Human Planet Forum
University of Twente, Enschede, The Netherlands,
13-15 September 2017

Settlement, Infrastructure, and Population Data: The POPGRID Data Collective

Dr. Robert S. Chen
Director and Senior Research Scientist

CIESIN, The Earth Institute, Columbia University
NASA Socioeconomic Data and Applications Center (SEDAC)

GROUP ON EARTH OBSERVATIONS

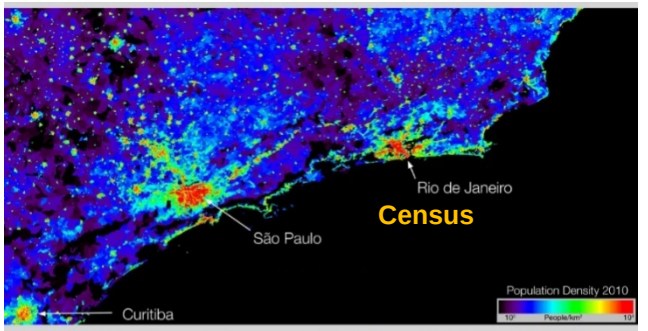
NASA

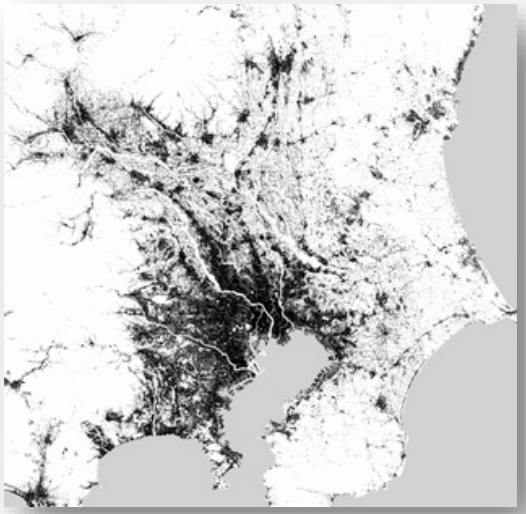
SEDAC

Center for International Earth Science Information Network
EARTH INSTITUTE | COLUMBIA UNIVERSITY

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)



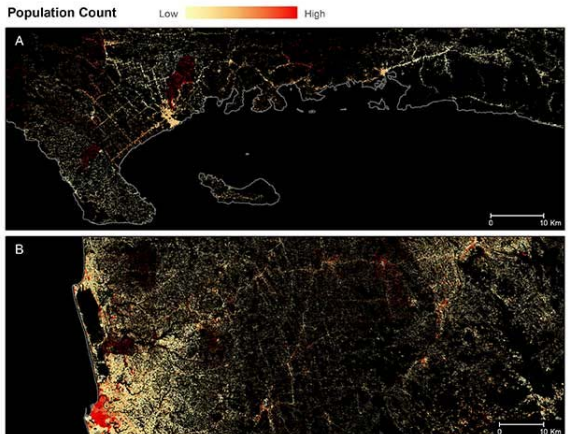


DLR

internet.org by facebook

http://ciesin.columbia.edu/data/hrsl/

https://urban-tep.eo.esa.int/#



http://ghslsys.jrc.ec.europa.eu/index.php

JRC EUROPEAN COMMISSION

Center for International Earth Science Information Network
EARTH INSTITUTE | COLUMBIA UNIVERSITY

