Communicating uncertainty in small-area spatial change estimates using a filter approach based on probabilities

Dorey, P., Tejedor-Garavito, N., Priyatikanto, R., Chan, H.M.T, Bonnie, A., Williams, Johnson, M, E.M., Tatem, A.J., Pezzulo, C.

WorldPop

University of Southampton

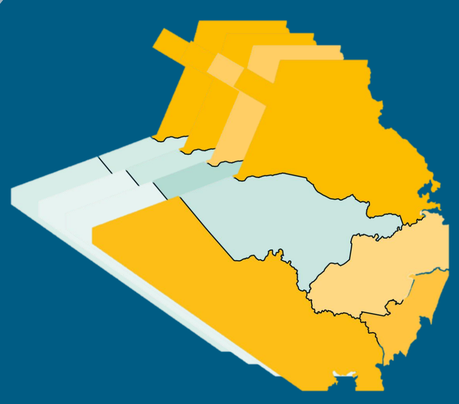
Project Rationale

The overarching aim of this project is to provide small-area mapping of child and maternal health and development indicators. Model based geostatistical methods (MBGs) were used to model various indicators of child and maternal health and their change over time across multiple low-and-middle income countries (LMICs). Geolocated survey data were derived from nationally representative household surveys such as the Demographic and Health Surveys (DHS), and a range of geospatial covariates encompassing climatic, geographical and socio-economic variables were used in the modelling. A focus of this project was to assess change in these indicators between subsequent rounds of the DHS surveys. This work motivated a novel methodology to visualise a policy relevant measure of uncertainty in these estimates of change. This allows us to convey to policy makers how certain we can be of the observed change in a given indicator in an area between two timepoints.

Background

- We first use MBGs to produce estimates of these indicators at 1x1km and then aggregate to policy relevant small-area administrative units
- This allows aggregation to lower-level administrative units which are consistent over time and where surveys are not representative
- Understanding how indicators change between two time points is crucial for policymakers to assess impact of interventions
- Visualising uncertainty on maps showing multiple values is a difficult challenge
- We have created an interactive tool tailored to policy decisions
- Two areas may have the same mean value of change, but this does not consider the uncertainty inherent in these figures
- Posterior samples of the 1x1km surfaces are taken from the models for both timepoints
- A distribution of the change between these two timepoints at 1x1km is created by subtracting samples at the first timepoint from those at the second timepoint since these posterior samples are independent
- Samples of the change at area level can be obtained by aggregation of the 1x1km change samples
- We then calculate the probability that the true value of the change is greater than zero
- This is closely related to exceedance probability
- We then use this value to filter the displayed values on the output maps

Methodology

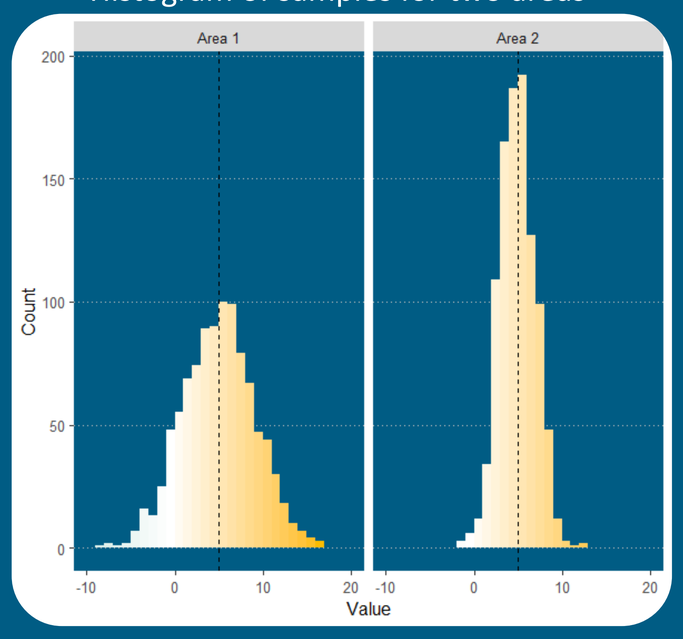


1000 posterior samples of the changes at area level are produced using MBG

For each area we calculate the proportion of values greater than 0

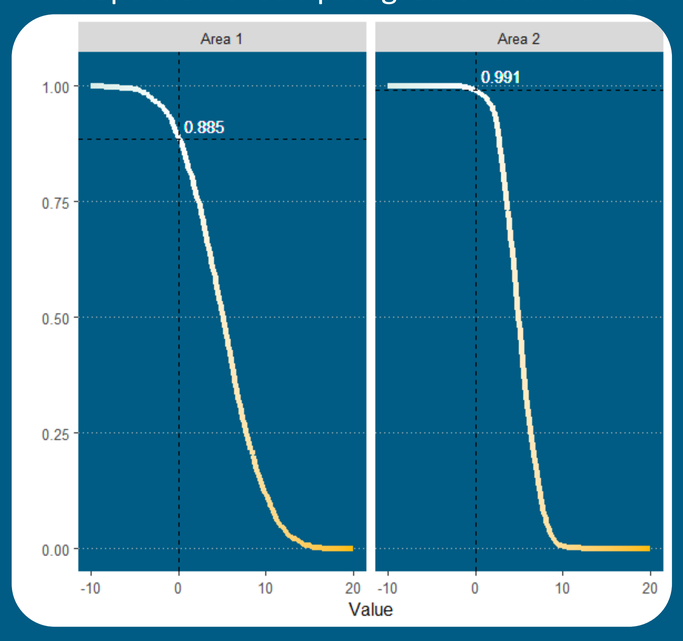
From this we can infer the probability that the true value of the change is greater than 0

