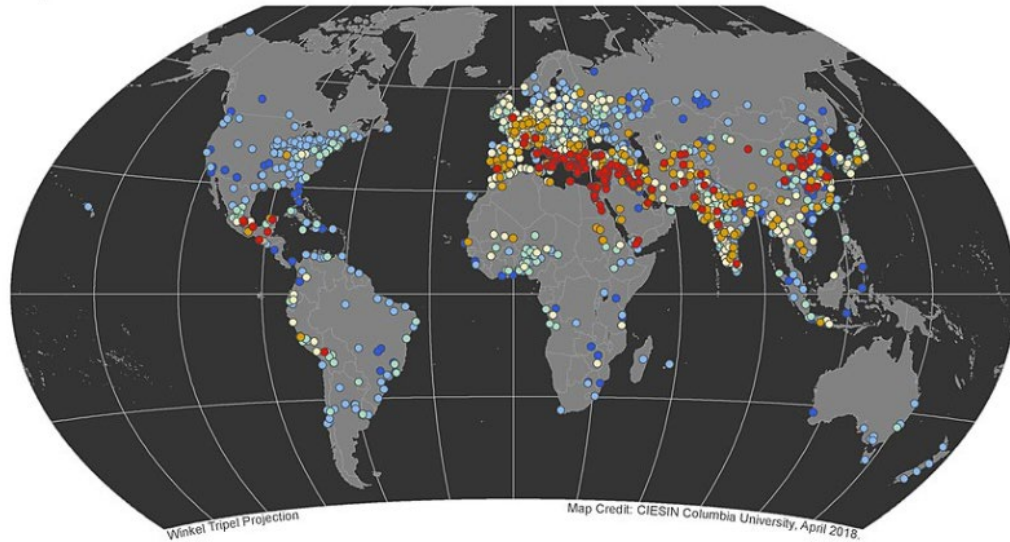


# Other Urban Data



## Historical Urban Population, 3700 BC - AD 2000: Earliest Recorded Year

### Urban Spatial Data

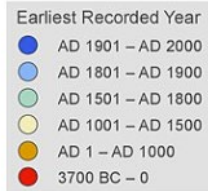


Historical Urban Population: 3700 BC - AD 2000, part of the Urban Spatial Data collection, is the first spatially explicit global data set containing location and size of urban populations over the last 6,000 years. The data set consists of 10,352 population records for 1,805 cities from 3700 BC to AD 2000. This map displays the first year in which population was recorded for each city.

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Data Source: Reba, M. L., F. Reitsma, and K. C. Seto. 2016. Spatializing 6,000 Years of Global Urbanization from 3700 BC to AD 2000. *Scientific Data* 3:160034. <https://doi.org/10.1038/sdata.2016.34>.

© 2018. The Trustees of Columbia University in the City of New York.



Reba, M. et al. 2018. Historical Urban Population: 3700 BC - AD 2000. <https://doi.org/10.7927/H4ZG6QBX>.

## Global Monthly and Seasonal Urban and Land Backscatter Time Series, v1 (1993–2020)

[Set Overview](#) [Data Download](#) [Documentation](#) [Metadata](#)

### Purpose:

To provide a 28-year time series of microwave backscatter to support analysis of patterns and trends in growth of global urban building infrastructure.

### Abstract:

The Global Monthly and Seasonal Urban and Land Backscatter Time Series, 1993-2020, is a multi-sensor, multi-decadal, data set of global microwave backscatter, for 1993 to 2020. It assembles data from C-band sensors onboard the European Remote Sensing Satellites (ERS-1 and ERS-2) covering 1993-2000, Advanced Scatterometer (ASCAT) onboard EUMETSAT satellites for 2007-2020, and the Ku-band sensor onboard the QuikSCAT satellite for 1999-2009, onto a common spatial grid (0.05 degree latitude /longitude resolution) and time step (both monthly and seasonal). Data are provided for all land (except high latitudes and islands), and for urban grid cells, based on a specific masking that removes grid cells with > 50% open water or < 20% built land. The all-land data allows users to choose and evaluate other urban

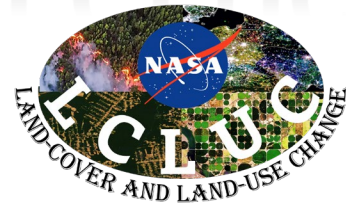
Frolking, S., et al. 2022. Global Monthly and Seasonal Urban and Land Backscatter Time Series, 1993-2020. <https://doi.org/10.7927/gr2e-dh86>



**EARTHDATA**

OPEN ACCESS FOR OPEN SCIENCE

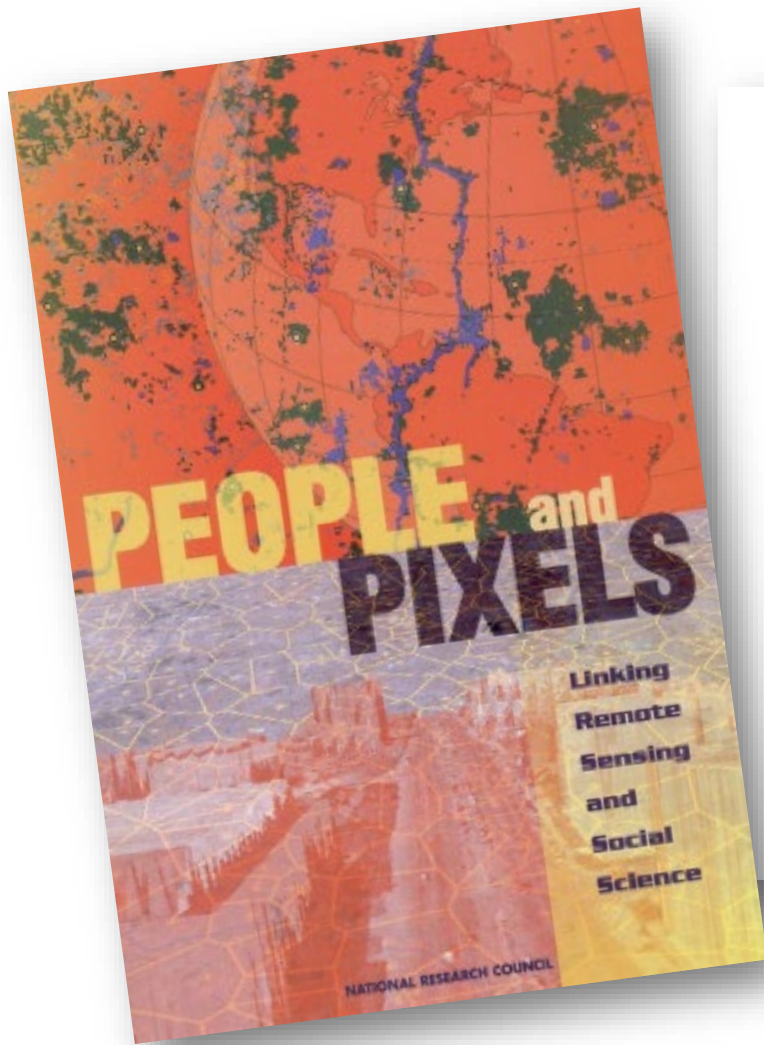
# SEDAC Data Use in LCLUC Analyses



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**A CIESIN Thematic Guide to  
Land-Use and Land-Cover Change (LUCC)**

