Every person deserves the chance to live a healthy, productive life.

Bill & Melinda Gates Foundation
Strategy, Data & Analytics (SDA) Team, Global Development
Director: Uyi Stewart

Mission:
- Provide internal support to BMGF program teams in the areas of data collection, use and analysis, geospatial technology, and cost effectiveness
- Oversee cross-cutting investments related to GIS, AI, big data, etc.
- Establish relationships with GIS/data technology vendors & service providers, international organizations, and partners

Cross-cutting Projects:
1. BMGF Data Platform – Polio-initiated effort to build a data platform to store, access, visualize, and share all foundation data assets.
3. RADIANT (Open Imagery Network) – Goal is to improve public access to imagery of all types, and provide standard tools to enable viewing, basic analyses and integration with other datasets. Co-funded by Omidyar.
BMGF Programmatic Areas/Teams with GIS-related Projects

CHAMPS will enable the collection of robust and standardized primary data addressing all causes of death.

Performance Monitoring and Accountability 2020 (PMA2020) uses innovative mobile technology to routinely gather rapid-turnaround, cost-effective population data on family planning and water, sanitation and hygiene.

Family Planning

Surveillance

Emergency Response

Malaria

Financial Services for the Poor

Integrating Geospatial Analysis into FSP’s Strategy and Execution

Figure 4: Spatial distribution of poor people relative to mobile money agents in Tanzania

Figure 5: Spatial distribution of poor people relative to network of mobile money agents in Pakistan
Agriculture

Geographical variation in the intensity of LF transmission

NTDs

The role of remote sensing in agricultural development and poverty alleviation

Polio - Locating Missed Settlements
Nigeria: GIS Base Layers Collected for 10 Northern States (2012-13)

Manual & Automated Feature Extraction of Satellite Imagery
Field Data Collection
Points of Interest
Settlement Attributes used to create Ward Boundaries
Existing Public Databases are Limited to Urban Centers

**Adamawa State, Nigeria (OpenStreet Maps)**

**Automated Feature Extraction (FE) Settlements (ORNL)**
486 features

14 settlement features
2 BUAs, 3 SSAs, 9 HA (56 hamlets)
Admin Boundaries Created from Settlement Attributes

Thiessen Polygons Tool used to create boundary

Settlement split between 2 Wards

= Ward settlement
= Other settlement
Polio Vaccination Campaign eTally: Local Supervisors had no trouble understanding and using the eTally application and preferred it over the paper tally
318 children vaccinated at 67HH at this point 10:26a-12:02p (both teams)

49 children vaccinated at 10HH at this point 11:02-11:10am (GSW: 013)

All tracks for Teams GWS: 013 and GSW:ST 013 are from Day 4 (1-March) between 10:24a – 12:16p
Administrative Boundaries

Nearly all existing data is inaccurate!

Reported sub-national boundaries do not align with GIS data collected in Nigeria.
Nigeria Sub-National Boundaries from VTS\textsuperscript{1}, GADM\textsuperscript{2} and UN-WHO (Census) all Differ

Gwale LGA, Kano State Jan 2015

\textsuperscript{1}VTS = Vaccination Tracking System and polio Nigeria geodatabase: http://www.geopode.world

\textsuperscript{2}GADM = internationally-recognized global boundary resource developed by Robert Hijmans & colleagues at the University of California, Berkeley and the University of California, Davis (Alex Mandel): http://www.gadm.org/
GIS Population Estimates: VTS, GADM\textsuperscript{1}, UN-WHO Boundaries

Gwale LGA, Kano State, Nigeria

VTS Boundaries
Pop. Est. = 678,198

GADM Boundaries
Pop. Est. = 372,703

UN-WHO (Census) Boundaries
Pop. Est. = 484,934

\textsuperscript{1}GADM Version 2.8, March 2016. http://www.gadm.org/
Second Administrative Level Boundaries initiative
In many areas of Nigeria, administrative population data is not reliable....
...which leads to gross over-estimation of the baseline population at the settlement level.

<table>
<thead>
<tr>
<th>Settlement</th>
<th>Total</th>
<th>US</th>
<th>Houses</th>
<th>Total</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNG MAIGADI</td>
<td>5055</td>
<td>1011</td>
<td>45</td>
<td>369</td>
<td>75</td>
</tr>
</tbody>
</table>
Since 2006, annual population growth of 2.7 – 3.4% applied at the state level – but growth varies widely from rural to urban areas.
2006 and 2014 Kano Settlement

Settlement Extent

- 2006
- 2006-2014 Growth

Managed by UT-Battelle for the Department of Energy
Percent Change in Settled Area by LGA

Geographic Information Science and Technology

% Change

- 0
- 1 - 10
- 11 - 20
- 21 - 30
- 31 - 40
- 41 - 50
- 51 - 60
- 61 - 70
- 71 - 80
- 81 - 90
- 91 - 100

- 67.29% Ungogo
- 26.44% Fagge
- 16.04% Dala
- 22.28% Nassarawa
- 58.22% Gwale
- 10.47% Kano Mun
- 22.60% Tarauti
- 77.39% Kumbotso

