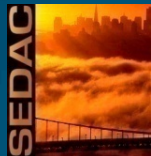


Potential Collaboration on Exposure Data for Population, Settlements, and Infrastructure

Dr. Robert S. Chen

Director and Senior Research Scientist

Manager, NASA Socioeconomic Data and Applications Center (SEDAC)



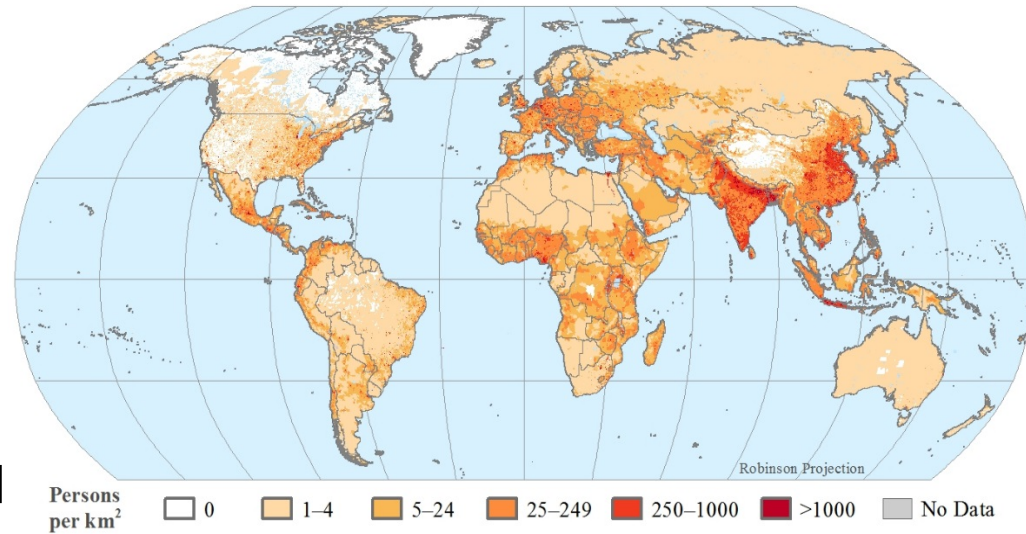
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Many Different Population Products Now Available – and More Are on the Way!

	Coverage	Resolution	Population	Method	Ancillary data used	Method consistency
GPWv4	Global	1km	Residential	Areal-weighting	None	Globally consistent
GRUMP	Global	1km	Residential	Dasymetric mapping	Nighttime lights, settlement points	Globally consistent
LandScan	Global	1km	Ambient	Dasymetric mapping	Roads, slope, elevation, land cover, urban boundaries, nighttime lights	Varies by country
WorldPop	Africa, Asia, Central and South America	100m - 1km	Residential	Dasymetric mapping	Land cover, settlement boundaries, roads, nighttime lights, health facility locations	Varies by country
Geostat	Europe	1km	Residential	Aggregation of microcensus; disaggregation and spatial modelling	Land cover, roads	Varies by country

Gridded Population of the World version 4 (GPWv4)

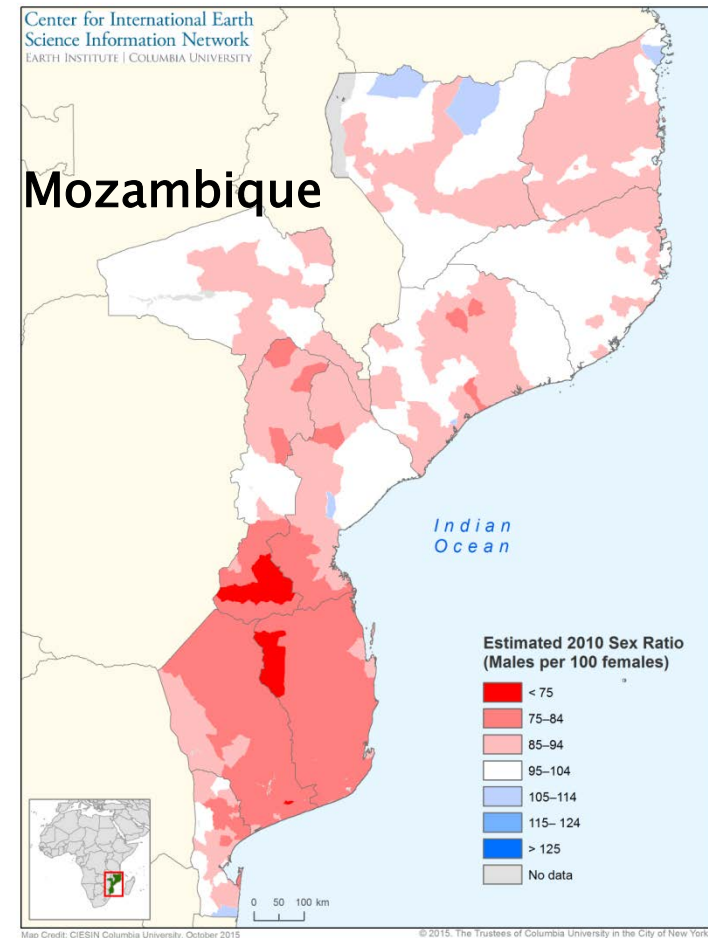
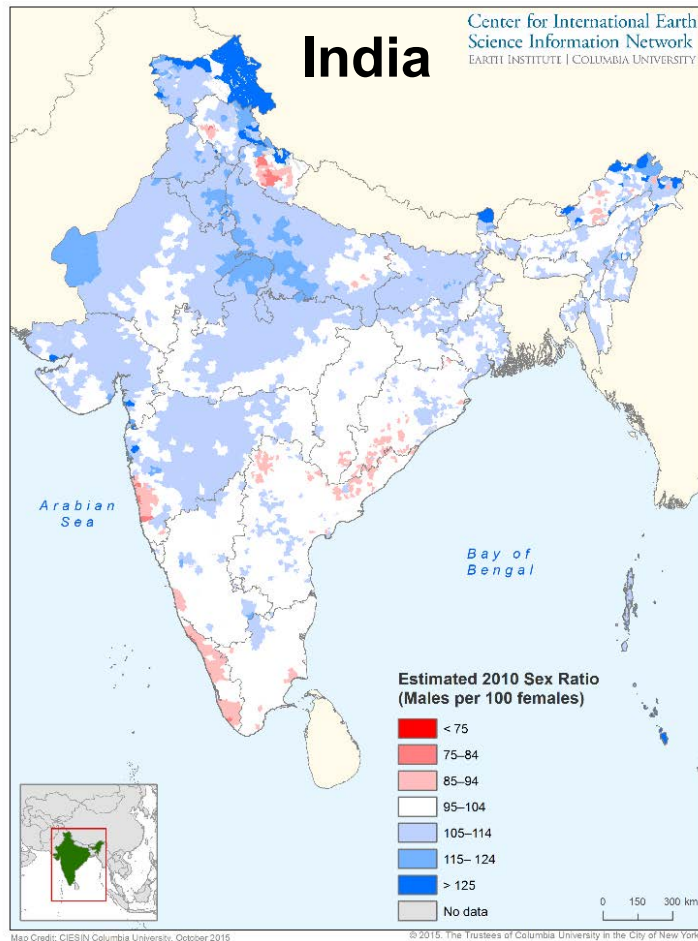
- ▶ Basic inputs:
 - 2010 round of population censuses or latest available census data
 - Geographic boundaries matching census cartography
- ▶ Variables: population counts, density, **urban/rural status** (as defined by the country), **age and gender structures**
- ▶ Higher resolution: **30 arc seconds** (approximately 1 km at the equator), vs. 2.5 arc minutes in GPW v3
- ▶ Coverages for 2000, 2005, 2010, plus short-term projections to 2015 and 2020



