Image credit: Doune Porter / GAVI Alliance

GRID3 NIGERIA

GRID3 Use Case Report

Geospatial Analysis of Measles Immunisation Coverage

UNITY AND FAITH, PEACE AND PROGRESS

GRID3 NIGERIA

Key abbreviations and terms

PCCS	Post-Campaign Coverage Survey
DHS	Demographic and Health Survey
LGA	Local Government Area
MICS	Multiple Indicator Cluster Survey
NICS	National Immunisation Coverage Survey
NPHCDA	National Primary Health Care Development Agency

Challenge and need

The 2017-18 measles post-campaign coverage survey (PCCS) was designed **to produce estimates of measles vaccination at 1x1 km and the Local Government Area (LGA) level.** These large-area estimates often mask spatial heterogeneities in coverage and do not facilitate targeting of immunisation efforts at the local scale. In February 2019, the Nigeria PCCS working group requested support from the VaxPop team at WorldPop at the University of Southampton, a GRID3 implementing partner, to undertake geospatial analyses of the PCCS data to produce estimates of measles vaccination at 1x1 km and the LGA level. The team was also requested to compare PCCS coverage estimates with previous coverage estimates produced using the 2013 Nigeria Demographic and Health Survey and the 2016-17 Multiple Indicator Cluster Survey / National Immunisation Coverage Survey to estimate trends in immunisation coverage at the LGA level.

The GRID3 programme provided both financial and technical support for the work and subsequently adopted it as one of its use cases in Nigeria.

Response

The VaxPop team at WorldPop carried out the work as requested. Over 72 geospatial covariate datasets were assembled for the PCCS analyses, from which 30 covariates were pre-selected using expert knowledge. These were then run through a covariate selection process, after which six covariates were retained for the final analyses.

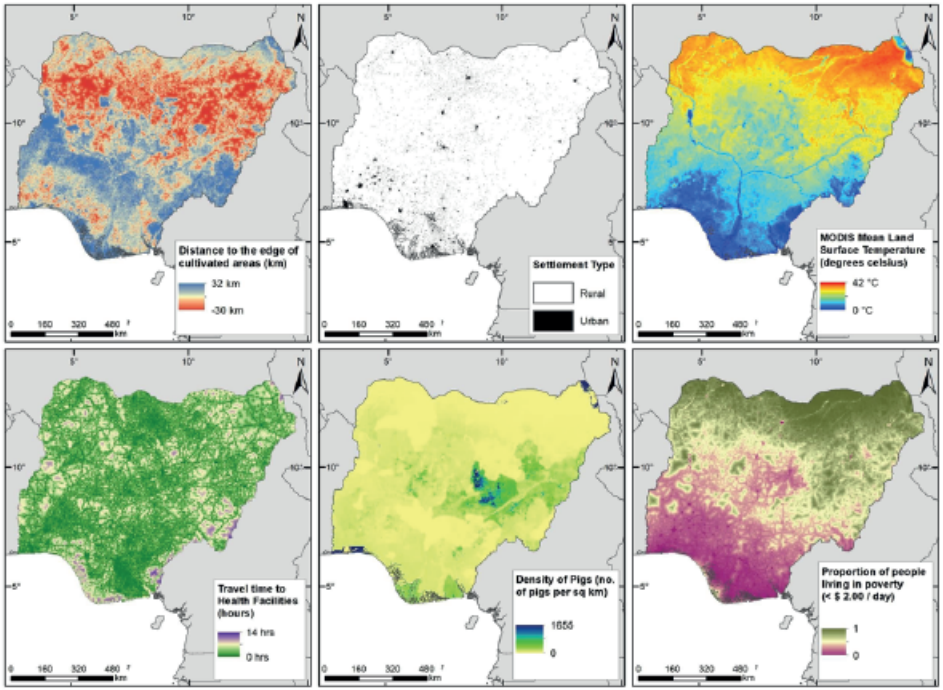
A Bayesian geostatistical model was fitted for each of five PCCS indicators assessing the individual and combined performance of routine immunisation and the campaign, to produce coverage estimates at different spatial scales.

GRID3 data

GRID3 data was not included in the fitted models, but was used to identify settlements in low coverage areas that failed to meet a coverage threshold of 50% during the campaign, so that these could be prioritised and targeted during future vaccination activities.