Alex de Sherbinin

September 2002

Center for International Earth Science Information Network (CIESIN)  
Columbia University  
Palisades, NY, USA



A collaborative effort of the Socioeconomic Data and Applications Center (SEDAC)  
and the IGBP/IHDP Land-Use and Land-Cover Change (LUCC)  
International Project Office

Population and Environment  
https://doi.org/10.1007/s11111-019-00326-5

ORIGINAL PAPER

**People and Pixels 20 years later: the current data  
landscape and research trends blending population  
and environmental data**



Tracy A. Kugler<sup>1</sup> · Kathryn Grace<sup>2</sup> · David J. Wrathall<sup>3</sup> · Alex de Sherbinin<sup>4</sup> ·  
David Van Riper<sup>1</sup> · Christoph Aubrecht<sup>5</sup> · Douglas Comer<sup>6</sup> · Susana B. Adamo<sup>4</sup> ·  
Guido Cervone<sup>7</sup> · Ryan Engstrom<sup>8</sup> · Carolynne Hultquist<sup>7</sup> ·  
Andrea E. Gaughan<sup>9</sup> · Catherine Linard<sup>10</sup> · Emilio Moran<sup>11</sup> · Forrest Stevens<sup>9</sup> ·  
Andrew J. Tatem<sup>12</sup> · Beth Tellman<sup>13</sup> · Jamon Van Den Hoek<sup>3</sup>

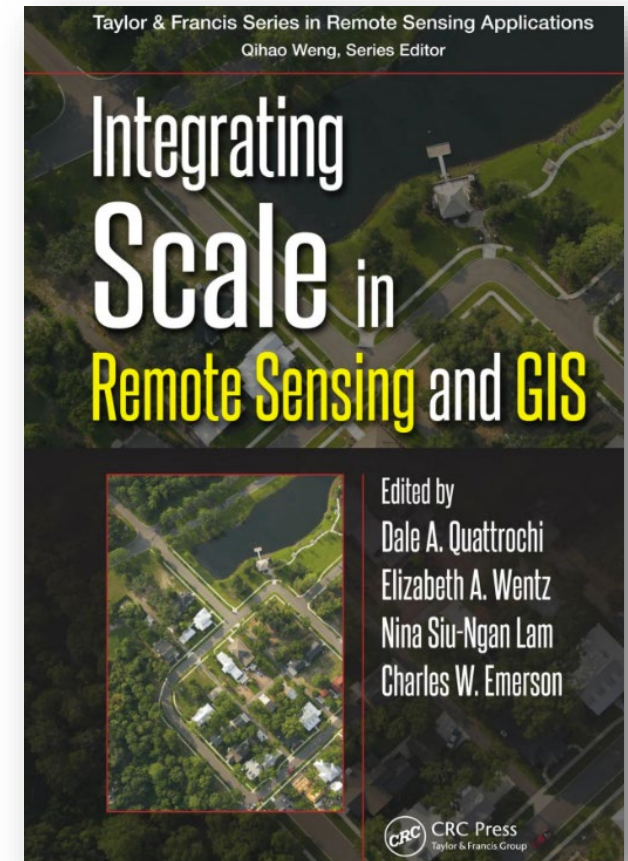


# Uses of SEDAC data in analyses



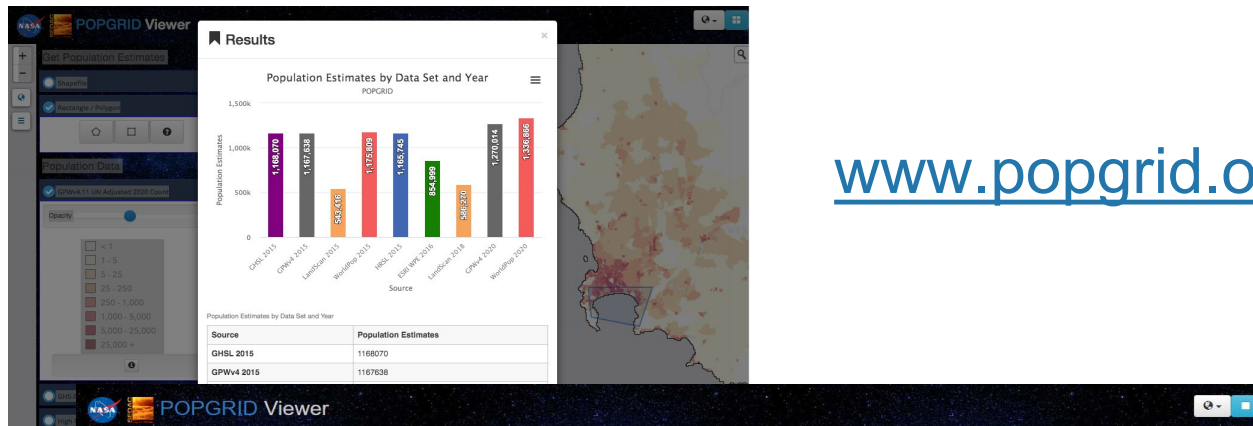
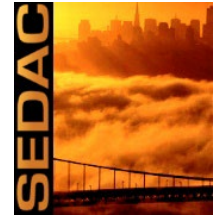
Population grids are used with remote sensing data to:

- Identify **drivers** of deforestation / biodiversity loss / land cover change / fire activity / environmental change
- **Control** for the influence of population variables in regression models
- Assess population **exposure** to hazards / infectious disease / pollutants
- Develop **population weighting of exposure** to create indices for health / hazards research
- Identify **vulnerability** of populations exposed to natural hazards / climate impacts
- **Mask** areas based on population density / human influence thresholds





# How to pick a population grid?



[www.popgrid.org](http://www.popgrid.org)

- The POPGRID viewer can help with population grid comparisons
- The article below is also an excellent overview article

Earth Syst. Sci. Data, 11, 1385–1409, 2019  
<https://doi.org/10.5194/essd-11-1385-2019>  
© Author(s) 2019. This work is distributed under the Creative Commons Attribution 4.0 License.