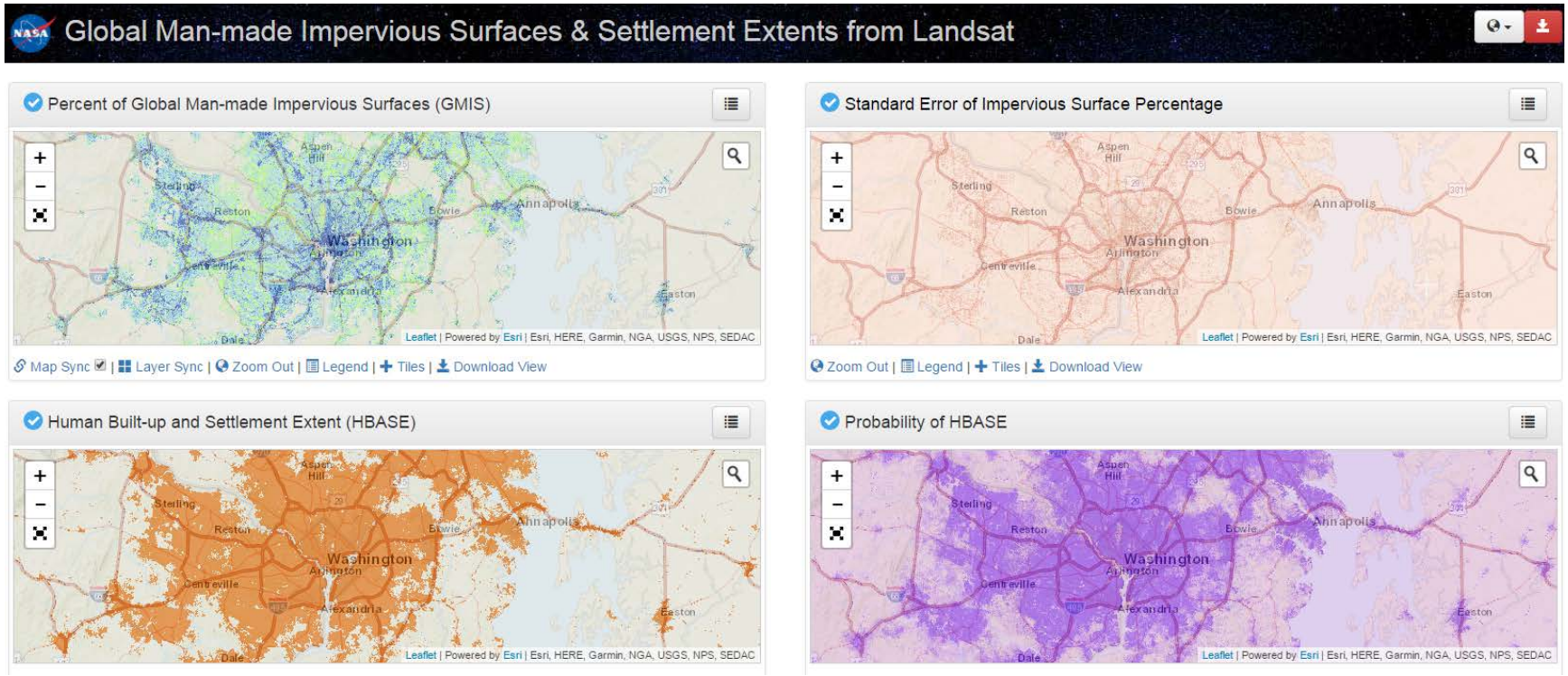
2012-200 (AS3110)

2012-200 (AS5000)

Courtesy, M. Roman, NASA

Status of NASA Land SIPS V1 Reprocessing (10-20X) & Forward Processing (10X) as of 12/10/2016
Completed Dates: 2012-019 to 2013-103; 2015-001 to YTD. http://landweb.nascom.nasa.gov/NPP_QA/