- ▶ Open access dataset (CC-BY-4.0)
- ▶ Accessible through open web services and query tools
- ▶ Pop counts and density datasets now available. Disaggregated data in development.



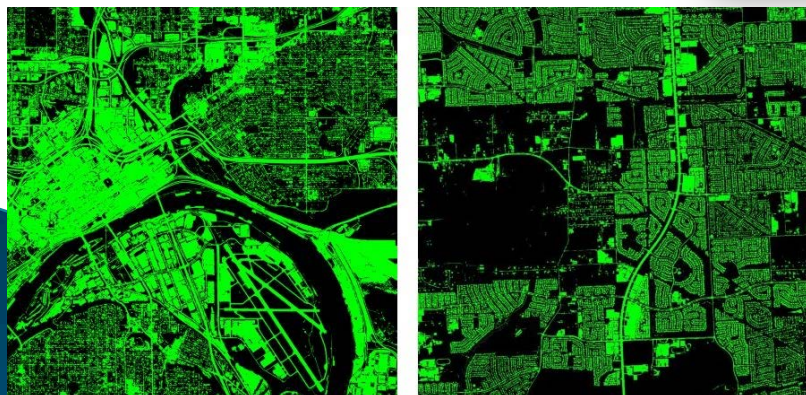
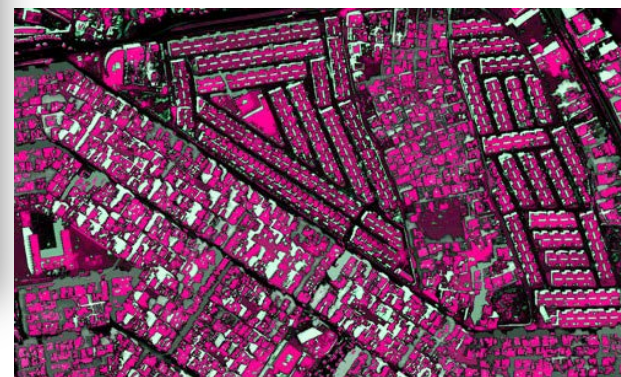
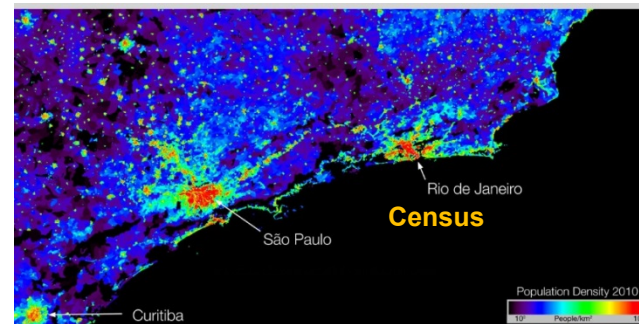
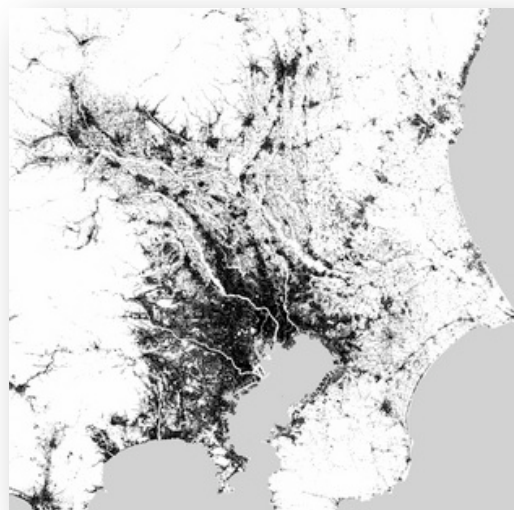
GPW v4: Sex Ratio Grids (preliminary 2010 estimates)



Source: Doxsey-Whitfield, E., S. Adamo and K. MacManus (2015). *Gridding global male and female populations: New data from the Gridded Population of the World (GPW)*. European Forum for Geography and Statistics (EFGS), Vienna conference.

Use of Remote Sensing to Map Urban vs. Rural Areas, Settlements, Infrastructure

- ▶ Night-time lights (DMSP >1 km → VIIRS ~750m)
- ▶ Landsat (~30 m)
- ▶ Radar (~12 m)
- ▶ High resolution imagery (< ~3m resolution)



Collaboration with Facebook

- ▶ Collaboration with Internet.org/Facebook to produce open access <30-m resolution population density estimates: based on 50-cm remote sensing imagery (IKONOS)
- ▶ Currently conducting a validation project with Facebook
- ▶ Aiming to release data for >30 countries by fall 2016

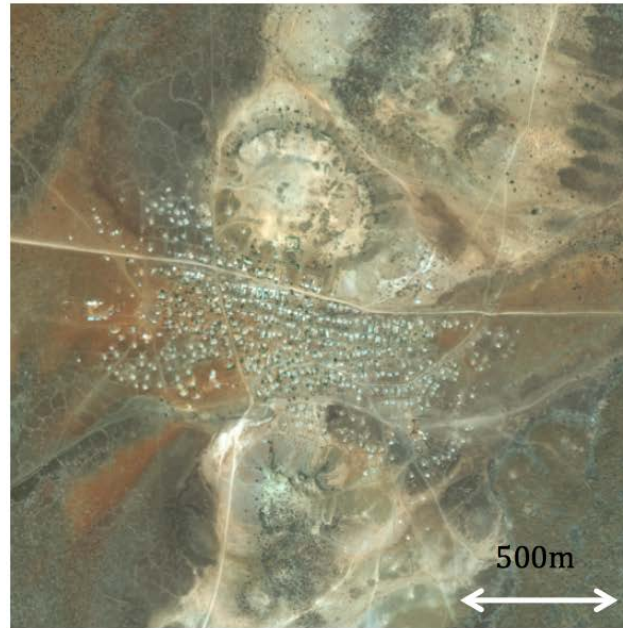


Figure 2A: Dense settlement where a short-range wireless hotspot would be efficient. Imagery: DigitalGlobe

