WorldPop
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Reach the Unreached Initiative: Digital technologies to map zero-dose and unreached children in West and Central Africa

Mapping population, vaccination coverage, and zero-dose children

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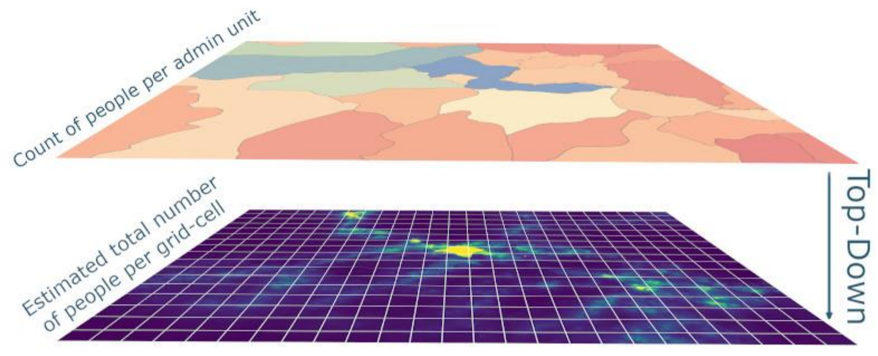
unicef for every child

Introduction

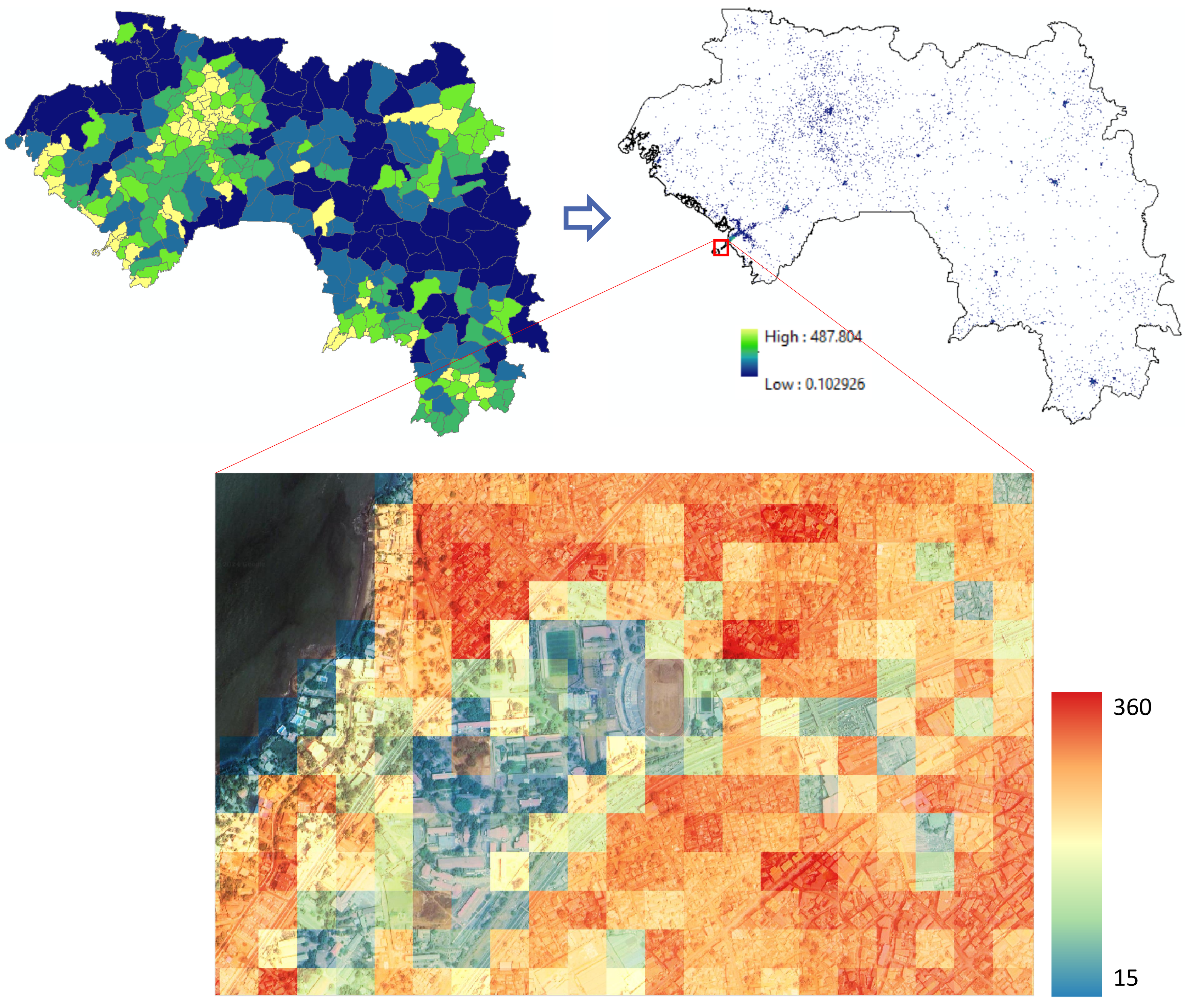
Accurate estimates of target, un- and under-vaccinated populations at various administrative units are key for effectively planning and delivering various policy-driven services within a country, especially immunisation services such as routine immunisation and campaigns, and humanitarian responses. However, due to outdated censuses, inaccessible areas (due to conflicts, extreme weather conditions, etc) movement of populations and lack of capacity, these data are often out of date, incomplete or unavailable in many countries. To bridge this gap, this project aims to develop these essential, current and programmable digital maps for Cameroon, Cote d'Ivoire, and Guinea.

