Fact file

# The bottom-up modelling approach
# Spotlight on the GRID3 Nigeria model

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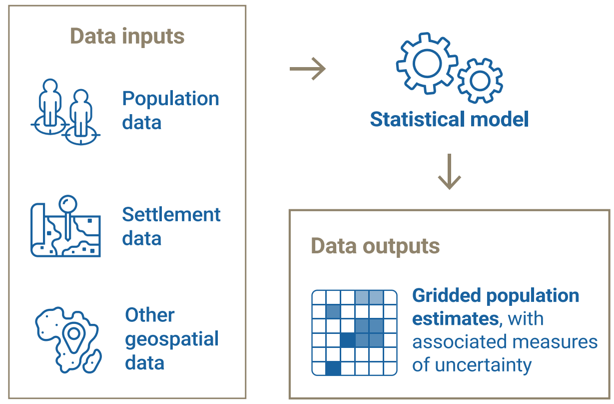
**A key part of achieving the Sustainable Development Goals, and leaving no one behind, is to put everyone on the map. Geospatial representation of people and the places they live allows policy makers and planners to allocate resources equitably and effectively.**

To provide countries with population estimates, WorldPop at the University of Southampton has developed a novel bottom-up modelling approach, based on a Bayesian model. It combines existing population data with satellite imagery to create **high-resolution gridded population estimates (100x100m)** and **measures of uncertainty** for the whole country or target area.

This fact file aims to showcase an example of a bottom-up model, and presents **the approach taken in Nigeria** as part of the GRID3 programme.




For more information about our global approach to population modelling, please read our fact file: "The bottom-up modelling approach".

## Understanding the data inputs for the GRID3 Nigeria model

Population data

**Population data:** The bottom-up modelling method uses population data from small, well-defined areas to predict population across Nigeria. These data are sourced from **microcensus surveys**, conducted between 2016 and 2017 by Oak Ridge National Laboratory and eHealth Africa who surveyed 1,141 areas across 15 Nigerian states. These survey results are a key input to improving the accuracy of the model's predictions about the geographical variations in population and demographic characteristics (age and sex).

Settlement data

**Settlement data** provides vital information on the location of potentially inhabited structures. The settlement data used in the GRID3 Nigeria model was derived from **high-resolution satellite imagery** and Oak Ridge National Lab's LandScan HD v1.1, which classifies settlements into the following categories: urban (A, B, D, E, F), rural (M) and non-residential (Z).


Since this classification assumes that no one is living in non-residential areas (Z) (Weber et al., 2018), the current model underestimates the population in those areas. We know, however, that non-residential areas do in fact have people living there (e.g. people living above businesses). New microcensus data being collected in 2019, however, includes non-residential areas and will be incorporated into the next iteration of the model (Nigeria model v.2.0) to increase its accuracy.

Geospatial covariate data

**Geospatial covariate data** refers to a range of information that are available for the whole country and can help predict the population based on local context. These include data on elevation, slope, vegetation types, and accessibility to major cities. In this model, we incorporated population data from WorldPop Global, school locations, demographic and health surveys as well as nearby (1km) residential and non-residential settlements around a grid cell to **quantify the relationship between these covariates and population density.** These relationships enabled us to estimate population for areas lacking collected population data. It is worth noting that accessing improved geospatial covariate data can strengthen the model's ability to reflect the estimated size of local populations.

# Results and Outputs

## Gridded population estimates

Our modelling produces population estimates at a resolution of **100m x 100m** (which we call 'grid cells'). Gridded population estimates give **greater flexibility** in grouping data into larger administrative units or service catchment areas, depending on user needs. For each grid cell, the model predicts a range of potential population densities based on the input data. **The mean value of those densities is the best estimate of the population for that area.** Population estimates cannot replace a complete census but they can guide the effective implementation of a national census and are useful in supporting successful development and humanitarian operations.

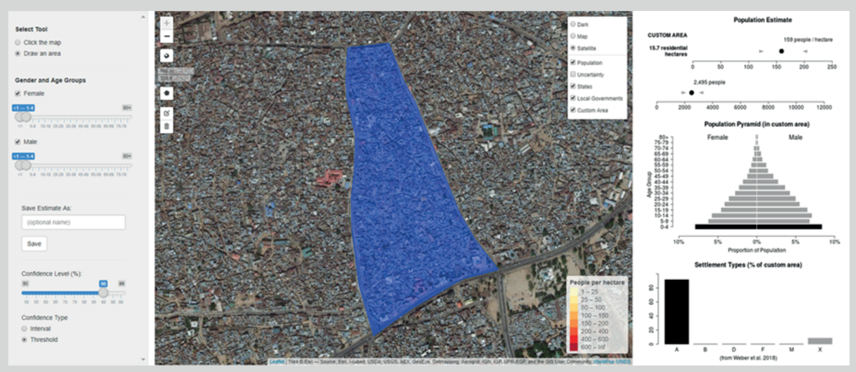
## Uncertainty measures for more effective planning

The bottom-up modelling approach also produces information on the **uncertainty attached to each estimate**. Uncertainty calculations are available for each grid cell, Local Government Area (LGA) and state totals, and can be used to assess the model's performance at various spatial scales. Improving the model by having better input data can help reduce uncertainty. These uncertainty measures provide upper and lower figures around the mean estimate and indicate the degree of confidence in each estimate. Understanding the degree of confidence corresponding to a given estimate can **help inform more appropriate, cost-effective decisions and interventions.** For example, for a vaccination campaign, uncertainty measures can help health workers agree on the number of vaccines to cover the entire population in a target area without risking that the vaccines are significantly over- or under-resourced.

For more information about uncertainty measures and how to use them, please read our fact file on "The value of uncertainty measures in population estimation".

## Easy and open data access

Dissemination of data is essential to actually **strengthening and expanding geospatial capacity, data investments, and technological innovation.** We provide simple access to GRID3 Nigeria estimates and corresponding uncertainty measures by hosting the data on a web application that easily enables end-users to extract relevant information tailored to their specific needs, from basic spreadsheets to sophisticated spatial data (e.g. raster or shapefile). This user interface is available online and includes information such as location, age and sex (please note that gridded age-sex population estimates were derived from WorldPop Global, based on Carioli et al., 2019). This tool can be used to estimate population within a specific area, LGA, or to create custom polygons that estimate the population in a custom zone of interest.



User Interface developed by WorldPop/Flowminder to interact with, and facilitate access to, the data (estimates and uncertainty measures)


### References

Blangiardo, M., and Cameletti, M. (2015)
Wardrop, et al. (2018)
Weber, E. M., et al. (2018)


GRID3 is a global partnership between the Bill & Melinda Gates Foundation, DFID, Flowminder, WorldPop at the University of Southampton, UNFPA and CIESIN. The programme builds spatial data solutions that make development goals achievable. **www.grid3.org**


info@flowminder.org www.flowminder.org wp@worldpop.uk www.worldpop.org