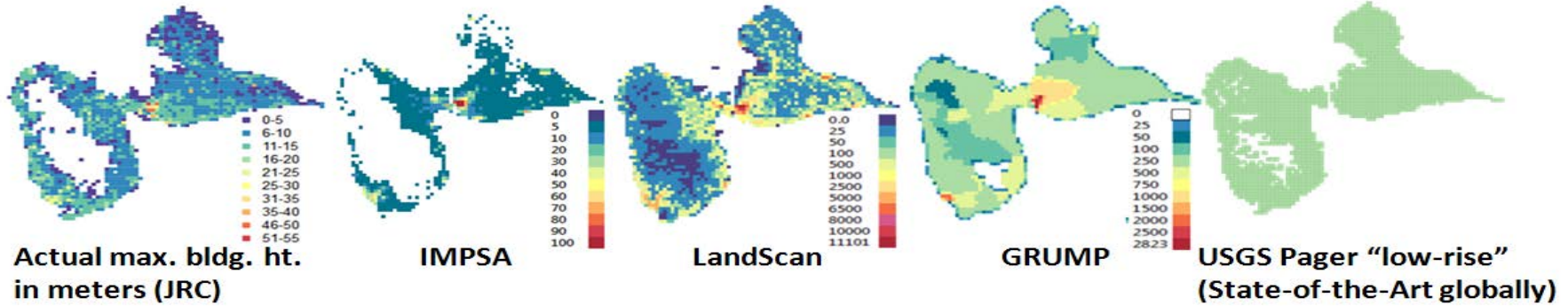


Figure 2B: Sparse, scattered settlement that would benefit from long-range cellular technology. Imagery: DigitalGlobe

- ▶ Specific relevance to SDG target 9.c: "Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020."

<http://blogs.ei.columbia.edu/2016/02/22/working-with-facebook-to-create-better-population-maps/>

Characterizing Building Fragility Using Remote Sensing



Zone Land Use	Basic Structural Type	Detailed Structural Type	Stories	# of Buildings	Total Sq Meters
Airport	Reinforced Concrete	Frame	1	20	15,000
Commercial	Masonry	Confined masonry	1	861	173,413
Commercial	Masonry	Confined masonry	2	270	173,616
Commercial	Masonry	Reinforced masonry	1	175	37,352
Commercial	Masonry	Unreinforced clay brick	1	2151	303,389
Commercial	Masonry	Unreinforced clay brick	2	97	35,452
Commercial	Masonry	Unreinforced, with reinforced concrete floors	2	97	41,191
Commercial	Reinforced Concrete	Frame	1	451	105,211
Commercial	Reinforced Concrete	Frame	2	296	387,201
Commercial	Reinforced Concrete	Shear wall	1	77	12,214
Commercial	Reinforced Concrete	Shear wall	2	146	57,050
Commercial	Timber/Wood	Open frame at grade	1	886	118,346
Commercial	Other	Other		171	173,692
Industrial	Masonry	Confined masonry	1	849	171,021
Industrial	Masonry	Reinforced masonry	1	849	181,263
Industrial	Reinforced Concrete	Frame	2	562	735,185
Industrial	Steel	Braced frame	1	280	134,875
Industrial	Steel	Braced frame	7	1	8,784
Industrial	Steel	Light frame (transverse-frame; longitudinal-steel rod tension-only bracing)	1	562	762,777
Industrial	Steel	Moment frame	1	280	58,204
Industrial	Steel	Moment frame	2	280	48,667

Developing Global Building Exposure for Disaster Forecasting, Mitigation, and Response

- ▶ PI: Ron Eguchi, ImageCAT
- ▶ Co-PIs: Robert Chen (CIESIN), Charles Hucyk (ImageCat), David Trailli (JPL)



Terra Populus: A Global Population/Environment Data Network

- ▶ Links census household microdata with areal and raster data
- ▶ Builds on IPUMS International holdings (859 million records across 65 countries)
- ▶ Harmonized subnational boundaries and variables across countries, time

TERRA POPULUS

Give us feedback Home | Login | Sign up | About | Contact Us | User Forum

1 Select Microdata Data 2 Attach Area-Level Data 3 Attach Raster Data 4 Submit NEXT

Browse Variables

Household Person Search

Technical Household 5

Group Quarters

Geography: Global

Geography: A-L

Geography: M-Z

Household Economic

Utilities

Appliances, Mechanicals, Other Amenities

Dwelling Characteristics

Other Household

Constructed Household

Microdata Data

Select Data [What is this?](#)

☐ Show only selected variables

☐ Show only selected datasets

☒ Display unavailable variables

Dwelling Characteristics Variables

Variable	Label
<input type="checkbox"/> AGESTRUCT1	Age of structure
<input type="checkbox"/> AGESTRUCT2	Age of structure, coded from intervals
<input type="checkbox"/> BATH	Bathing facilities
<input type="checkbox"/> BATHROOMS	Number of bathrooms
<input type="checkbox"/> BEDROOMS	Number of bedrooms

Browse Datasets

Countries Search

Browsing Options

Africa

Asia

Europe

North America

Oceania

South America

Funding provided by: National Science Foundation Copyright © 2012 - 2016 Regents of the University of Minnesota All rights reserved.