Earth System Science Data  
Open Access

**The spatial allocation of population: a review of large-scale gridded population data products and their fitness for use**

Stefan Leyk<sup>1,11</sup>, Andrea E. Gaughan<sup>2,10</sup>, Susana B. Adamo<sup>3</sup>, Alex de Sherbinin<sup>3</sup>, Deborah Balk<sup>4</sup>, Sergio Freire<sup>5</sup>, Amy Rose<sup>6</sup>, Forrest R. Stevens<sup>2,10</sup>, Brian Blankespoor<sup>7</sup>, Charlie Frye<sup>8</sup>, Joshua Comenetz<sup>9</sup>, Alessandro Sorichetta<sup>10</sup>, Kytt MacManus<sup>3</sup>, Linda Pistoletti<sup>3</sup>, Marc Levy<sup>3</sup>, Andrew J. Tatem<sup>10</sup>, and Martino Pesaresi<sup>5</sup>

# Global Relative Deprivation Index, v1

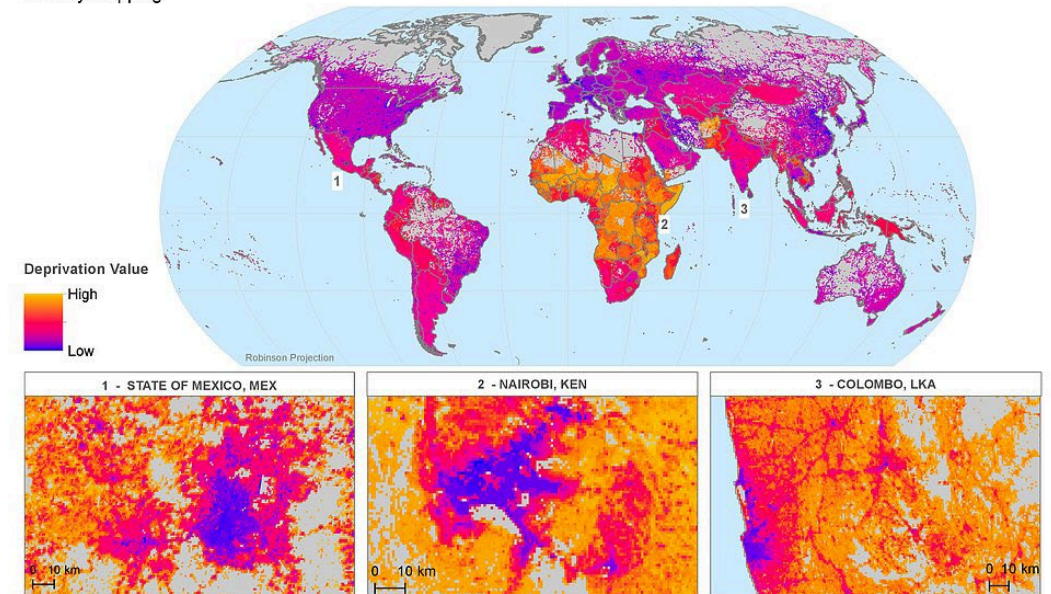
The **first global data set on relative deprivation**, useful for **environmental justice** and **vulnerability assessment** applications

This data set defines relative deprivation on a 1-km grid-cell basis incorporating the following layers:

1. Subnational human development index (from Smits & Permanyer 2019)
2. Child dependency ratios (from SEDAC's GPWv4 Basic Demographic Characteristics)
3. Infant mortality rates (from SEDAC's Global Subnational Infant Mortality Rates, v2.01)
4. Building footprints as a proportion of each grid cell (from HRSL, Microsoft, and Geofabrik/OSM)
5. Current nighttime lights (from VIIRS DNB)
6. Change in nighttime lights (from VIIRS DNB)

## Gridded Relative Deprivation Index (GRDI), Version 1

Poverty Mapping



The Global Gridded Relative Deprivation Index (GRDI), Version 1 (GRDIv1) data set is part of the Poverty Mapping collection. The GRDIv1 provides a global index value that characterizes the levels of multidimensional deprivation in each pixel, where a value of 100 represents the highest level of deprivation and a value of 0 the lowest. All insets are indexed respectively. The GRDIv1 uses a variety of sociodemographic and satellite data inputs that were spatially harmonized, indexed, and weighted to provide an index that represents relative levels of multidimensional deprivation and poverty. This map displays deprivation values at a spatial resolution of ~1 km.