Managed by UT-Battelle
for the Department of Energy
Calculated Rates of Annual Population Change for Both Methods (2006-2014)
High Resolution Population Distribution In Northern Nigeria

Budhendra Bhaduri
Eddie Bright, Anil Cheriyadat, Amy Rose, Jake McKee, Jeanelle Weaver,
Mary Urban, Raju Vatsavaiah

Demographics & Mobility mapping

Andy Tatem, University of Southampton

FLOWMINDER.ORG
Settlement Neighborhood Classification Layer

- Reference Layer for Northern States (based on Kano metro area)
  - established 7 residential settlement types (6 Urban, 1 rural) + non-residential
- Population density of each neighborhood type determined from microcensus data (>100 clusters for each type)

M: rural
Z: non-residential
The Microcensus Process

Enumerate population with ground-based ‘microcensus’ surveys in small areas that capture a range of settlement and neighbourhood types to get training data.

Urban neighbourhood types mapped using satellite imagery and microcensus surveys conducted in each type.
OUTPUT: 90-meter population grid with total counts, or selected demographic counts. Gridded Population Layer provides/validates denominator data.
% Children under 5 Varies from North to South, East to West

For an LGA with a total population of 300,000:
11% = 33,000  20% = 60,000  23% = 69,000

Alegana, et al. 2015  http://rsif.royalsocietypublishing.org/
Select the Layers tab to see the drop-down

Type in coordinates to go to a specific place

Map layers and Total Population or < 5 population can be selected here

Custom Demographics slider: 0-12 mos, 5 year intervals

Polygon and point buffer options

Print Screen

Change Basemap

Scale Bar

http://geopode.world/
Neighborhood Classification
Ibadan Metro Area
Oyo State, Nigeria

M: rural
Z: non-residential
Settlement Features are the basic Geospatial Reference Data

Administrative Boundaries

Settlements and Points of Interest

GRID
(Core Data Layers)

Transportation Network

Population / Demographics
TRADITIONAL GIS MAPPING & POPULATION ESTIMATES – FIELD BASED

**Satellite Imagery**
- 0.5m, panchromatic
- <10% cloud cover, <18 months old
- Avg Cost: $1/km²

**Extracted Settlement Layer (Feature Extraction)**
- 3 settlement types: (BUA, SSA, Hamlet)
- >95% accuracy
- Avg Cost: $0.60/km²

**Field Data Collection:**
- Settlements
- POIs
  - HFs
  - markets
  - schools
  - water points

**Dashboard/Data Platform:**
VTS Website

**Estimated Cost:**
$5 – 7 million/country

**Population/Demographic Modeling:**
Neighborhood Types/HH Survey Data

*** Confidential – for internal use only ***
Traditional census data
Enumeration areas created manually – not geo-referenced

Geo-referenced census data
HH or Enumeration Area level

Complete Settlement map

GIS-Based Population Model

National Geo-referenced census database
Supports sophisticated geospatial analyses of all census-related metrics

Accurate Administrative boundaries

Figure 10: Example of a large-scale map showing enumeration area (EA) boundaries used when sampling in an urban district.
DfID-BMGF Partnership to co-fund GRID and other Key Geospatial and Data-related Projects

Leverages existing BMGF-DFID Collaborative Agreement
DfID Contribution: £15 million over 5 years beginning in 2017
- 75% of funds will be allocated to support the creation of Core Geo-Spatial Reference Layers and GIS/data management Capacity-Building in priority countries (GRID)
- 25% of funds will be allocated to other data-related projects (TBD)
- BMGF expected to contribute an equal or greater amount for each project

Priority BMGF-DfID GRID Geographies - 2017

BMGF Leads
Vince Seaman | Deputy Director | Io Blair-Freese | APO | Strategy, Data & Analytics Team | Global Development

DfID Leads
Seb Mhatre | Data Innovation Lead | Data For Development Team
Partnership to Develop Core Geo-Spatial Reference Layers and Build Capacity

- Collect basic geospatial reference data (access geo-referenced national census data where available)
- Build capacity within Census/Population Commission, Bureau of Statistics (UNFPA, Flominder)
- Develop Population/Demographics & Population dynamics modeling
- Build data management/use capacity across all sectors

PROJECT 1 (census-based)
Support National Statistics Office/Population Council to conduct georeferenced census & manage data

PROJECT 2 (no census)
Support National Statistics Office/Population Council to collect/model geospatial reference data

GRID Layers
- Settlement names/locations
- Key Points of Interest
- Administrative Boundaries
- Population Estimates
GRID PROJECT DELIVERABLES

1. Geo-referenced layer of all settlements and key POIs (from feature extraction layer)

2. Validated sub-national boundary layers (from settlement attributes)

3. Population & demographic estimates at 90 meters (from neighborhood classification and microcensus data)

4. Capacity-building for NSO, NGA, and other government agencies

5. Country and Global Data Platforms
Intensive Capacity-Building *(minimum 24 months)*

**NATIONAL STATISTICS OFFICE/POPULATION COMMISSION**
- Training, software & hardware provision, technical support
- Manage, use and curate census data and other national statistics