Source Code Finger Print: acd7bd4 | Build 20160429

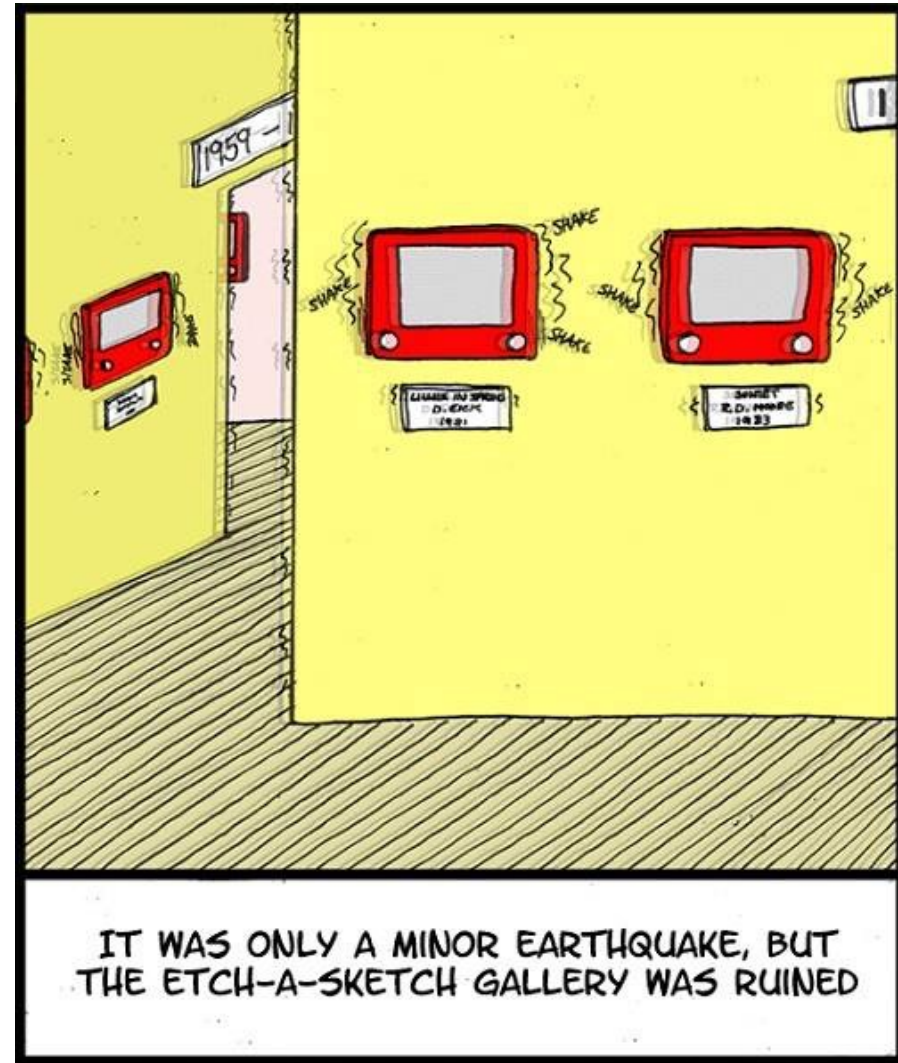


What Infrastructure Is of Interest?

- ▶ Residential, commercial, and public buildings and other structures
- ▶ Road networks, bridges, tunnels, shipping facilities
- ▶ Airports, ports, marinas
- ▶ Rail & mass transit facilities
- ▶ Water, sanitation, storm sewers, reservoirs, dams
- ▶ Communication networks & facilities
- ▶ Hospitals, clinics, shelters
- ▶ Power plants, power grids, gas lines, gas stations...
- ▶ Police & fire stations, military facilities, jails
- ▶ Industrial and office parks, warehouses, food storage & processing facilities
- ▶ Landfills, hazardous waste sites
- ▶ Universities, schools, daycares
- ▶ Theatres, museums, parks
- ▶ Malls, commercial areas, slums

For this infrastructure, we would also like to know...

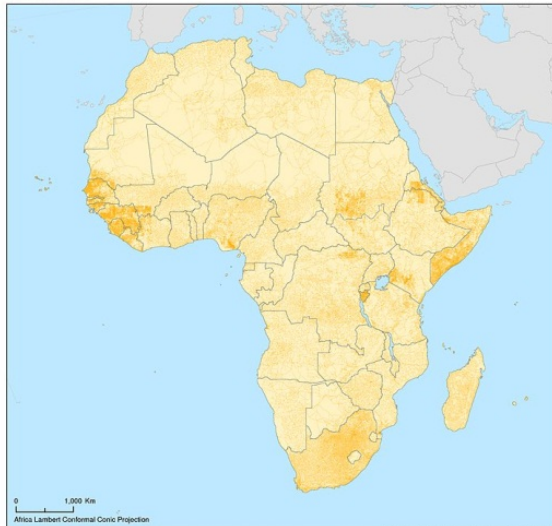
- ▶ Location and access
- ▶ Construction type, design, materials
- ▶ Building heights and volumes
- ▶ Condition
- ▶ Occupancy and contents
- ▶ Insured and uninsured value
- ▶ Replacement costs
- ▶ Usage by time of day, day of week, season
- ▶ Protective measures (alarms, sprinklers, etc.)
- ▶ System/network interdependencies
- ▶ ...



Example Infrastructure Data at SEDAC

Global Roads Open Access Data Set, Version 1 (gROADSv1): Africa

Global Roads



The Global Roads Open Access Data Set, Version 1 (gROADSv1) was developed under the auspices of the CODATA Global Roads Data Development Task Group. The data set combines the best available roads data by country into a global roads coverage, using the UN Spatial Data Infrastructure Transport (UNSDI-T) version 2 as a common data model. Because the data are compiled from multiple sources, the dates for road network representations range from the 1980s to 2010, depending on the country, and spatial accuracy varies. National borders are provided for reference purposes only, and CIESIN and its sponsors do not take a position with regards to the representation of boundaries.

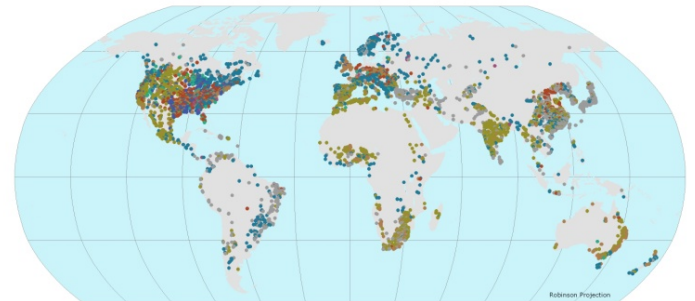
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In the works:

- Georeferenced power plant data (CARMA update)
- Global impervious surface data (NASA GSFC)
- gROADS version 2