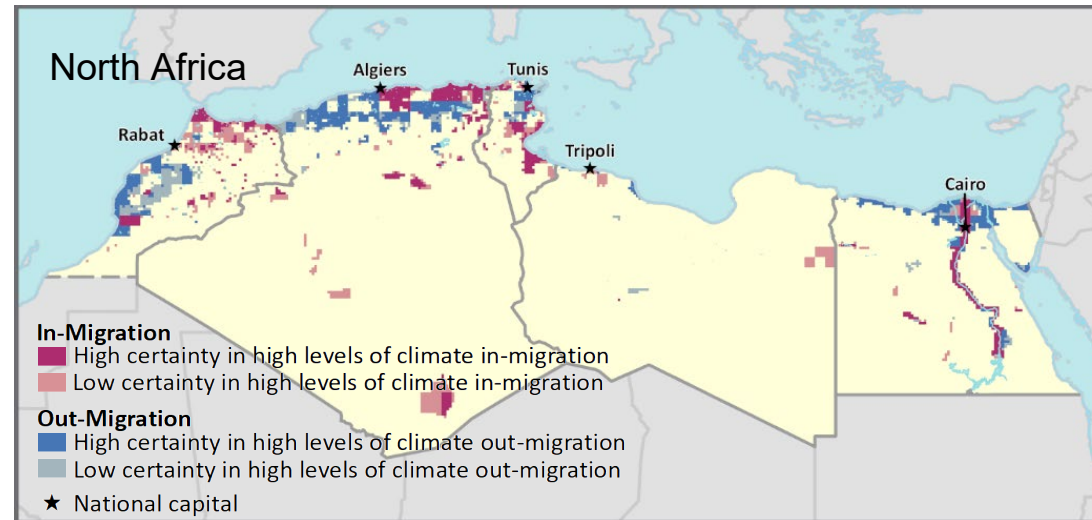
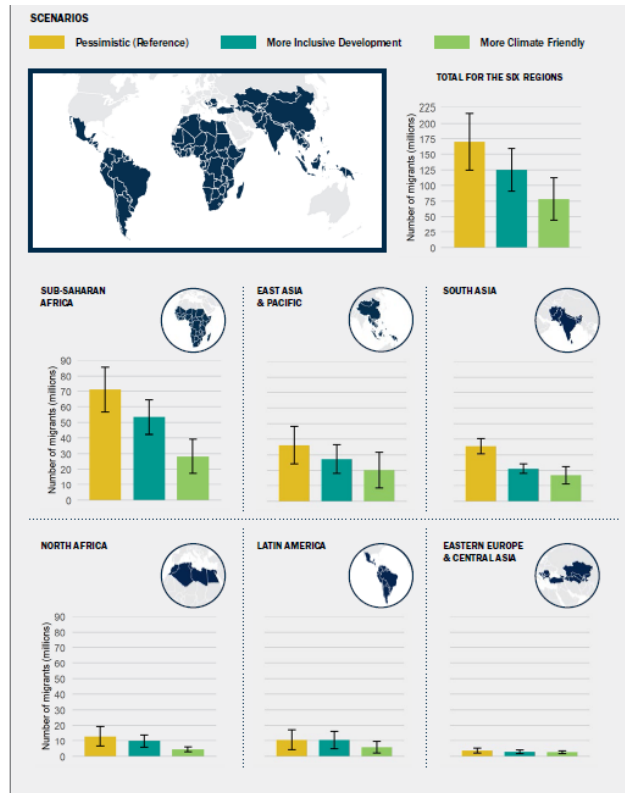
COLUMBIA CLIMATE SCHOOL  
CENTER FOR INTERNATIONAL EARTH SCIENCE  
INNOVATION IN RESEARCH Data Source: Center for International Earth Science Information Network - CIESIN - Columbia University, 2022. Global Gridded Relative Deprivation Index (GRDI), Version 1, Palisades, New York: NASA Socioeconomic Data and Applications Center (SEDAC), <https://doi.org/10.7927/3xxx-ap97>.

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# Groundswell Spatial Population and Migration Projections at One-Eighth Degree According to SSPs and RCPs, 2010-2050

Maps the effect of slow-onset climate change impacts on water availability and crop productivity, coupled with sea-level rise and storm surge, on future population distribution and climate-related internal migration in low to middle income countries.



Based on:

Rigaud, K.K., A. de Sherbinin, B. Jones, J. Bergmann, V. Clement, K. Ober, J. Schewe, S. Adamo, B. McCusker, S. Heuser, and A. Midgley. 2018. *Groundswell: Preparing for Internal Climate Migration*. Washington DC: World Bank.

<https://openknowledge.worldbank.org/handle/10986/29461>

Clement, V., K.K. Rigaud, A. de Sherbinin, B. Jones, S. Adamo, et al. 2021. *Groundswell Part 2: Acting on Internal Climate Migration*. Washington, DC: The World Bank.

<https://openknowledge.worldbank.org/handle/10986/36248>

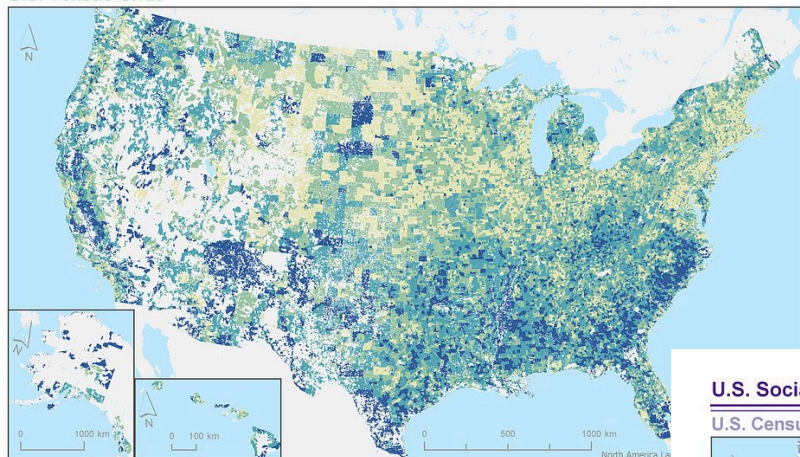
# US Social Vulnerability Index Grids and U.S. Climate Risk Projections by County, v1

<https://doi.org/10.7927/6s2a-9r49> and <https://doi.org/10.7927/abr8-v666>.

- 1) Gridded version of CDC's SVI data sets for 2000-2020
- 2) Projected county-level climate risk for 2040-2049. Includes frequency of heat waves, cold spells, drought, and heavy precipitation events along with anomalies of temperature and precipitation using high resolution (4 km) downscaled climate projections.

**U.S. Social Vulnerability Index Grids (2018): Overall Score**

U.S. Census Grids



The U.S. Social Vulnerability Index Grids are part of the U.S. Census Grids collection. This map displays the overall score for the Centers for Disease Control and Prevention (CDC) Social Vulnerability Index (SVI) gridded at a spatial resolution of 1 km with a mask for no population for the year 2018.

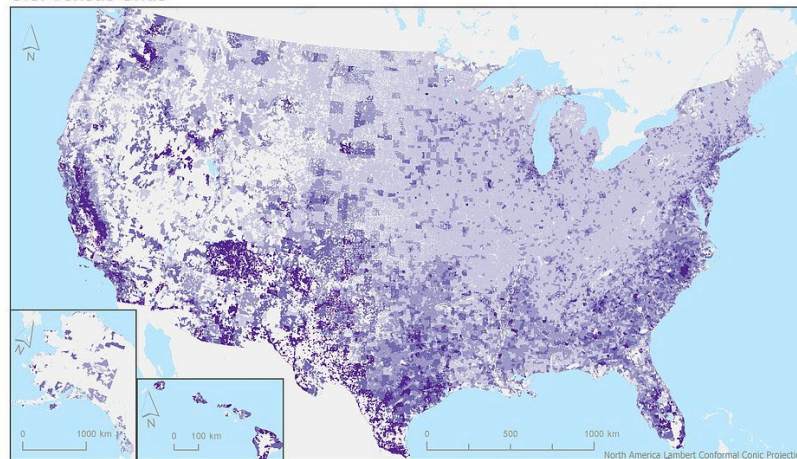
Center for International Earth Science Information Network  
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Data Source: Center for International Earth Science Information Network - CIESIN - Columbia University, 2021. U.S. Social Vulnerability Index Grids. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). <https://doi.org/10.7927/6s2a-9r49>.