Additional data

The covariate data* selected for the final analyses included 1) proportion of people living in poverty, 2) pig density density, 3) travel time to health facilities, 4) mean land surface temperature, 5) settlement type – urban/rural, and 6) distance to the edge of cultivated areas. These datasets were obtained from other projects undertaken by WorldPop.



See Annex 1 for the dataset citations.

Key Stakeholders

- PCCS Working Group
- Department of Planning, Research and Statistics (PRS), NPHCDA
- National Measles Technical Coordination Committee (NMTCC), NPHCDA
- National Bureau of Statistics (NBS)
- National Emergency Routine Immunization Coordination Centre (NERICC), NPHCDA
- Dr. Zakari Lawal, Director of Monitoring and Evaluation, Ministry of Budget and National Planning
- The Bill & Melinda Gates Foundation

Image 1. Covariates selected for the final model.

Source: Utazi CE, Wagai J, Pannell O, Cutts FT, Rhoda DA, Ferrari MJ, Dieng B, Oteri J, Danovaro-Holliday CM, Adeniran A, Tatem AJ (2019). Geospatial variation in measles vaccination coverage through routine and campaign strategies in Nigeria: analysis of recent household surveys. Submitted to Vaccine.

Outcome and impact

In May 2019, members of the VaxPop team visited Nigeria to present results to the National Bureau of Statistics, the National Measles Technical Coordination Committee, and the Department of Planning, Research and Statistics at the National Primary Health Care Development Agency (NPHCDA).

Coverage during the campaign, coverage among zero-dose children during the campaign, and coverage with at least one dose of measles vaccine were generally high and spatially homogeneous; few pockets of low coverage exist).

Lower coverage areas during the campaign were concentrated mostly in the northeast, northwest, and southwest of Nigeria. The results indicate a high probability of attaining the 95% coverage target of at least one dose of the vaccine in the south and north-central areas, and a low probability in the northeast and northwest of the country. However, nearly the entire country is far from reaching the target of at least two doses.

The trend analysis from 2013 - 2017 indicated that much of the northeast and northwest were consistent areas of low coverage before the latest campaign. Comparing data from 2016 with coverage before the latest campaign showed that measles immunisation coverage had fallen in more than 80% of the LGAs across the country.

The results indicate that all poor coverage areas should be prioritised during the next campaign as well as through routine immunisation activities. The results also point to the need to improve routine immunisation services across the country, particularly in the northern regions.

The deliverables were:

- **Coverage estimates & maps at 1x1 km and at the LGA, state, and regional levels**
- **Maps of areas and clusters of low coverage**
- **Estimates of numbers of unvaccinated children**
- **Comparison of immunisation coverage during the campaign with previous analyses of DHS 2013 and MICS/NICS 2016 data**
- **Summary of findings**

The VaxPop team also presented a proposal to increase PCCS sample sizes at the cluster level to improve future geospatial analysis, as the current analyses revealed that sample sizes greater than 15 would likely ensure that prediction uncertainty was less than 10%. This recommendation was accepted and will be applied when designing future PCCS surveys.

Prior to VaxPop's involvement, the PCCS team analyses and reporting were limited to the state level, which do not demonstrate immunisation coverage variation at finer-scale administrative and settlement resolutions. With the support of VaxPop and GRID3, this limitation was overcome. Additionally, by monitoring metrics at LGA and 1x1km scales, improvements in vaccination coverage can be properly measured over time.

The application of the GRID3 settlement data also enabled the specific identification of settlements that should be targeted in future vaccination efforts.