Global Reservoir and Dam Database (GRanD), v 1

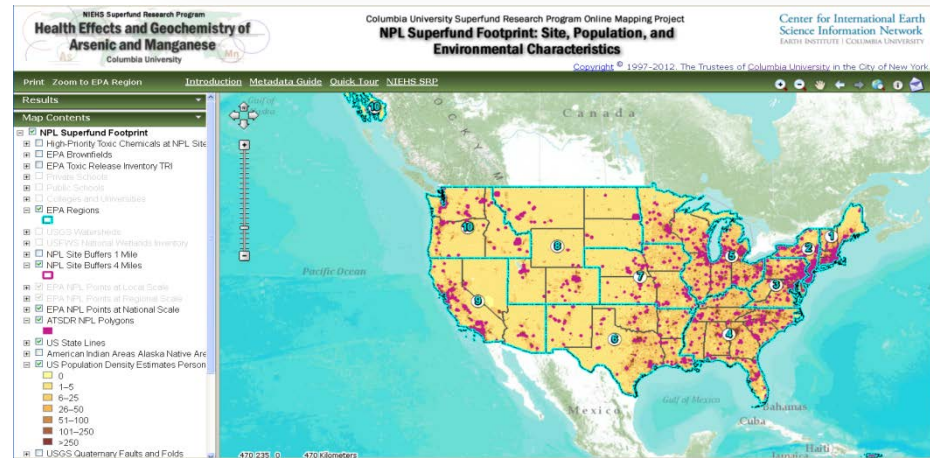
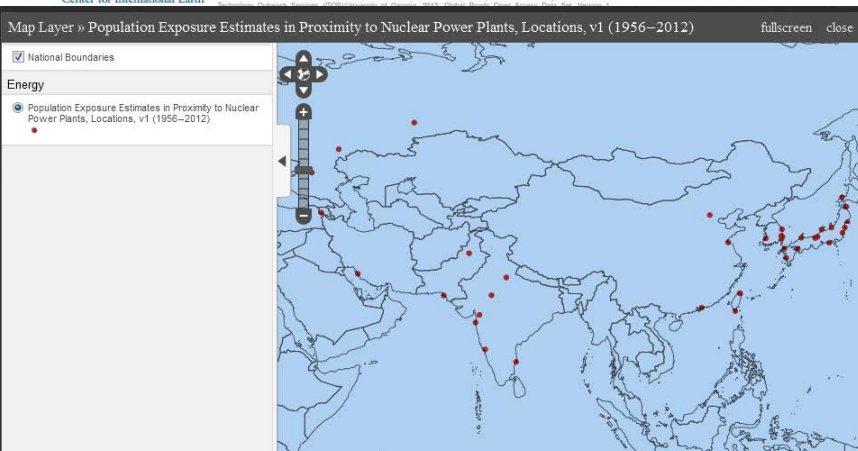
Dams



Reservoir and Dam

The Global Reservoir and Dam Database, Version 1 (Revision 01) contains 6,862 records of reservoirs and their associated dams with a cumulative storage capacity of 6,197 cubic km. The dams were geospatially referenced and assigned to polygons depicting reservoir outlines at high spatial resolution. While the main focus was to include all dams associated with reservoirs that have a storage capacity of more than 0.1 cubic kilometers, many smaller dams and reservoirs were added where data were available.

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Other Relevant Urban Data and Projections

Recently released:

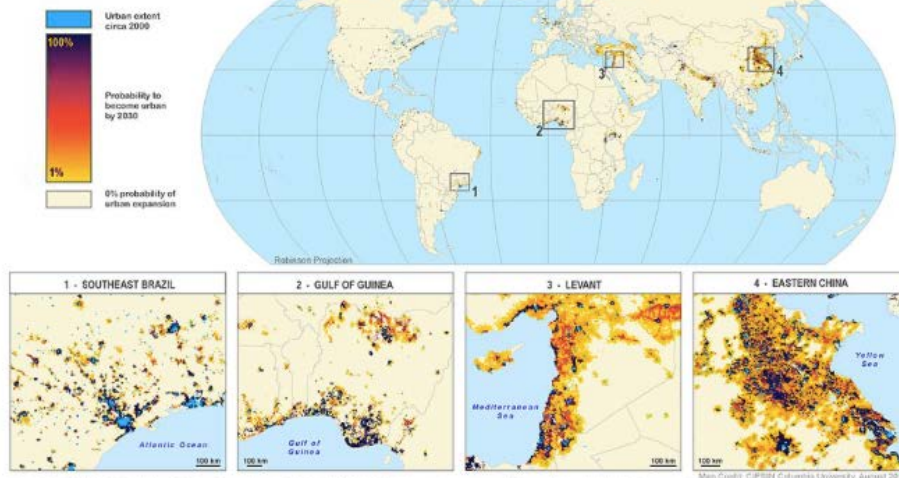
- Probabilities of Urban Expansion to 2030 (Seto)
- Slum maps for Dar es Salaam, 1982-2003

In process or under consideration:

- G-ECON GDP grids (Nordhaus)
- Population and GDP grids for SSPs (ICONICS)
- Global urbanization, 3700 BC to AD 2000 (Seto)

Global Grid of Probabilities of Urban Expansion to 2030

Land Use and Land Cover (LULC)



The Global Grid of Probabilities of Urban Expansion to 2030, v1 (2000-2030) data set presents spatially explicit probabilistic forecasts of global urban land-cover change from 2000 to 2030 and is part of the Land Use and Land Cover (LULC) collection. For each grid cell that is non-urban in 2000, a Monte-Carlo model assigned a probability of becoming urban by the year 2030. The authors first extracted urban extent circa 2000 from the NASA MODIS Land Cover Type Product v5, then used population densities from SEDAC's Global Rural-Urban Mapping Project (GRUMPv1) to create a population density driver map. Next, using the present empirical distribution of regional urban population densities along with the probability density functions of projected regional population and GDP values for 2030, new urban land in each region by 2030 was estimated in a Monte-Carlo fashion.

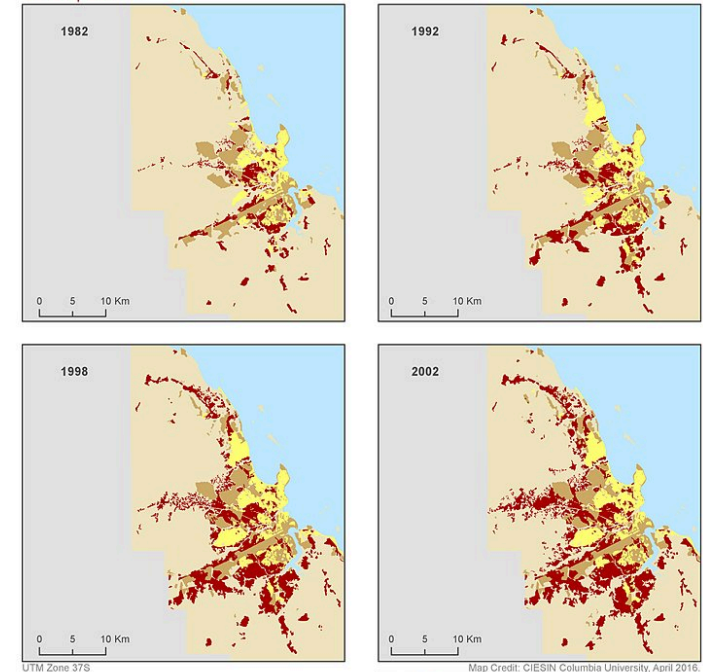
Center for International Earth Science Information Network
Data Source: Seto, K., B. Güneralp, and L.R. Hutyra. 2015. Global Grid of Probabilities of Urban Expansion to 2030. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). <http://dx.doi.org/10.7927/H43T9F56>.