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**U.S. Social Vulnerability Index Grids (2018): Minority Status and Language Score**

U.S. Census Grids



The U.S. Social Vulnerability Index Grids are part of the U.S. Census Grids collection. This map displays the minority status and language score for the Centers for Disease Control and Prevention (CDC) Social Vulnerability Index (SVI) gridded at a spatial resolution of 1 km with a mask for no population for the year 2018.

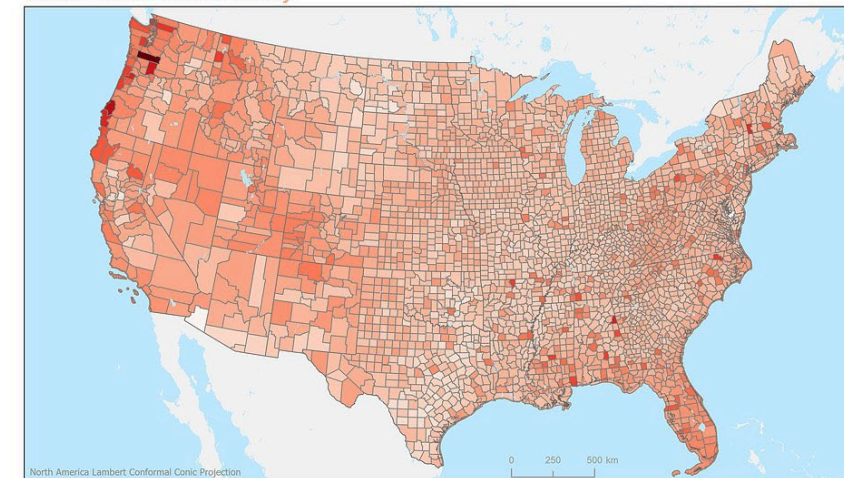
Center for International Earth Science Information Network  
UNIVERSITY

Data Source: Center for International Earth Science Information Network - CIESIN - Columbia University, 2021. U.S. Social Vulnerability Index Grids. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). <https://doi.org/10.7927/6s2a-9r49>.

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**U.S. Climate Risk Projections by County, 2040-2049: Hazard Index**

Climate Risk and Vulnerability



The U.S. Climate Risk Projections by County, 2040-2049 data set is part of the Climate Risk and Vulnerability collection. This map displays a projection for 2040-2049 risk through an index that combines variables for hazards at the county level.

COLUMBIA CLIMATE SCHOOL  
CENTER FOR INTERNATIONAL EARTH SCIENCE  
INFORMATION NETWORK

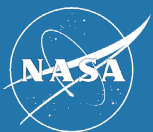
Data Source: KC, B., J. M. Shepherd, A. W. King, and C. J. Galther. 2023. U.S. Climate Risk Projections by County, 2040-2049. Palisades, New York: NASA Socioeconomic Data and Applications Center (SEDAC). <https://doi.org/10.7927/abr8-v666>.

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# SEDAC Impacts and Applications



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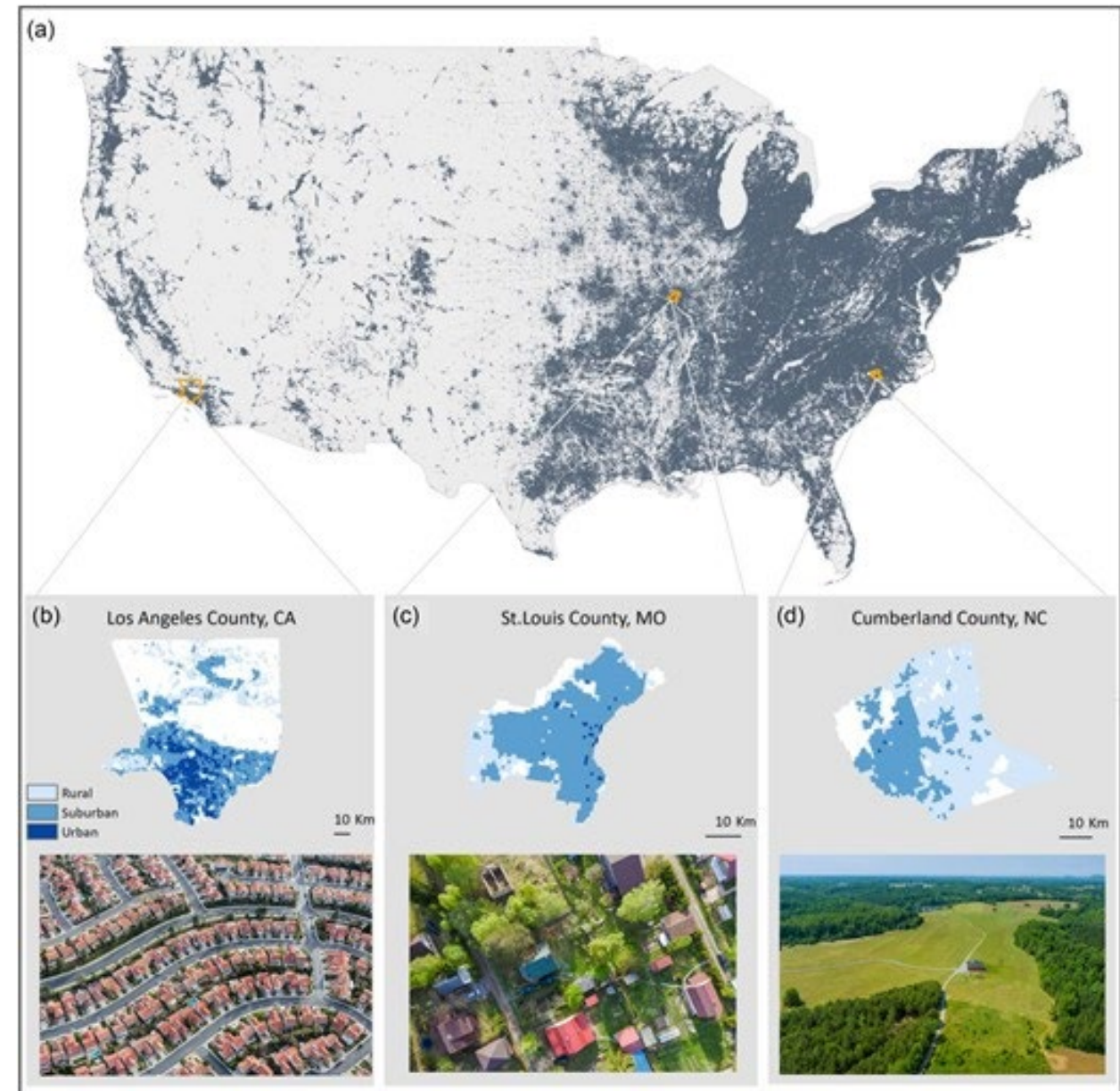
## Recent Citations: *Bioscience*