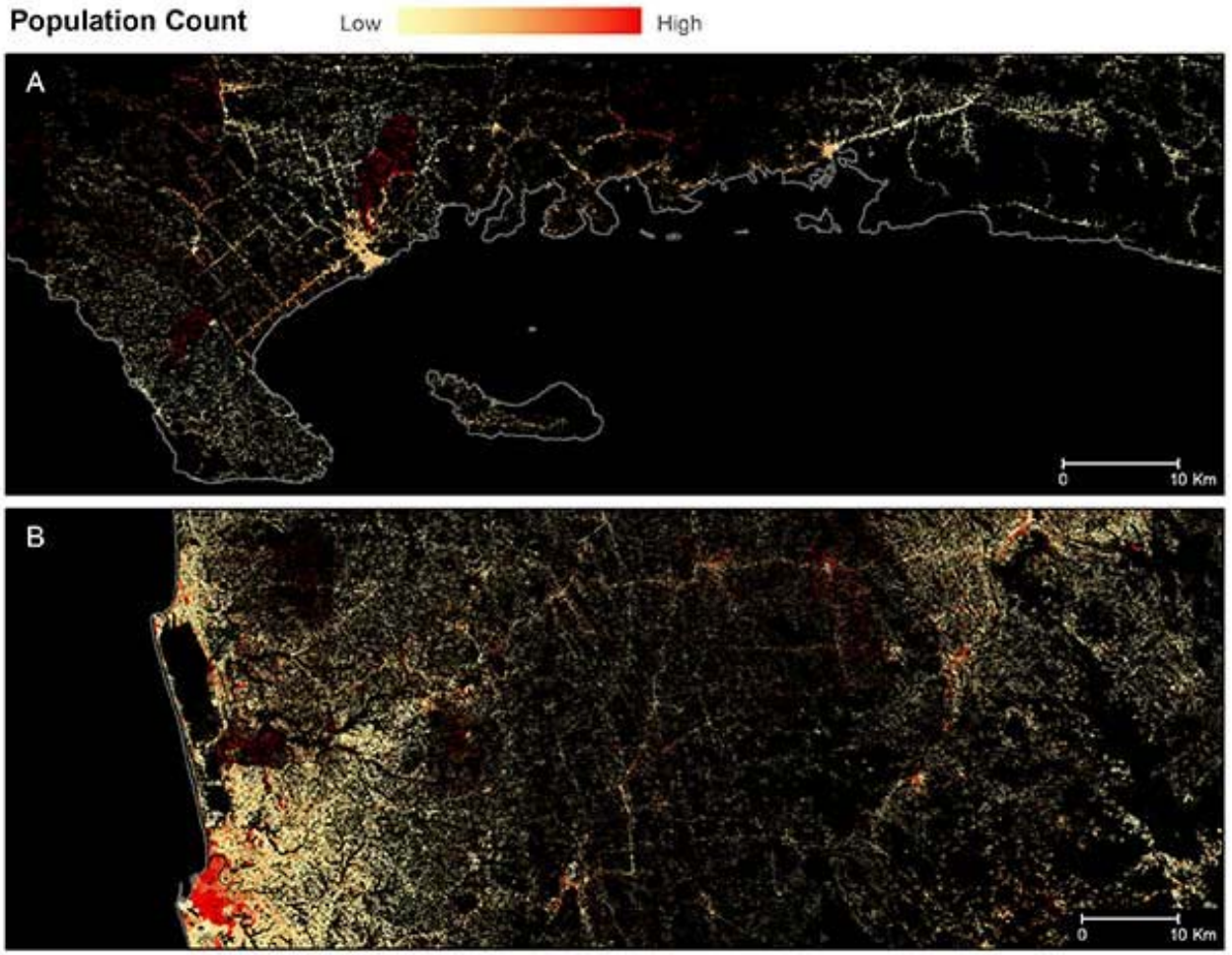
New Impervious Surface Data Based on Landsat



- **Global Man-made Impervious Surfaces & Settlement Extents from Landsat (GMIS) and Human Built-up and Settlement Extent (HBASE)**
  - Developed by E. Brown de Coulston et al. at GSFC
  - Now in beta testing: http://beta.www.ciesin.columbia.edu/mapping/gmis-hbase/explore-view/

High Resolution Settlement Maps

- Collaboration with **Internet.org/Facebook** to produce open access 30-m resolution population density estimates: based on 50-cm remote sensing imagery (IKONOS)
- Data for 13 countries released
- Additional countries in the works