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Dar es Salaam Land Use and Informal Settlement (1982, 1992, 1998, 2002): Tanzania

Urban Spatial Data



The Dar es Salaam Land Use and Informal Settlement Data Set (1982, 1992, 1998, 2002) represents urban land use changes and consolidation of informal settlements for the years 1982, 1992, 1998 and 2002, and is part of the Urban Spatial Data collection. This map displays the spatial extent of land use and informal settlements.

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Data Source: Sliuzas, R.V., A. Hill, C. Lindner, and S. Greiving. 2016. Dar es Salaam Land Use and Informal Settlement Data Set. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). <http://dx.doi.org/10.7927/H43T9F56>.

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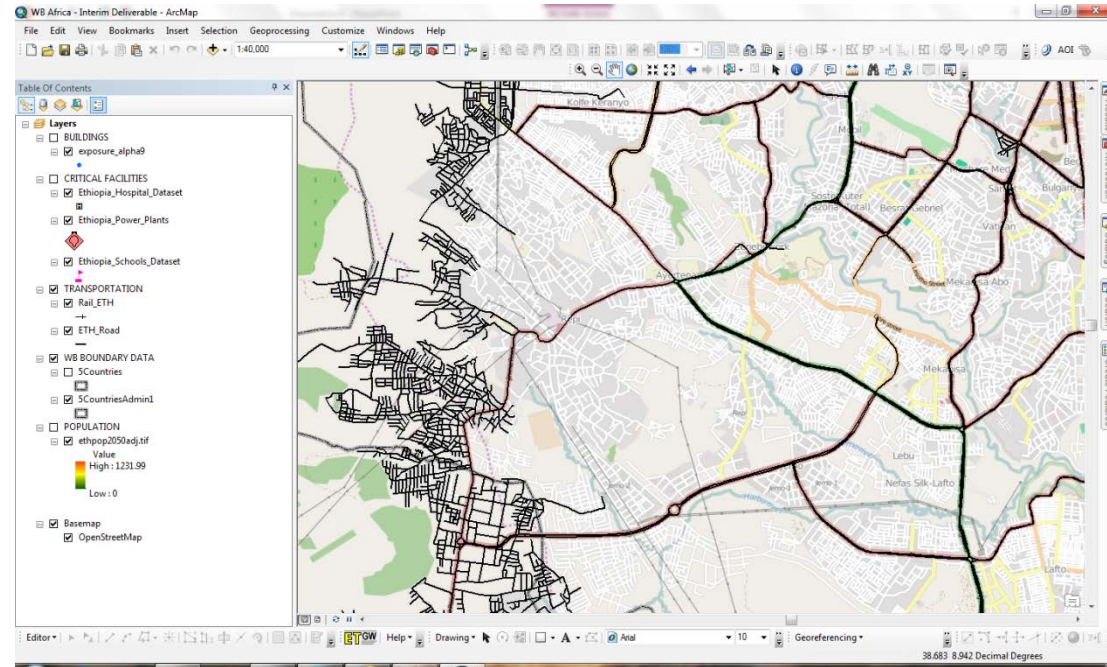
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World Bank GFDRR Project



GFDRR
Global Facility for Disaster Reduction and Recovery

- ▶ World Bank's Global Facility for Disaster Risk Reduction commissioned 5 teams to prepare hazard data for selected African countries
- ▶ CIESIN is part of exposure team led by ImageCat, Inc.
 - Population and GDP distribution, current and 2050 (SSP2)
 - Building characteristics
 - Roads, rails, and **bridges**
 - Critical facilities
 - **Replacement costs**
- ▶ Ethiopia, Kenya, Niger, Uganda, and Senegal
- ▶ Phase 2: Cape Verde, Mali, Malawi, Mozambique



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Settlements, Infrastructure, and Population Data Intercomparison Project (SIP-DIP)

► Purpose

- Accelerate development of high quality, consistent, highly usable georeferenced SIP data
- Improve understanding of the strengths and weaknesses of existing and planned SIP data products relative to different user needs
- Create an intercomparison framework, including testing and validation strategies, consensus on standards/reference data
- Create a collaborative SIP data community (both producers and users) across the natural, social, health, engineering, and data sciences and the public and private sectors
- Develop functional links between research and innovation on SIP data and emerging operational uses of such data in monitoring the SDGs, disaster management, climate adaptation, etc.

► Plan

- Session and side meeting at SciDataCon 2016 in Denver in September
- Follow-up meeting at Columbia in early 2017

SciDataCon 2016 Session and Side Meeting

Session 74: Mapping Population Distribution and Human Settlements: Pushing Boundaries and Expanding Applications

- **Baruch College:** Deborah Balk, Bryan Jones
- **Columbia U./CIESIN:** Robert Chen, Alex de Sherbinin, Kytt MacManus, Greg Yetman
- **Columbia U./LDEO:** Chris Small
- **Esri:** Charles Frye, Earl Nordstrom
- **European Forum for Geography & Statistics/Statistics Norway:** Vilni Verner Holst Bloch
- **Facebook:** Andi Gros
- **Google:** Allison Lieber, Matt Hancher
- **ImageCat, Inc.:** Charles Huyck
- **JRC:** Martino Pesaresi
- **ORNL:** Budhendra Bhaduri, Eddie Bright, Amy Rose, Marie Urban, Jeanette Weaver, Eric Weber
- **WorldPop/U. of Southampton/U. of Louisville:** Andrea Gaughan
- **US Census Bureau/UN-GGIM:** Tim Trainor
- **(DLR:** Julian Zeidler)

SciDataCon 2016





SEDAC HazPop Mobile App and Hazard Mapper



Hazards and Population Mapper

By NASA

Open iTunes to buy and download apps.



Description

Hazards and Population Mapper (HazPop) is a free app that enables users to easily display recent natural hazard data in relationship to population, major infrastructure, and satellite imagery. Hazards data include the location of active fires over the past 48 hours; earthquake alerts over the past seven days; and yesterday's air pollution data measured

[Hazards and Population Mapper Support](#) [Application License Agreement](#) [... More](#)

What's New in Version 1.3

- Image layers, such as Population Density, AOD, and Fires, are now retrieved over secure HTTPS connection.
- Population estimates are now retrieved over secure HTTPS connection.
- Bug fix.