- ▶ Susannah B Lerman, Kelli L Larson, Desirée L Narango, Mark A Goddard, Peter P Marra, Humanity for Habitat: Residential Yards as an Opportunity for Biodiversity Conservation, *BioScience*, 73(9) 671–689, Sept. 2023, <https://doi.org/10.1093/biosci/biad085>.
  - ▶ Cites: **U.S, Census Grids** (2010)



2022 Impact Factor: 10.1

Fig. 1: Residential lands are a significant proportion (estimated at 30%) of the conterminous US landscape. (a) The high-resolution map (1 square kilometer resolution) shows detached housing density and the extent of residential yards based on the 2010 US Census for the conterminous United States (CIESIN 2017).

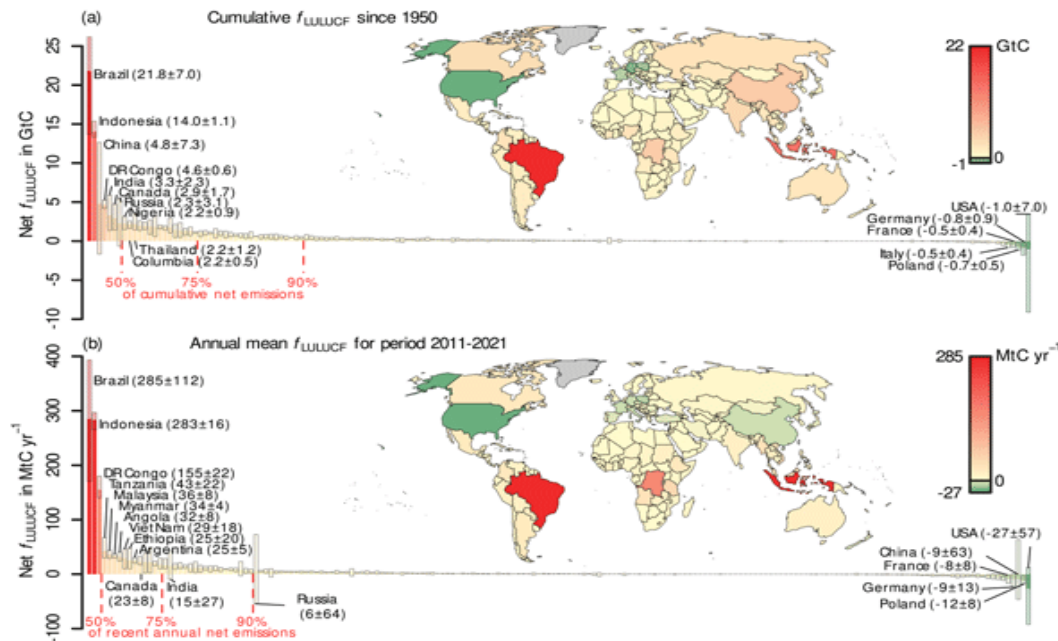




# Recent Citations: *Earth System Science Data*

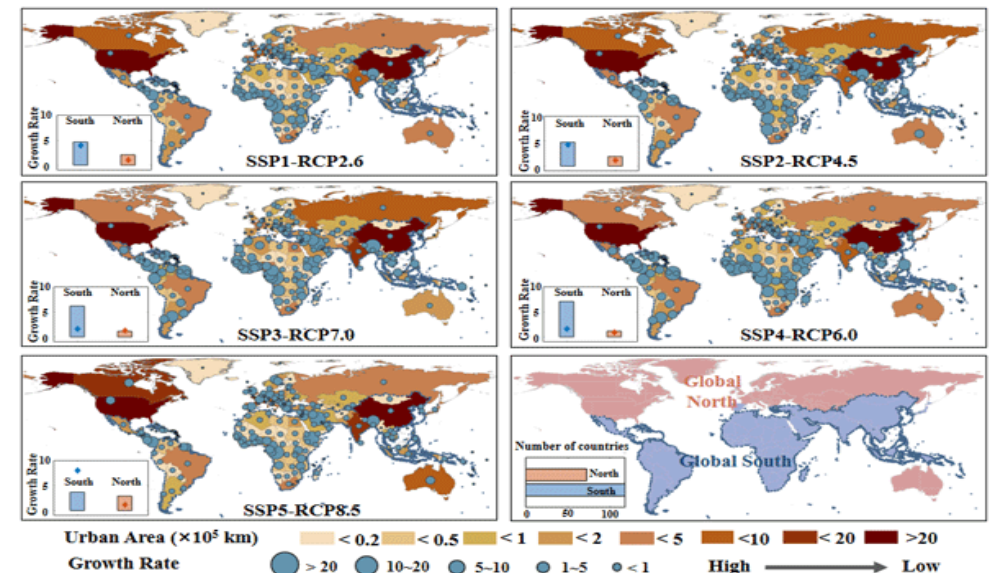
- Obermeier, W. A., Schwingshackl, C., Bastos, A., Conchedda, G., Gasser, T., Grassi, G., . . . Pongratz, J. (In press). Country-level estimates of gross and net carbon fluxes from land use, land-use change and forestry. *Earth System Science Data*. doi: 10.5194/essd-2023-281.