Population Estimates

High resolution population estimates are generated by disaggregating trusted administrative unit level census totals or projections to 100m x 100m resolution based on relevant geospatial data and using a Random Forest machine learning method.



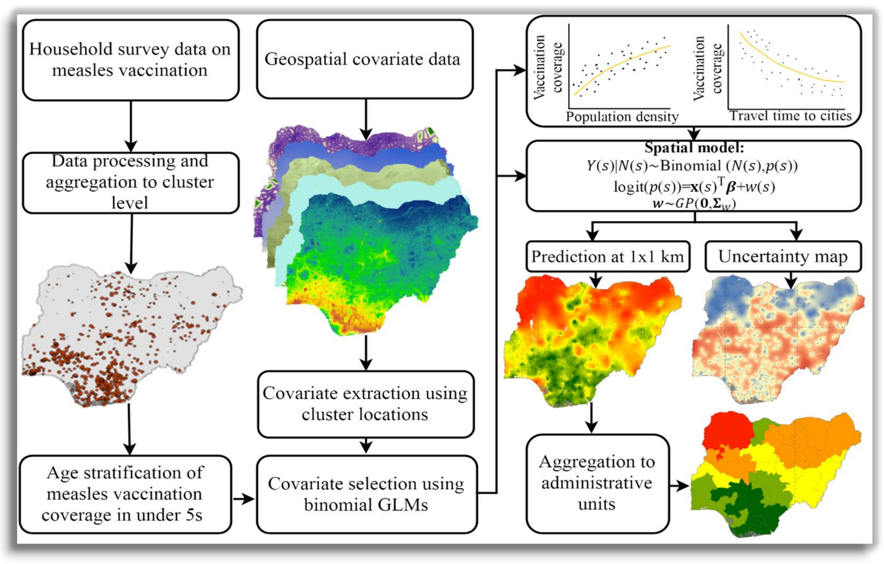
An example is shown for Guinea, where the 2023 age and sex-structured census projections are disaggregated from administrative unit level 3 to 100m resolution. By using a stack of informative geospatial datasets, such as land use/land cover, settlement and building information, climate data, distance to point of interest locations like markets, etc., the high-resolution spatial distribution of the population can be mapped. For example, non-settled pixels do not have an estimated population and the different neighborhood types, and non-residential areas are accurately differentiated.