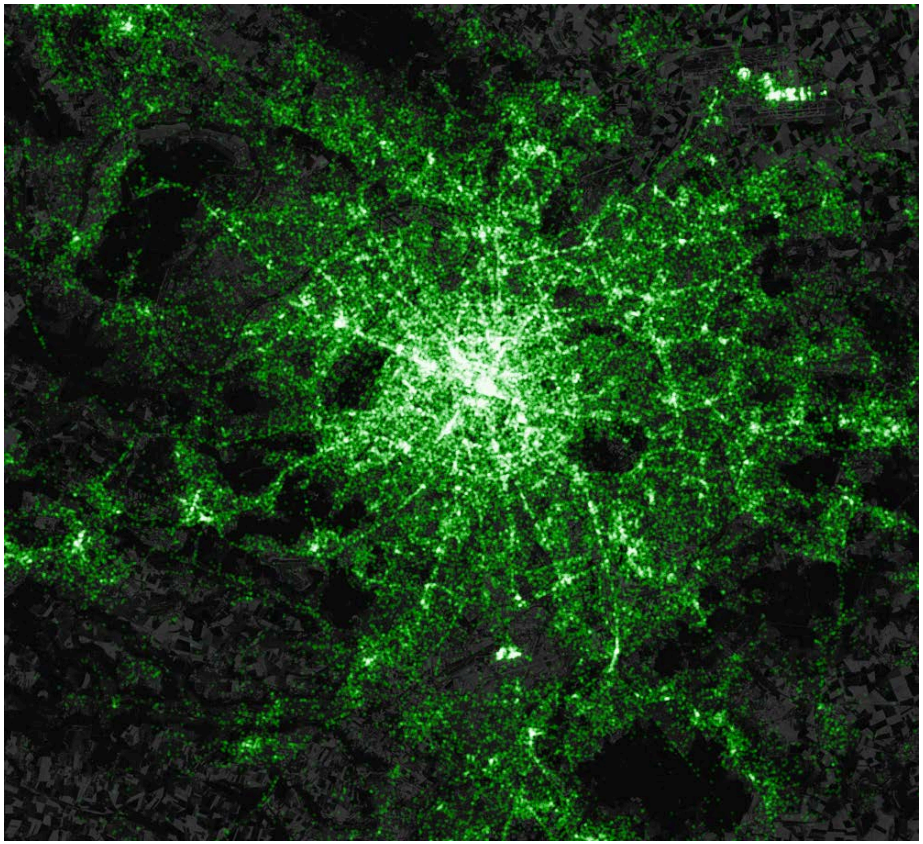


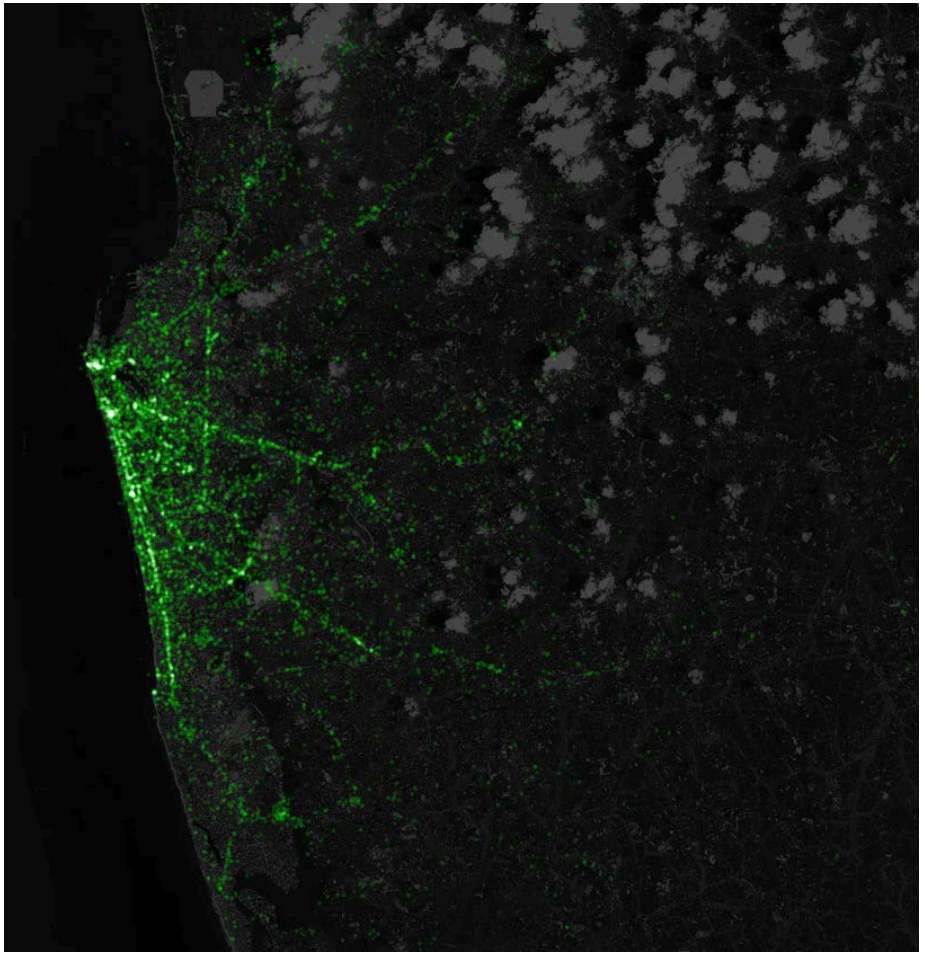
internet.org by facebook

http://ciesin.columbia.edu/data/hrsl/

Center for International Earth Science Information Network
EARTH INSTITUTE | COLUMBIA UNIVERSITY