Histogram of samples for two areas



Area 1 and Area 2 have the same mean value of change, but we see from the histogram that there is more uncertainty in this value for Area 1

Proportion of samples greater than value

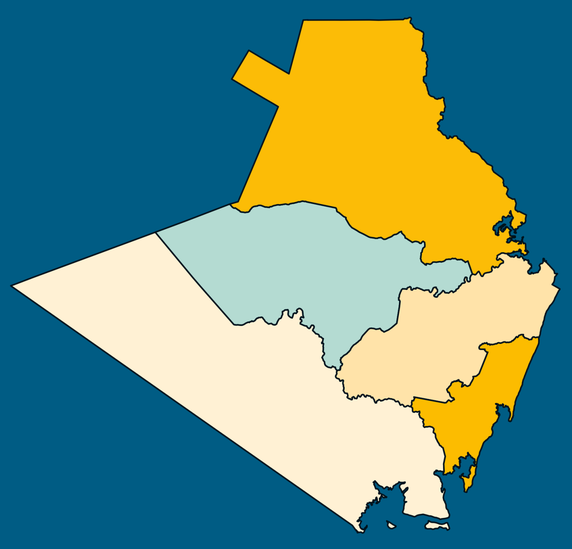


We see that over 99% of the samples for Area 2 are greater than zero, compared to only 88% for Area 1.

There is therefore over 99% probability that the indicator has increased in Area 2 whereas only 88% probability that the indicator has increased in Area 1

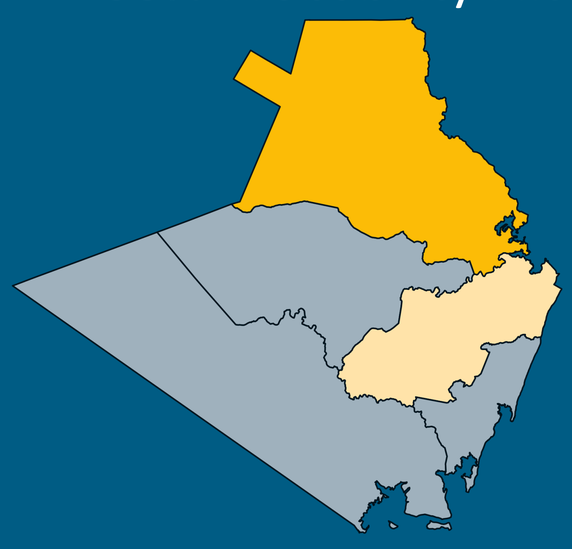
Displaying Outputs

No Filter



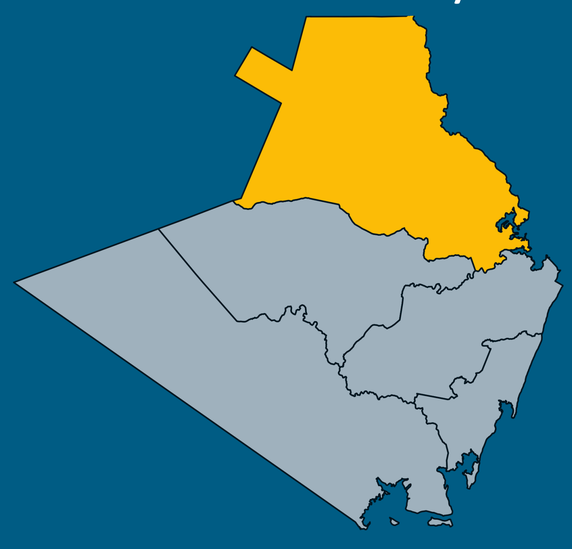
Mean values of change of the indicator for each area

95% Probability Filter



Areas where there is 95% probability (it is highly likely) that the true value represents an increase. Areas where we are not 95% certain there has been an increase are shown in grey.

99% Probability Filter



Areas where there is 99% probability (it is almost certain) that the true value represents an increase. Areas where we are not 99% certain there has been an increase are shown in grey.

Acknowledgements

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Poster prepared by Peter Dorey (P.Dorey@soton.ac.uk)

Pezzulo, C., Tejedor-Garavito, N., Chan, H.M.T. et al. A subnational reproductive, maternal, newborn, child, and adolescent health and development atlas of India. Sci Data 10, 86 (2023).

Subnational mapping of child and maternal health and development indicators in selected low- and middle-income countries