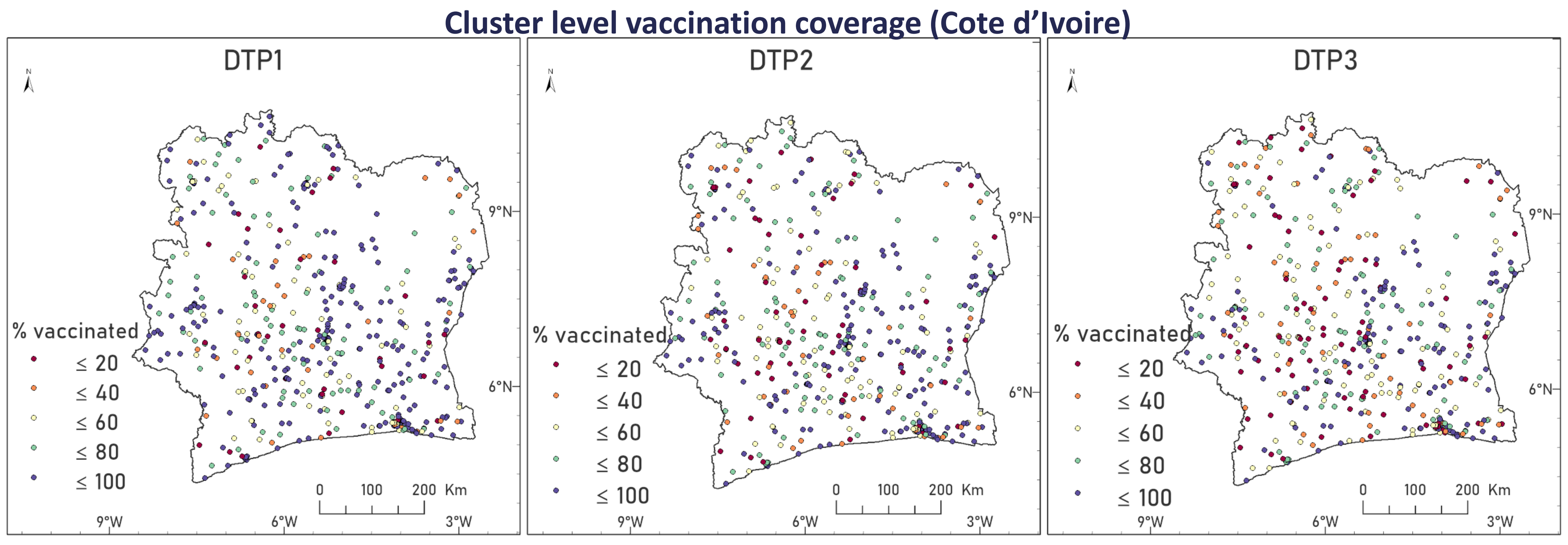
100m x 100m population estimates for Conakry, Guinea [9.5496305°,-13.6678673°]

Vaccination coverage estimates

Bayesian geospatial modelling makes it possible to map the coverage of DTP1-3, MCV1 and other vaccinations of children aged 12-23 months at 1km x 1km spatial resolution using mostly DHS, MICS and other national household survey data, as well as a suite of relevant geospatial data (e.g., land use, urbanicity, night-time lights, travel time to health facilities, etc.) – see the flowchart on the right.