Twitter Density from Mapbox





Center for International Earth Science Information Network
EARTH INSTITUTE | COLUMBIA UNIVERSITY

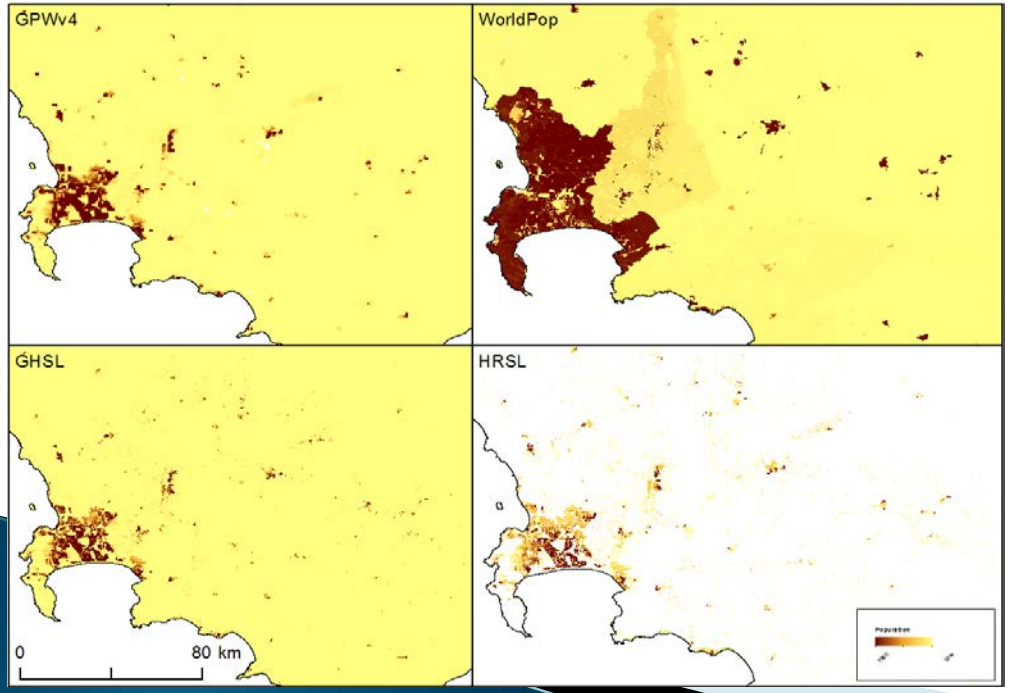
Diversity of Products with Different Characteristics