- GPWv4.11

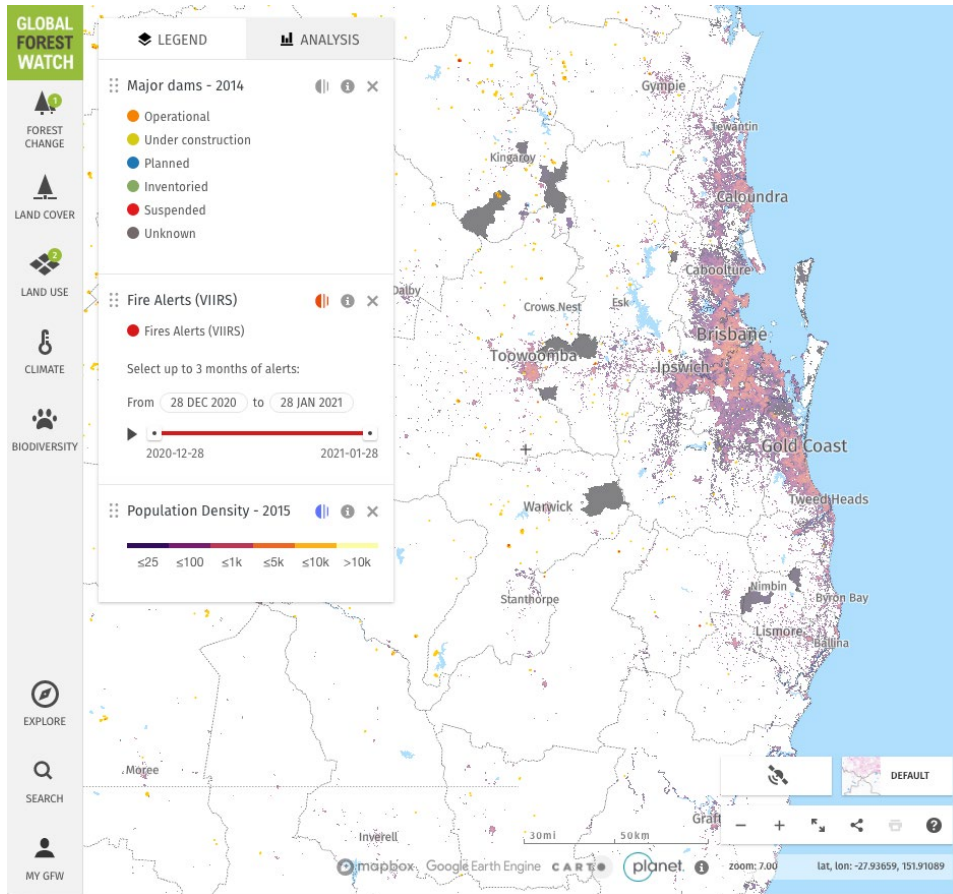


- He, W., Li, X., Zhou, Y., Shi, Z., Yu, G., Hu, T., . . . Gong, P. (2023). Global urban fractional changes at a 1-km resolution throughout 2100 under eight scenarios of Shared Socioeconomic Pathways (SSPs) and Representative Concentration Pathways (RCPs). *Earth System Science Data*, 15(8), 3623-3639. doi: 10.5194/essd-15-3623-2023.

- Global Man-made Impervious Surface (GMIS) Dataset From Landsat, v1, NASA Moderate Resolution Imaging Spectroradiometer (MODIS), and Shuttle Radar Topography Mission (SRTM)

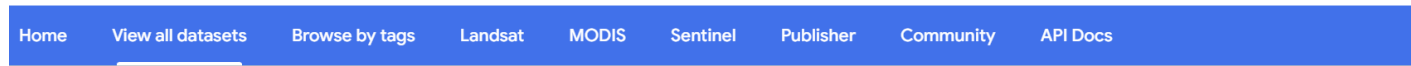


# SEDAC data and services are available through data analysis tools and decision support systems, e.g., Global Forest Watch and Google Earth Engine

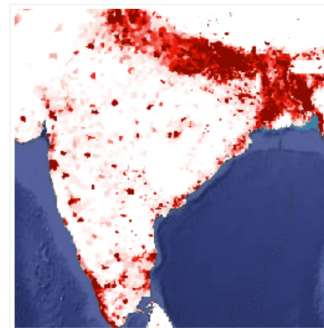


<https://www.globalforestwatch.org/>

## Earth Engine Data Catalog



### GPWv411: Basic Demographic Characteristics (Gridded Population of the World Version 4.11)



#### Dataset Availability

2000-01-01T00:00:00Z-2020-01-01T00:00:00Z

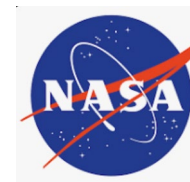
#### Dataset Provider

[NASA SEDAC at the Center for International Earth Science Information Network](#)

#### Earth Engine Snippet

```
ee.ImageCollection("CIESIN/GPWv411/GPW_Basic_Demographic_Characteristics")
```

<https://developers.google.com/earth-engine/datasets/catalog/>



<https://lpdaac.usgs.gov/tools/appears/>



# SEDAC Guide to Remote Sensing for Social Scientists: Tools to Facilitate the Use of Remote Sensing Data in the Social and Health Sciences Research

## Welcome to **AppEEARS!**

Application for Extracting and Exploring Analysis Ready Samples (AppEEARS)

**AppEEARS** (Application for Extracting and Exploring Analysis Ready Samples) aims to significantly reduce the amount of data users needed to download and process. It enables similar datasets to be discovered more easily and provides a way to more efficiently explore results. It enables users to subset [geospatial datasets](#) using spatial, temporal, and band/layer parameters. Three layers from SEDAC's Gridded Population of the World version 4 (data quality indicators, population counts and population densities) are included among the available datasets.

## **GIOVANNI**

**Giovanni** (GES-DISC (Goddard Earth Sciences Data and Information Services Center) Interactive Online Visualization AND aNalysis Infrastructure) is a web application that provides a simple, intuitive way to visualize, analyze, and access Earth science remote sensing data, particularly from satellites, without having to download the data. SEDAC socioeconomic and population datasets can be easily integrated with Giovanni layers, as shown in this [use case](#).

*These additional tools also offer significant power for social and health science users interested in integrating remote sensing with socioeconomic and health data:*

## ArcGIS Living Atlas of the World

The **ArcGIS Living Atlas of the World** is the foremost collection of geographic information from around the globe. It includes maps, apps, and data layers to support your work. It allows to explore maps, apps, and data layers from Esri and thousands of other organizations; to combine content with the user's own data to create new maps and applications; and to share how other users are visualizing data and solving problems. A large number of SEDAC data layers – from population, to poverty, to roads – are included in the Living Atlas. Just search on the term "SEDAC" from the large search box on the home page.

## **GEOQUERY**

**Geoquery** is a tool developed by AidData at William and Mary College to enable users to integrate satellite, conflict, development aid, economic, health and more subnational data, from anywhere in the world, into a single simple-to-use file compatible with Excel, STATA, or your own favorite program. Users are able to extract these data for subnational administrative units for any country. Remote sensing derived data include VIIRS and DMSP-OLS nighttime lights, MODIS land surface temperature, MODIS land cover, and two air quality metrics. A handy user [user guide](#) provides step-by-step instructions.