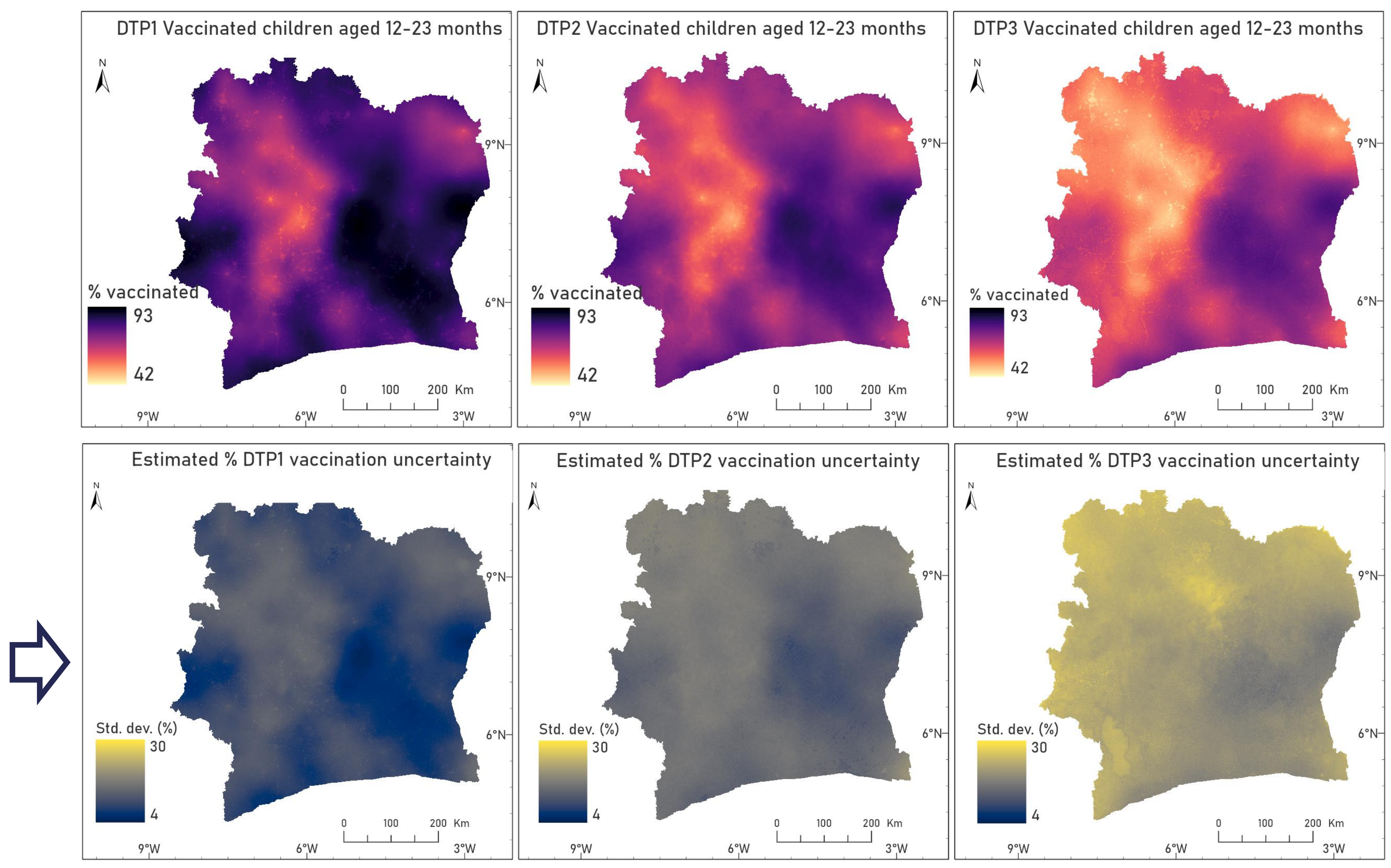


Cluster level vaccination coverage (Cote d'Ivoire)



The geospatial statistical modelling is an iterative process in multiple steps: data extraction/processing, eliminating correlating variables, developing a spatial Bayesian framework, model fitting, validation and prediction. The ratio-based approach (Utazi et al., 2022) ensures that $p(DTP1) \geq p(DTP2) \geq p(DTP3)$.

Estimated DTP 1 - 3 coverage and uncertainty at 1 km X 1 km resolution (Cote d'Ivoire)



