**Appendix I. Spatial-statistical analysis approach**

Let $Y\_{it}$ denote the number infants infected with HIV in district $i$ and time $t$ out of $N\_{it}$ children at risk,$ i=1,…,12$ and $t=1,…,7$. We assumed that $Y\_{it}$ has a Poisson distribution with a risk of infection $θ\_{it}$ . That is, $Y\_{it}\~Poisson\left(E\_{it} exp⁡( θ\_{it})\right)$, where $E\_{it}$ denotes the expected number of infants infected with HIV in district $i$ and time $t$. We model the risk of HIV infection using Hierarchical spatial Poisson regression models that accounts for excess heterogeneity and similarity over space and time. A class models were fitted to the data to assess the effects of selected covariates on the outcome of interest. These were based on a variant of the [Knorr-Held[[1]](#footnote-2)](#_ENREF_2)  formulation expressed as:

$$log\left(Y\_{it}\right)=log\left(E\_{it}\right)+\sum\_{j=1}^{n\_{f}}f^{\left(j\right)}\left(u\_{ji}\right)+\sum\_{k=1}^{n\_{β}}β\_{k}z\_{ki}+υ\_{i}+ν\_{i}+γ\_{t}+ϕ\_{t}$$

where $\left\{f^{\left(j\right)}\left(.\right)\right\}$’s are unknown functions of the covariates $u$, the $\left\{β\_{k}\right\}$’s represent the linear effect of covariates $z,$ $ν\_{i}'$s are spatial unstructured components, which are independent and identically distributed with zero mean and unknown precision, $τ\_{ν}$; and $υ\_{i}'$s is spatially structured component which is assumed to vary smoothly from region to region. To account for such smoothness $υ\_{i}'$s are modelled as an intrinsic Gaussian Markov random field with unknown precision, *τ**s*. In this formulation, $ϕ\_{t}$ represents temporally unstructured components which are independent and identically distributed with zero mean and unknown precision, $τ\_{ϕ}$; and $γ\_{t}$ is the temporally structured effect, modelled dynamically using a random walk through the following structure:

$$γ\_{t}|γ\_{t-1}\~N\left(γ\_{t+1},τ\_{γ}\right) for t=1$$

$$γ\_{t}|γ\_{t-1}\~N\left(\frac{γ\_{t-1}+γ\_{t+1}}{2},\frac{τ\_{γ}}{2}\right) for t=1$$

$$γ\_{t}|γ\_{t-1}\~N\left(γ\_{t-1},τ\_{γ}\right) for t=12$$

Estimation of parameters was carried out using the Integrated Nested Laplace approximation approach. The latent Gaussian field for the model was $ξ=\left\{f^{(j)}\left(.\right),β\_{k},υ\_{i},ν\_{i},γ\_{t},ϕ\_{t}\right\}$ with hyperparameter vector $θ=\left\{τ\_{β},τ\_{υ},τ\_{ν},τ\_{γ},τ\_{ϕ},\right\}$. Vague independent Gamma priors are assigned to each of the elements in *ϑ*.

The model was also expanded to include an interaction between space and time as follows:

$$log\left(Y\_{it}\right)=log\left(E\_{it}\right)+\sum\_{j=1}^{n\_{f}}f^{\left(j\right)}\left(u\_{ji}\right)+\sum\_{k=1}^{n\_{β}}β\_{k}z\_{ki}+υ\_{i}+ν\_{i}+ϕ\_{t}+δ\_{it},$$

Where $δ\_{it}\~N\left(0,τ\_{δ}\right).$

1. Knorr-Held, L., *Bayesian modelling of inseparable space-time variation in disease risk.* Statistics in medicine, 2000. **19**(17-18): p. 2555-2567 [↑](#footnote-ref-2)