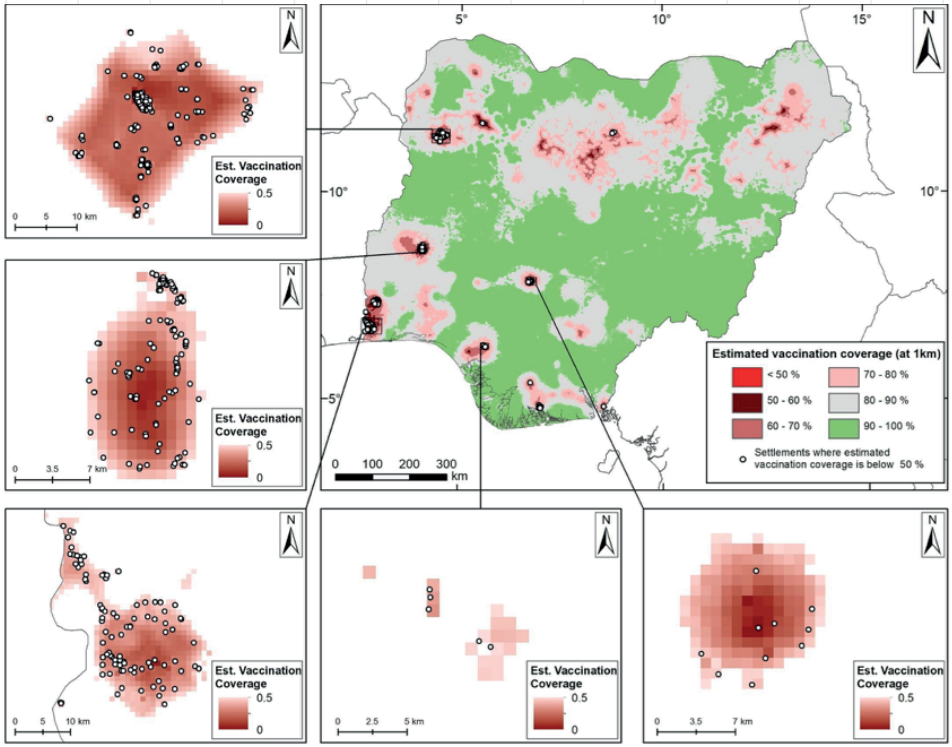


Image 2. Estimated coverage during the campaign at 1x1 km

Low coverage areas with <50% coverage are highlighted in red and other coverage classes in different colorus. The white dots indicate settlements located within the low coverage areas. Inset (top left – bottom right): 276 (Kebbi), 132 (Oyo), 97 (Ogun), 5 (Edo) and 10 (Kogi) settlements are located in these low coverage areas. In all, about 681 settlements were identified in the low coverage areas.

Source: Utazi CE, et al. (2019). Geospatial variation in measles vaccination coverage through routine and campaign strategies in Nigeria: analysis of recent household surveys. Submitted to *Vaccine*.

Next steps

The next measles vaccination campaign and subsequent PCCS have begun in late 2019. The GRID3 team will follow up with NPHCDA and other stakeholders to track how the results and recommendations are considered in designing future campaigns and post-campaign coverage surveys.

VaxPop is writing a report on the results and will coordinate with colleagues within NPHCDA for approval before publication.

Learning and continuous development

VaxPop and GRID3 Nigeria plan to perform similar analyses for upcoming meningitis, yellow fever, and measles immunisation campaigns. In these analyses, combining vaccination coverage estimates with GRID3 population data will allow the team to estimate the number, instead of percentage, of children under five who remained unvaccinated after the campaign. This has the potential to further improve campaign planning and targeting of specific LGAs and age groups, thus helping Nigeria to meet its goal of eliminating measles by 2020.

VaxPop received positive feedback on the format of the results presented - NPHCDA thought the maps and analyses were easy to understand and compare with existing data on measles outbreaks. On the other hand, there was room for improvement in terms of stakeholder engagement, as the VaxPop team was not able to meet with all key groups that could benefit from their analyses. In the future, the team hopes to engage stakeholders through a workshop in order to secure buy-in and help maximise the reach and impact of the work. Lessons learned about timing and type of engagement are being included in the work plan for future PCCS analyses.