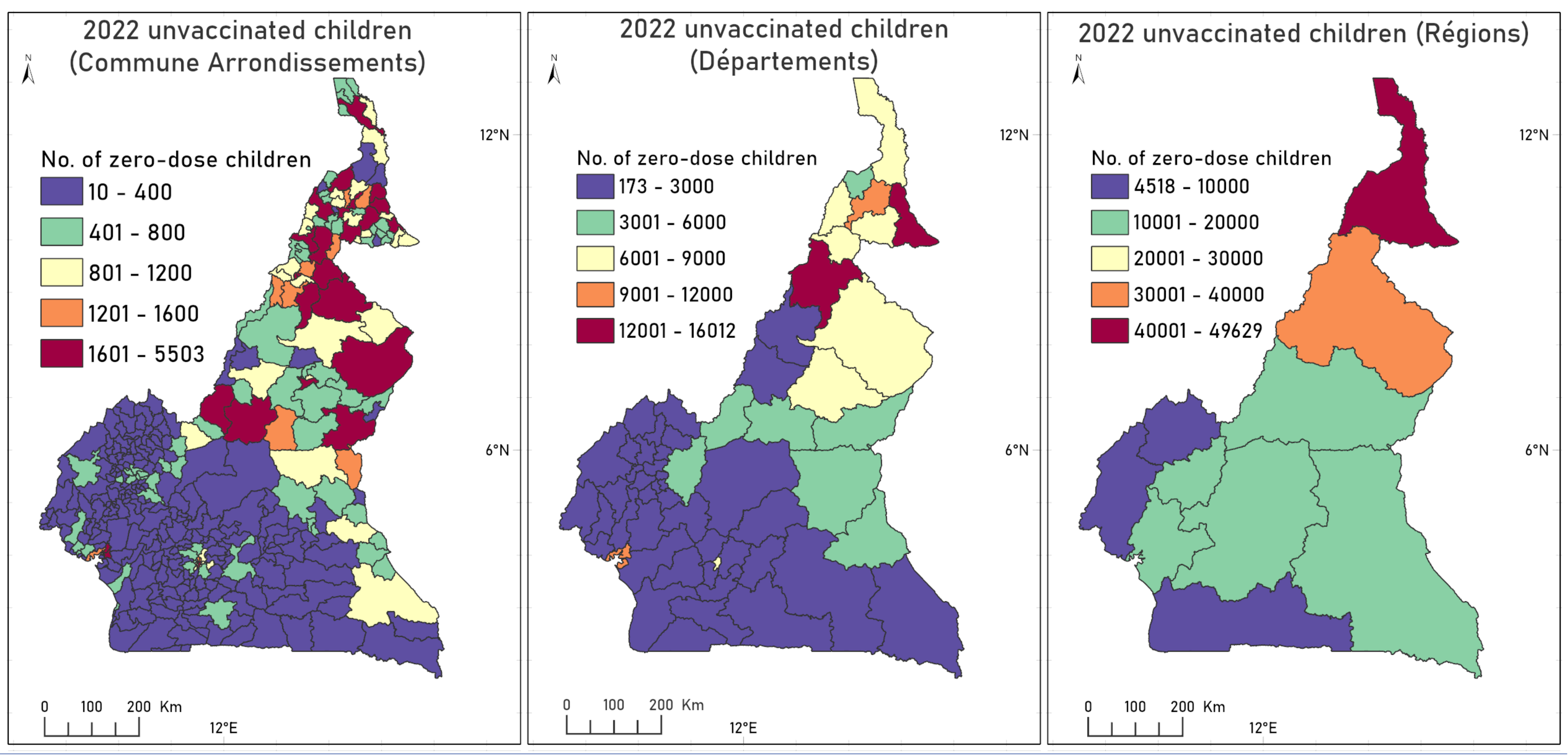
Levels of uncertainty at the grid level are often affected by small cluster-level sample sizes, however, precision greatly improves when these are aggregated to the admin level. In the example here, areas of lower coverage are concentrated in the western and northeastern areas. The dropout rates between doses 1 & 2 are highest in the northern and northwestern areas. The likelihood of attaining the 80% coverage threshold is highest in the eastern and south-eastern areas.

Zero-dose children estimates

Using geospatial analytical and mapping techniques the high-resolution estimates of children under 1 year-of-age are combined with the vaccination coverage results for 12-23 months children to estimate the number of under 1-year-old children not receiving the first and third doses of the diphtheria, tetanus toxoid and pertussis (DTP1, DTP3) at high resolution for the most recent year available. The 1km x 1km resolution results are easily aggregated up to various administrative and health area boundaries, providing clear and actionable outputs.

In this example, lower vaccination coverage areas are located in the north and northeastern areas, but dropout rates between doses 1 and 2 and between doses 2 and 3 are significant in the central, eastern as well as northern regions. The likelihood of attaining the 80% coverage threshold is highest in the southwestern regions.

Estimates of numbers of zero-dose children (Cameroon)



Acknowledgement

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