Project	Prop. Allocation	Dasymetric	Statistical / machine learning	Multiple Time Points	Imagery / spectral data	Radar	Nominal Spatial Resolution
GPW	✓			✓			1km
Landscan		✓	✓?	✓	✓		1km
WorldPop			✓	✓ *			100m
GHSL		✓	✓	✓	✓		30m, 250m, 1km
GUF		✓	✓			✓	~12m for scientific research ~84m public
Esri		✓					250m
HRSL			✓		✓		30m
GMIS/HBASE			✓		✓		30 m

*** Exists for some countries, planned for WorldPop Global**

Some Challenges in Using These Data for Sustainable Development Monitoring and Applications

- Access is scattered; not all open access
- Methods not clear; inconsistent documentation, metadata
- Some are 1-time, research-oriented products; not updated regularly
- Quality may vary by region, time period
- No rigorous validation or intercomparison conducted
- Not interoperable or well integrated with other related data, e.g., on critical infrastructure, administrative units, water bodies, pop projections



Four population models for Cape Town and environs, South Africa:

- **Gridded Population of the World, version 4 (GPWv4)**
- **WorldPop South Africa**
- **Global High Resolution Settlement Layer, Population (GHSL)**
- **High Resolution Settlement Layer (HRSL)**

Center for International Earth Science Information Network
EARTH INSTITUTE | COLUMBIA UNIVERSITY

Rethinking the Issue

- Human settlements and infrastructure are a dynamic, integrated system, dependent on environmental conditions and ecological services, and managed by people!
  - People live and work in infrastructure
  - Households, communities invest in, expand, and maintain infrastructure
  - Vulnerability to disaster, climate change, pollution, etc. depends on infrastructure
  - Sustainability of infrastructure (physical, economic, social) depends on environmental conditions and ecological services, and their variability
  - Key subsystems related to energy, water, transportation, sanitation, communications, etc. need to work together
  - Infrastructure is a critical economic asset, essential to future income generation and sustainable development

Rethinking the Issue

- Therefore, interoperable data from diverse sources, disciplines, scales are needed, e.g.:
  - Engineering data on buildings, infrastructure (materials, design, construction methods)
  - Spatial data on footprints, connectivity, mobility patterns, critical infrastructure
  - Socioeconomic data on occupance, household characteristics, economic activity, access to information, etc.
  - Environmental data across time and space
  - Sectoral data on key subsystems
  - Governance/policy data affecting resilience, investment decisions, risk management, incentives
- How do we integrate these data in scientifically sound but also practical ways to support science, applications, and decision making—especially the SDGs?

Kickoff Meeting: SciDataCon 2016, Denver CO

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

SciDataCon 2016

INTERNATIONAL DATA WEEK 2016

Center for International Earth Science Information Network
EARTH INSTITUTE | COLUMBIA UNIVERSITY

POPGRID Workshop, February 2017, Columbia

- **Settlement, Infrastructure and Population Data Technical Interchange Meeting, New York, 1-3 February**
  - ~25 participants from all the major population and settlement mapping developers, including university-based, government sponsored, and private-sector groups
  - Included ½-day stakeholder meeting with ~15 additional participants representing UN and US government agencies, the private sector, non-governmental organizations, and academic institutions

A "Data Collaborative" for Settlement, Infrastructure, and Population Data

- Public-private data partnership involving intergovernmental organizations, national & academic research institutions, large and small companies, NGOs, foundations, universities, data stewards, etc.