**NATIONAL GEOSPATIAL AGENCY**
- Training, software & hardware provision, technical support
- Manage, use and curate national geodatabase
- Regular updates of boundaries, settlements, & POIs

**OTHER GOVERNMENT MINISTRIES/AGENCIES (FINANCE, ELECTORAL, EDUCATION, UTILITIES, ETC.)**
- Identify priority use-cases & applications
- Assist NSO and NGA in supporting other agencies

**REGIONAL WORKSHOPS & TRAINING**
- Additional opportunities to enhance GIS skills
- Network and share best practices with other AFRO country teams
SMART Survey 2016

Cluster locations – Kano Metro LGAs

Neighborhood Types - Kano Metro Area

Z = Non-Residential

2016 SMART Survey Cluster – HH Points
Share the VISION!

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**C** +1.206.669-7259  
**E** Vincent.Seaman@gatesfoundation.org
### Upcoming Censuses 2017-2019

<table>
<thead>
<tr>
<th>Country</th>
<th>Census 2017</th>
<th>Census 2018</th>
<th>Census 2019</th>
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</thead>
<tbody>
<tr>
<td>Burkina Faso</td>
<td>Algeria</td>
<td>Azerbaijan</td>
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<tr>
<td>Chile</td>
<td>DPRK</td>
<td>Belarus</td>
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<td>El Salvador</td>
<td>Cambodia</td>
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<td>Liberia</td>
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<tr>
<td>Comoros</td>
<td>Malawi</td>
<td>Djibouti</td>
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</tr>
<tr>
<td>Cameroon</td>
<td>Nigeria</td>
<td>Guinea Bissau</td>
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<tr>
<td>Ethiopia</td>
<td>Wallis and Futuna</td>
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<td>Kenya</td>
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<tr>
<td>Congo</td>
<td>Mali</td>
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<tr>
<td>Colombia</td>
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<tr>
<td>Madagascar</td>
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<td>Mozambique</td>
<td>Nicaragua</td>
<td>New Caledonia</td>
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<td></td>
<td></td>
<td>Solomon Islands</td>
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<tr>
<td>Swaziland</td>
<td>Vanuatu</td>
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</tr>
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</table>

### Status of Census 2010 round georeferencing in DfID priority countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Geo-reference status</th>
<th>Census Date (upcoming)</th>
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</thead>
<tbody>
<tr>
<td>Afghanistan</td>
<td>No census in 2010 round</td>
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<tr>
<td>Bangladesh</td>
<td>Yes- EA Level</td>
<td>2011</td>
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<tr>
<td>Burma/Myanmar</td>
<td>No</td>
<td>2014</td>
</tr>
<tr>
<td>Cambodia</td>
<td>Yes- EA level</td>
<td>2008 (2019)</td>
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<tr>
<td>DR Congo</td>
<td>No census in 2010</td>
<td>2007 (2017)</td>
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<tr>
<td>Ethiopia</td>
<td>No</td>
<td>2010</td>
</tr>
<tr>
<td>Ghana</td>
<td></td>
<td>2011</td>
</tr>
<tr>
<td>India</td>
<td>Yes- EA Level</td>
<td>2009</td>
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<tr>
<td>Kenya</td>
<td>Yes-EA Level</td>
<td>2009</td>
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<tr>
<td>Kyrgyzstan</td>
<td>No</td>
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<tr>
<td>Liberia</td>
<td>Yes- EA Level</td>
<td>2008</td>
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<tr>
<td>Malawi</td>
<td>Yes- EA Level</td>
<td>2008</td>
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<tr>
<td>Mozambique</td>
<td>Yes</td>
<td>2007</td>
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<tr>
<td>Nepal</td>
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<td>Pakistan</td>
<td>No census in 2010 round</td>
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<tr>
<td>Rwanda</td>
<td>?</td>
<td>2012</td>
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<tr>
<td>Sierra Leone</td>
<td>Yes- EA Level</td>
<td>2015</td>
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<tr>
<td>Somalia</td>
<td>No census in 2010 round</td>
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<td>South Africa</td>
<td>Yes- EA level</td>
<td>2011</td>
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<tr>
<td>South Sudan</td>
<td>No</td>
<td>2008</td>
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<tr>
<td>Sudan</td>
<td></td>
<td>2008</td>
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<tr>
<td>Tanzania</td>
<td>No</td>
<td>2010</td>
</tr>
<tr>
<td>Uganda</td>
<td>Yes- EA level</td>
<td>2014</td>
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<tr>
<td>West Bank and Gaza</td>
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<td>2012</td>
</tr>
<tr>
<td>Yemen</td>
<td></td>
<td>2010</td>
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<tr>
<td>Zambia</td>
<td>Yes- EA Level</td>
<td>2010</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td></td>
<td>2010</td>
</tr>
</tbody>
</table>
Aggregated tracks show road network
Problem:
IPV Health Camps (HCs) had to be located no further than 1km from any resident.

Solution:
An automated tool was created that clustered settlements within 1km of one another. Target populations were then used to determine the number of days the HC would work in a cluster.

Result:
>95% coverage overall, no missed settlements
Borno WPV Outbreak – 2016