## Google Earth Engine

**Google Earth Engine** is a platform for petabyte-scale scientific analysis and visualization of geospatial datasets, both for public benefit and for business and government users. Earth Engine stores satellite imagery, organizes it, and makes it available for the first time for global-scale data mining. The public data archive includes historical earth imagery going back more than forty years, and new imagery is collected every day. Earth Engine also provides APIs in JavaScript and Python, as well as other tools, to enable the analysis of large datasets. SEDAC's Gridded Population of the World v4 is included as a data layer that can be used in conjunction with satellite remote sensing imagery.



**IPUMS Terra** provides globe-spanning data on human population characteristics, land use, land cover, and climate and makes these data interoperable by performing transformations across population microdata (individual- and household-level records), area-level data, and raster data, enabling researchers can get the variables they need in the data structure best suited to their analysis.



**Worldview** allows users to interactively browse global satellite imagery within hours of it being acquired. This app from NASA's [EOSDIS](#) provides the capability to interactively browse over 600 global, full-resolution satellite imagery layers and then download the underlying data. Many of the available imagery layers are updated in near real time (NRT, or within three hours of observation), essentially showing the entire Earth as it looks "right now". This supports time-critical application areas such as wildfire management, air quality measurements, and flood monitoring. Arctic and Antarctic views of several products are also available for a "full globe" perspective. SEDAC population, settlements, hazard and socioeconomic data may be added to the map viewer by clicking on the orange "Add Layers" button, then clicking on the "Science Disciplines" tab, and then selecting the "Human Dimensions" category, or by using the search box. Once a layer is selected, overlays of NRT satellite data are possible by clicking on the "layer options" from the legend, and setting opacity to 50% or lower.

<http://sedac.ciesin.columbia.edu/binaries/web/sedac/thematic-guides/remote-sensing-tools-for-social-scientists.pdf>

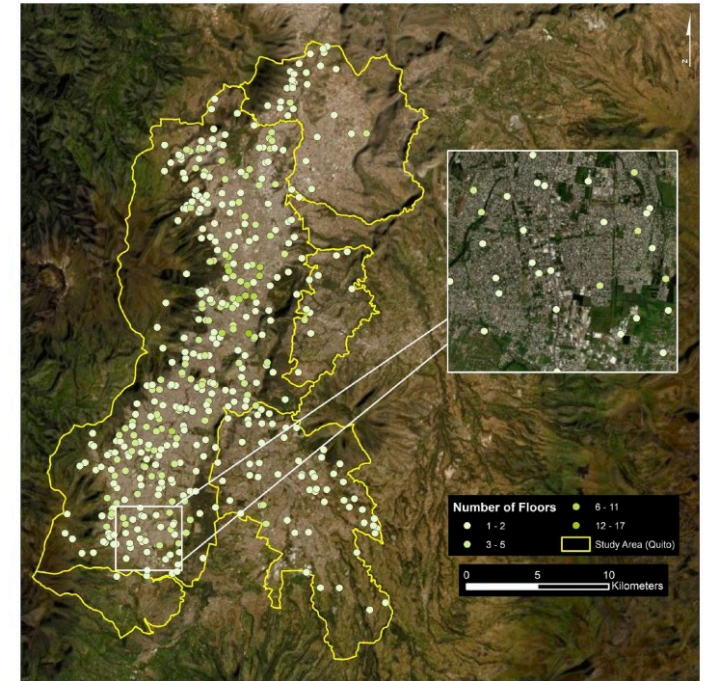


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# SEDAC Impact: Training Young Professionals

- ▶ SEDAC's contract includes a HBCU/MSI subcontracting/spending goal
  - ▶ SEDAC collaborated with faculty from Lehman Colleges' MS in Geographic Science program
  - ▶ Team of 5 students used machine learning (Amazon Turk) to characterize features of built infrastructure from imagery for flood hazard assessment
  - ▶ Paper published in IEEE journal
  - ▶ Two students hired by NASA MSFC: Natalia Bermudez and Lauren Carey; another student now works for the U.S. Census Bureau
- ▶ Similar goal in new contract; working with Lehman to identify additional students and data projects



**FIGURE 5.** Map of observations collected on the number of floors at point locations.

<https://doi.org/10.1109/OJCS.2022.3166887>



Juan Martinez from SEDAC with students from Colombia at AmeriGEO 2023

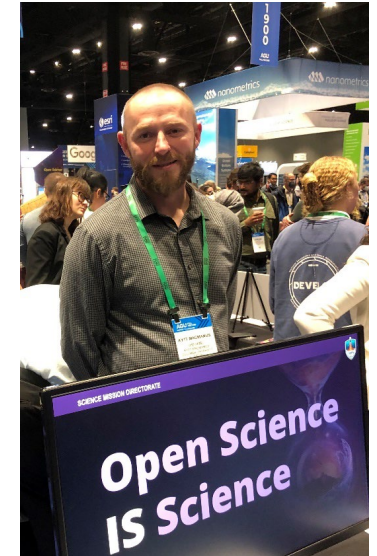




# Open Science Efforts at SEDAC



- ▶ **K. MacManus** is leading a 2-year TOPS project on “Science Core Heuristics for Open Science Outcomes in Learning” (SCHOOL).
- ▶ **R. Chen** and **R. Downs** helped organize the GEO Open Data & Knowledge Workshop in Geneva in June 2023.
- ▶ **R. Downs** served on the organizing committee for the NASA SMD Open Source Science Data Repositories Workshop in Boulder CO on 27-29 September 2023.
- ▶ **S. Adamo** virtually attended the first meeting of the Committee on Science and Open Data of the InterAmerican Institute for Global Change Research (IAI) on 5 Sept 2023.
- ▶ SEDAC organized a workshop on open science for the **human dimensions of environmental change community** on 9 January 2024 in New York. Topics included:
  - ▶ Introductions to NASA Open Science Initiatives
  - ▶ Interactive sessions with pioneers in the field showcasing their workflows and techniques
  - ▶ Discussions on ethical considerations, cloud data providers, and open access practices
  - ▶ Breakout sessions focusing on specific themes like environmental justice, climate impacts, and remote sensing and socioenvironmental data integration
  - ▶ Networking opportunities to connect with fellow researchers and professionals



K. MacManus at NASA booth, AGU 2022



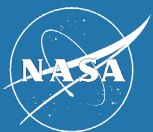
R. Downs with ESIP's 2023 Martha Maiden Lifetime Achievement Award



Thanks!

Alex de Sherbinin

Reach out at [amd155@columbia.edu](mailto:amd155@columbia.edu)



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