[View in iTunes](#)

This app is designed for both iPhone and iPad

Free

Category: Reference

Updated: Oct 18, 2016

Version: 1.3

Size: 11.9 MB

Language: English

Seller: NASA

© NASA 2016

Rated 4+

Compatibility: Requires iOS 9.0 or later. Compatible with iPhone, iPad, and iPod touch.

Customer Ratings

We have not received enough ratings to display an average for the current version of this application.

More by NASA

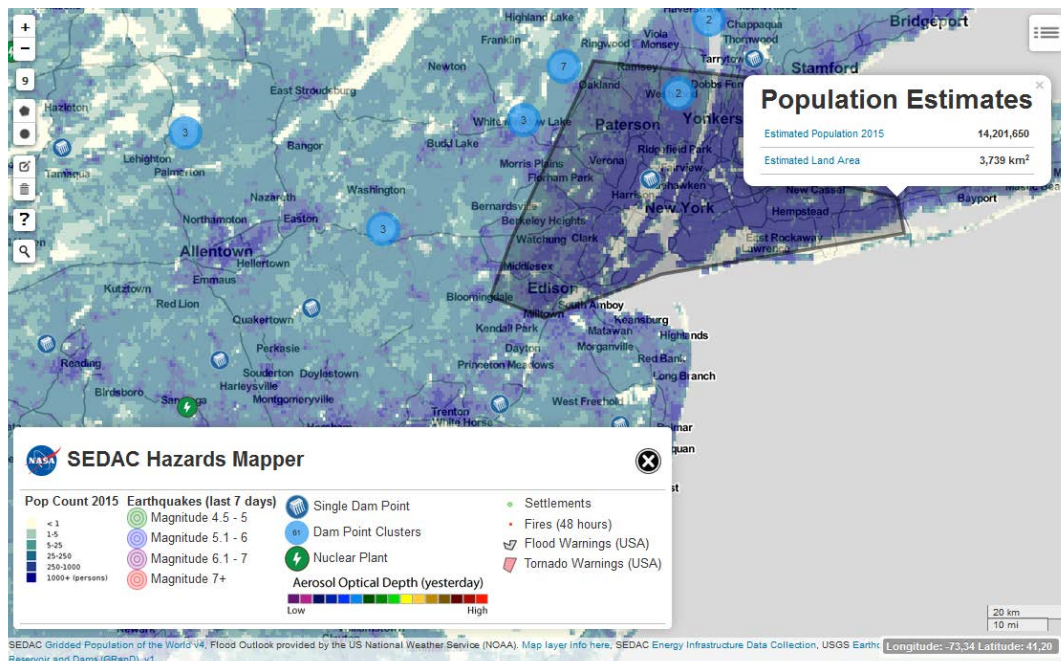
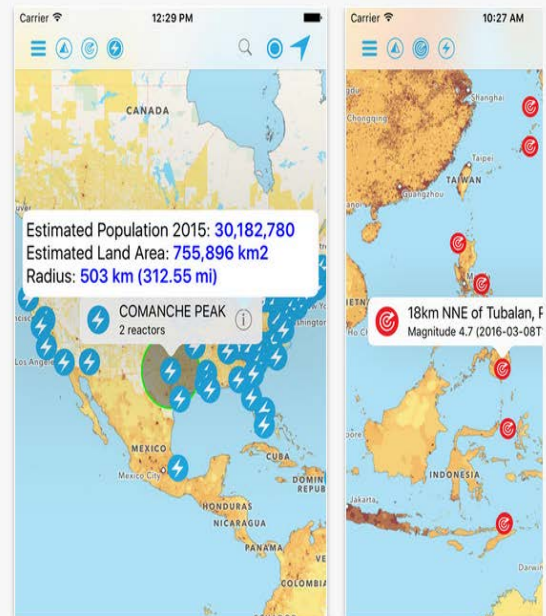


[View in iTunes](#)

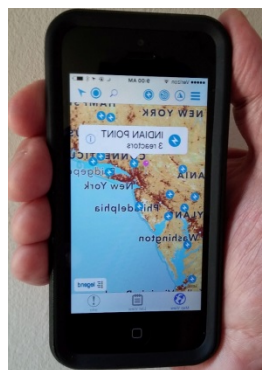


[NASA Lunar Electric Rover Sim... View in iTunes](#)

Screenshots



<http://sedac.ciesin.columbia.edu/mapping/hazards>



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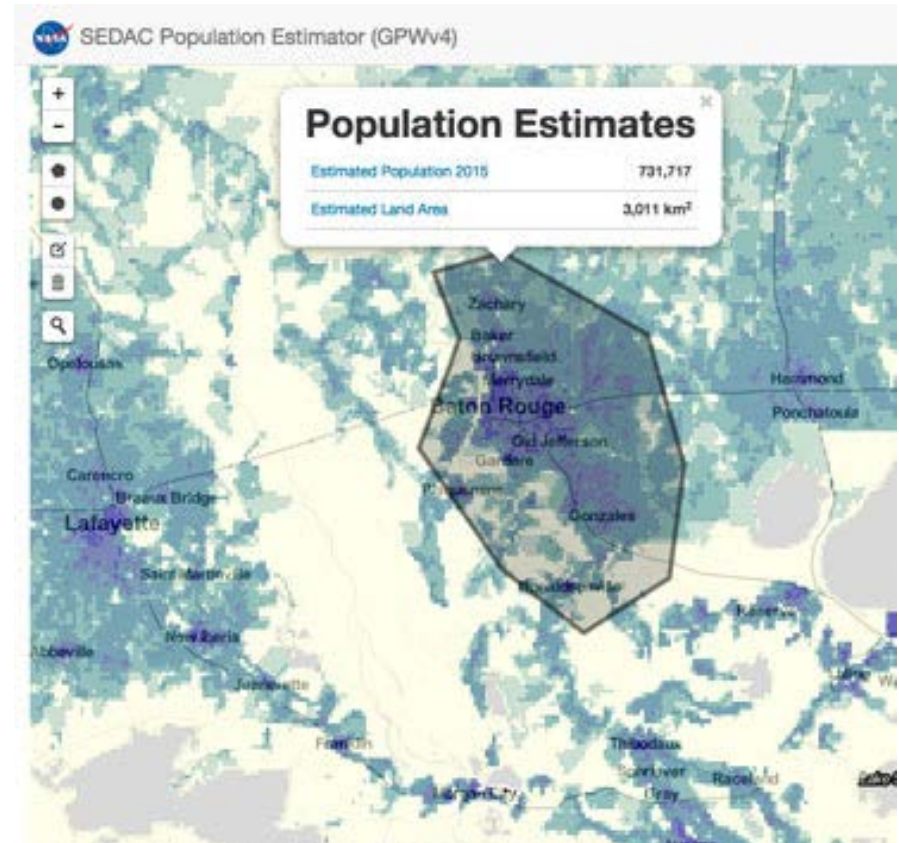
<https://itunes.apple.com/us/app/hazards-population-mapper/id1092168898?mt=8>