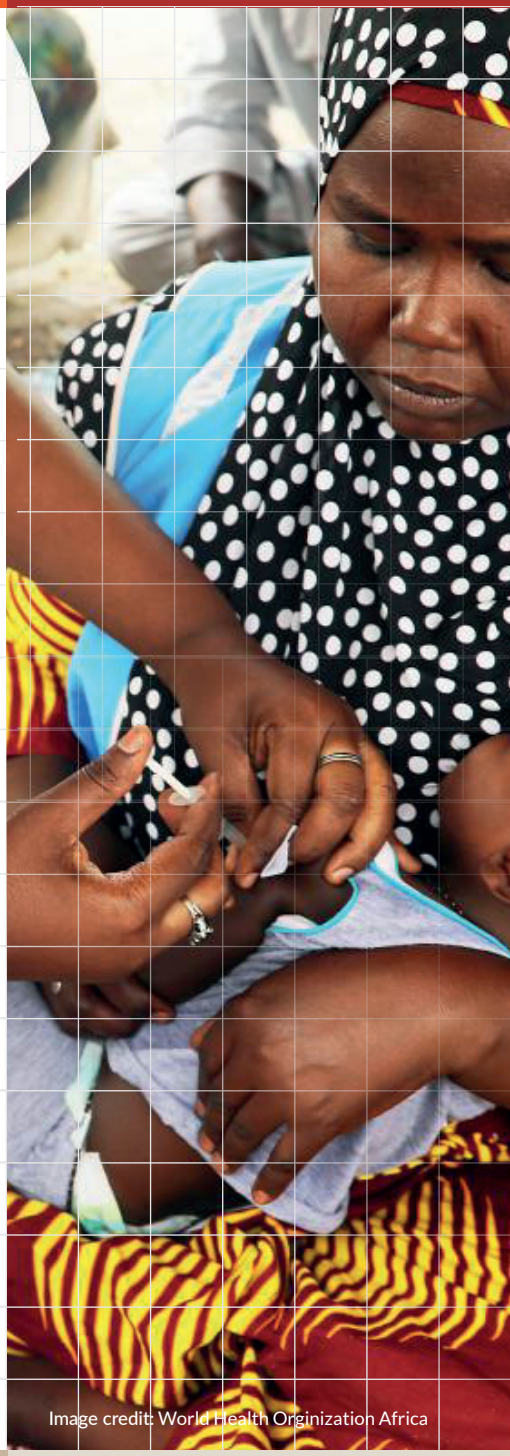


Image credit: World Health Orginization Africa

Annex 1 Covariate Datasets

Datase	Source
Proportion of People Living in Poverty	Tatem AJ, Gething PW, Bhatt S, Weiss D and Pezzulo C. (2013). *Pilot high resolution poverty maps. University of Southampton/Oxford University. DOI : 10.5258/SOTON/WP00200*
Density of Pigs	Gilbert M, G Nicolas, G Cinardi, S Vanwambeke, TP Van Boeckel, GRW Wint, TP Robinson (2018) *Global Distribution Data for Cattle, Buffaloes, Horses, Sheep, Goats, Pigs, Chickens and Ducks in 2010. Nature Scientific data, 5:180227. doi: 10.1038/sdata.2018.227*
Travel Time to Health Facilities	[Adapted from] Weiss DJ, Nelson A, Gibson HS, Temperley W, Peedell S, Lieber A, Hancher M, Poyart E, Belchior S, Fullman N, Mappin B, Dalrymple U, Rozier J, Lucas TCD, Howes RE, Tusting LS, Kang SY, Cameron E, Bisanzio, D, Battle KE, Bhatt S, Gething PW. (2018). *A global map of travel time to cities to access inequalities in accessibility in 2015 . Nature.*
MODIS Mean Land Surface Temperature	Wan Z, Hook S, Hulley, G. MOD11C3 MODIS/*Terra Land Surface Temperature/Emissivity Monthly L3 Global 0.05Deg CMG Voo6 [Data set]. NASA EOSDIS Land Processes DAAC.*
Settlement Type (interpolated)	[Derived from GUF & GHSL] Pesaresi M, Ehrlich D, Florczyk A J, Freire S, Julea A, Kemper T, … Syrris, V. (2015). *GHS built-up grid, derived from Landsat, multitemporal (1975, 1990, 2000, 2014).* Esch T, Heldens W, Hirner A, Keil M, Marconcini M, Roth A, … Strano, E. (2017). *Breaking new ground in mapping human settlements from space – The Global Urban Footprint. ISPRS Journal of Photogrammetry and Remote Sensing, 134, 30–42.*
Distance to the Edge of Cultivated Areas	ESA (European Space Agency) CCI (Climate Change Initiative) Land Cover project 2017. "*Land Cover CCI Product - Annual LC maps from 2000 to 2015 (v2.0.7).*" http://maps.elie.ucl.ac.be/CCI/viewer

GRID3

GEO-REFERENCED INFRASTRUCTURE AND DEMOGRAPHIC DATA FOR DEVELOPMENT

in partnership with the VaxPop team at WorldPop, University of Southampton

grid3.org info@grid3.org @GRID3Global

BILL & MELINDA GATES foundation

UKaid from the British people

world pop FLOWMINDER.ORG

UNFPA

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