Center for International Earth Science Information Network
EARTH INSTITUTE | COLUMBIA UNIVERSITY

Goals and Objectives of the POPGRID Data Collective

- Overall Goal
  - Accelerate the development and use of high quality, highly usable georeferenced data on population, human settlements, and infrastructure, drawing on an international, interdisciplinary community of data developers and users from both the public and private sectors.
- Objectives
  - Share resources
  - Improve data quality and documentation
  - Clarify user needs and priorities
  - Address scientific and technical challenges
  - Facilitate appropriate data use and interpretation in a range of sustainable development application areas

One-Year Project Supported by BMGF

BILL & MELINDA GATES foundation

- Working Groups
  - Documentation and Publication
  - Framework Data, Standards, and Interoperability
  - Validation and Intercomparison
  - User Needs, Stakeholder Engagement, and Governance
  - Tools, Portals, and Shared Resources
  - Infrastructure
- Additional Stakeholder Meeting(s)
- Working Meeting at Columbia in early 2018

- Discussions initiated with Global Partnership for Sustainable Development Data (GPSDD)

GLOBAL PARTNERSHIP
ON SUSTAINABLE DEVELOPMENT DATA

Center for International Earth Science Information Network
EARTH INSTITUTE | COLUMBIA UNIVERSITY

Participation Welcome!

- **POPGRID Google Group**
  https://groups.google.com/forum/#!forum/popgrid
- **GEO-XIV Plenary side event**, Washington DC, 24 October
  http://www.earthobservations.org/geo14.php
- **American Geophysical Union**, New Orleans LA, 11-15 December
  http://fallmeeting.agu.org/2017/
  - POPGRID session organized: 2 oral and 1 poster session, ~27 papers
  - Side meeting to be scheduled

GEO GROUP ON EARTH OBSERVATIONS

AGU FALL MEETING
New Orleans | 11–15 December 2017

IN058: Where We Live and Work: Improving Data and Models for Human Settlements, Infrastructure, and Population Distribution

- **Methods and Sources**
  - D. Balk et al. (CUNY)
  - F. Stevens et al. (WorldPop)
  - C. Frye et al. (Esri)
  - A. Rose et al. (ORNL)
  - A. de Sherbinin et al. (CIESIN)
  - M. Marconcini et al. (DLR)
  - A. Gros (Facebook)
  - A. Desch IV (US Census)
  - T. Kugler (U. Minnesota)

- **Needs and Applications**
  - V. Seaman (BMGF)*
  - C. Linard et al. (Univ. Libre de Bruxelles)*
  - B. Blankespoor (The World Bank)
  - S. Rose et al. (Cal Poly)
  - R. Engstrom et al. (GWU)
  - A. Lieber et al. (Google)
  - H. Zoraghein et al. (NCAR)
  - M. Zhao (IGSNNR/Nanjing U.)
  - H. Baldwin et al. (NASA DEVELOP)

AGU FALL MEETING
New Orleans | 11–15 December 2017

*invited

Center for International Earth Science Information Network
EARTH INSTITUTE | COLUMBIA UNIVERSITY

POPGRID Working Group Objectives 1

BILL & MELINDA GATES foundation

- Documentation and Publication
  - Improve consistency, usability of metadata and data documentation
  - Coordinate preparation of technical reports, peer-reviewed articles and other materials
- Framework Data, Standards, and Interoperability
  - Coordinate development and sharing of input data
  - Develop quality control processes for identification of framework data
  - Identify and develop consensus on data standards and schemas
  - Encourage data interoperability (scientific, technical, legal)
- Validation and Intercomparison
  - Design intercomparison framework and metrics (including uncertainty assessment)
  - Develop and plan intercomparison experiments

POPGRID Working Group Objectives 2

BILL & MELINDA GATES foundation

- User Needs, Stakeholder Engagement, and Governance
  - Develop strategic approach to stakeholder engagement
  - Identify user requirements and develop user scenarios
  - Explore options for establishing and sustaining data collective with existing international initiatives
  - Coordinate outreach and training efforts for stakeholder communities, especially in developing countries
- Tools, Portals, and Shared Resources
  - Establish coordinated POPGRID web presence
  - Document relevant tools and portals and potential shared resources and identify gaps
  - Develop proposals to fill gaps
- Infrastructure
  - Explore characterization of infrastructure associated with the built environment including review of types of assets, taxonomies, and database representation