Updated SEDAC Population Estimation Service and Client



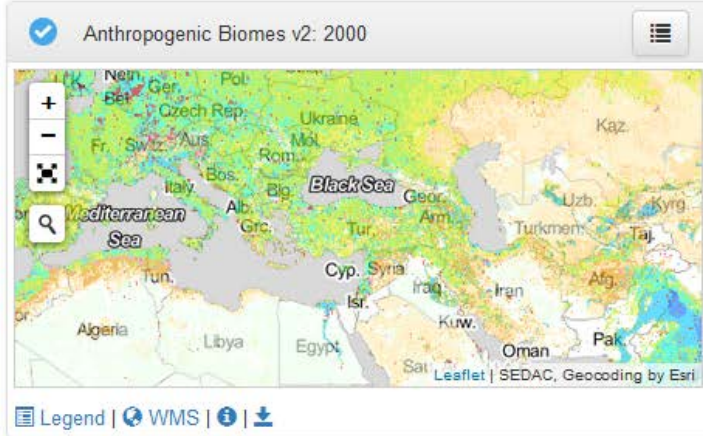
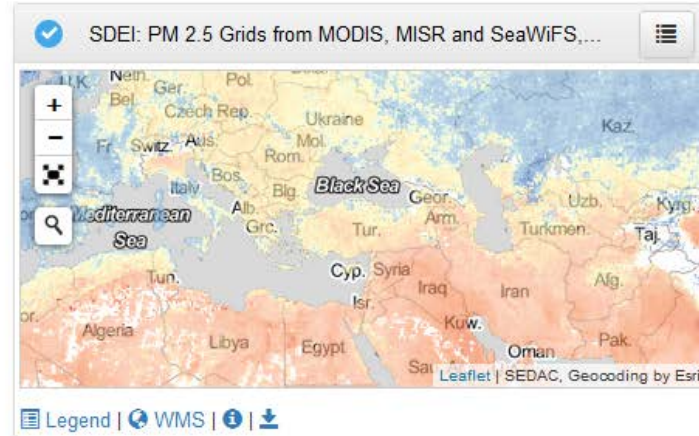
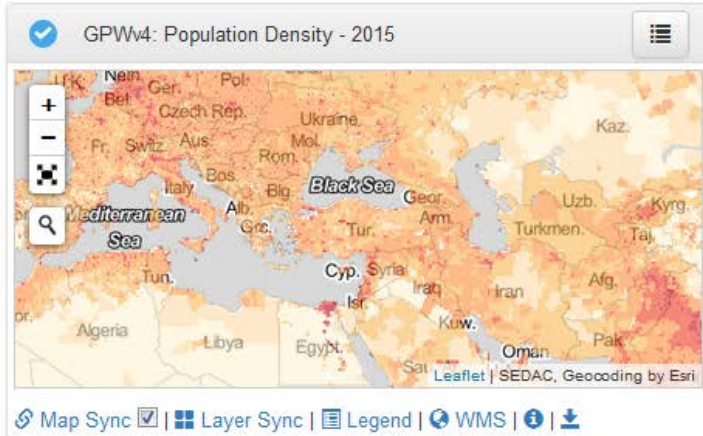
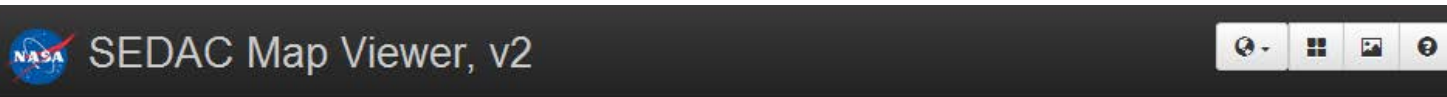
- ▶ Open web service provides population estimates and statistics for the years 2000, 2005, 2010, 2015, and 2020.
- ▶ Supports REST, WPS, and SOAP interfaces
- ▶ Provides quick population estimates and zonal statistics, usually under 5 seconds
- ▶ <http://sedac.ciesin.columbia.edu/data/collection/gpw-v4/population-estimation-service>



<http://sedac.ciesin.columbia.edu/mapping/popest/gpw-v4>



SEDAC Map Viewer, version 2



- ▶ Ability to switch between traditional overlay view and 4-panel view
- ▶ Panels can be synchronized in map extent or for a single layer
- ▶ Based on open web services
- ▶ Links directly to download pages

<http://sedac.ciesin.columbia.edu/mapping/viewer/>

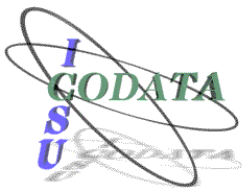
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Some Ideas for Collaboration

- ▶ Development of integrated historic settlement, infrastructure, and population data to improve assessment of exposure relative to observed disaster impacts
- ▶ Development of web services for past events, enabling search, filtering, visualization of past events in context of past, current, and/or future exposure and events
- ▶ Development of Web tool or app to facilitate entry of disaster loss data with respect to known exposure
- ▶ Expansion of client functionality to include more sophisticated queries, e.g.:
 - Difference in exposure between 2000 vs. 2020
 - Population by building characteristics
 - Vulnerable groups in relationship to critical infrastructure
 - Network analysis

Other Potential Collaboration Areas

- ▶ New CODATA Task Group with the ICSU World Data System (WDS)
 - Citizen Science and the Validation, Curation, and Management of Crowdsourced Data (co-chaired by Alex de Sherbinin at CIESIN)
- ▶ GEO Human Planet Initiative
 - Global Human Settlement Layer site just launched
<http://ghsl.jrc.ec.europa.eu/>



- ▶ Integration with SDG data efforts
 - UN SDSN Thematic Network on Sustainable Development Data
 - Global Partnership for Sustainable Development Data



GLOBAL PARTNERSHIP
ON SUSTAINABLE DEVELOPMENT DATA

- ▶ UN World Data Forum
 - January 15-18, 2017, Cape Town
 - Potential for session

