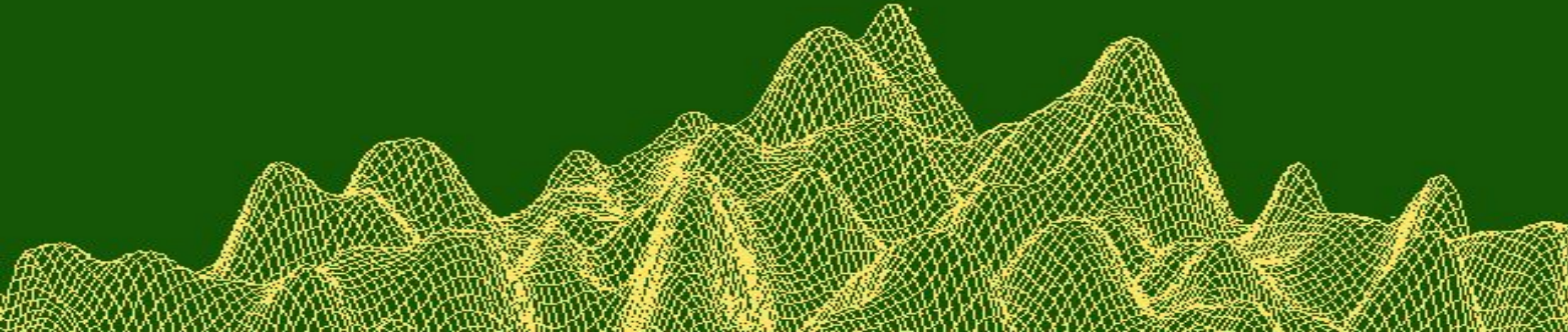
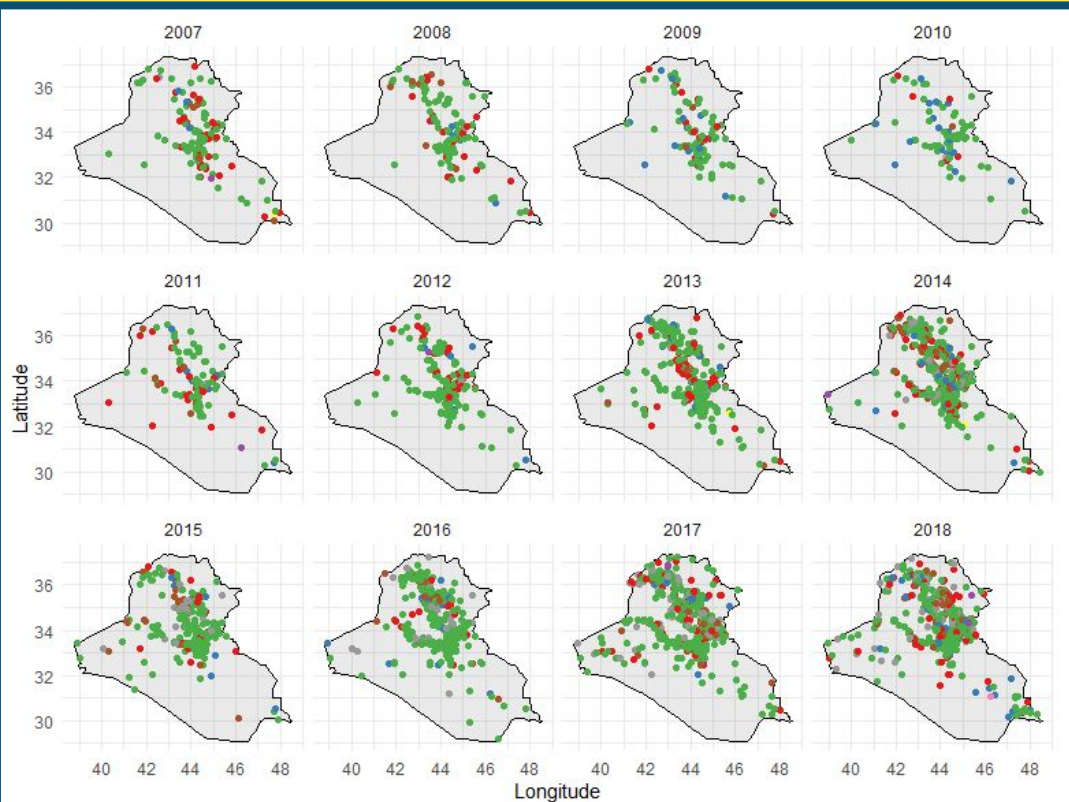


Modelling Terrorist Events in Iraq as a Log-Gaussian Cox Process

Alice Hankin



Terrorism Dataset



What is a Log-Gaussian Cox Process?

$$\Lambda(x, y) = \exp\{\beta_0 + \beta_1 * Population(x, y) + G(x, y) + \varepsilon(x, y)\}$$

Intensity

Intercept

Covariate

Gaussian Random Field

Error term

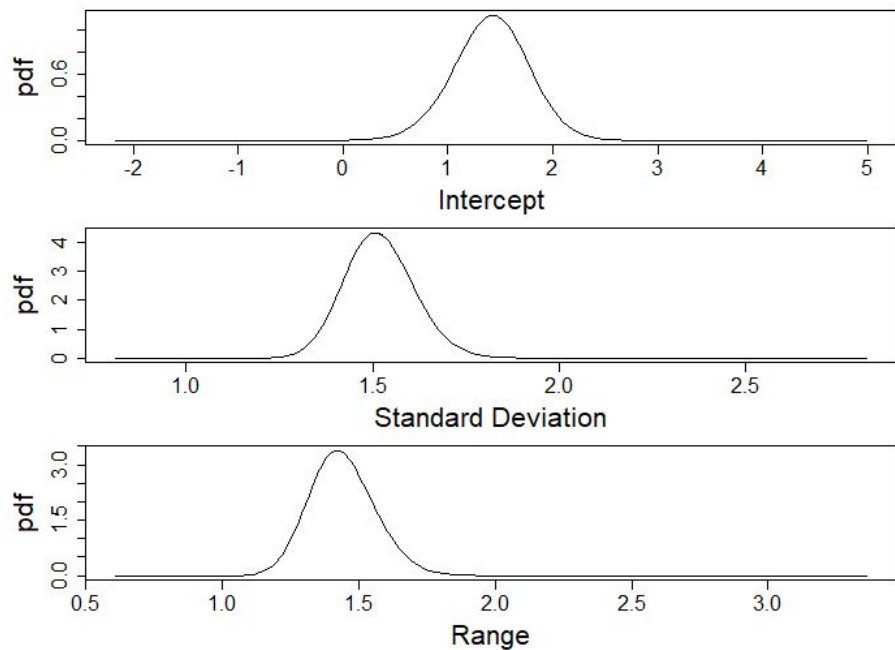
The Gaussian Random Field $G(x, y)$ is characterized by the Matérn covariance function, giving the covariance between two points d units apart. It has three parameters:

- range r
- standard deviation σ^2
- smoothness ν

$$C_\nu(d) = \sigma^2 \frac{2^{1-\nu}}{\Gamma(\nu)} \left(\sqrt{2\nu} \frac{d}{0.5r} \right)^\nu K_\nu \left(\sqrt{2\nu} \frac{d}{0.5r} \right)$$

Spatial Model - Results

$$\Lambda(x, y) = \exp\{\beta_0 + G(x, y) + \varepsilon(x, y)\}$$

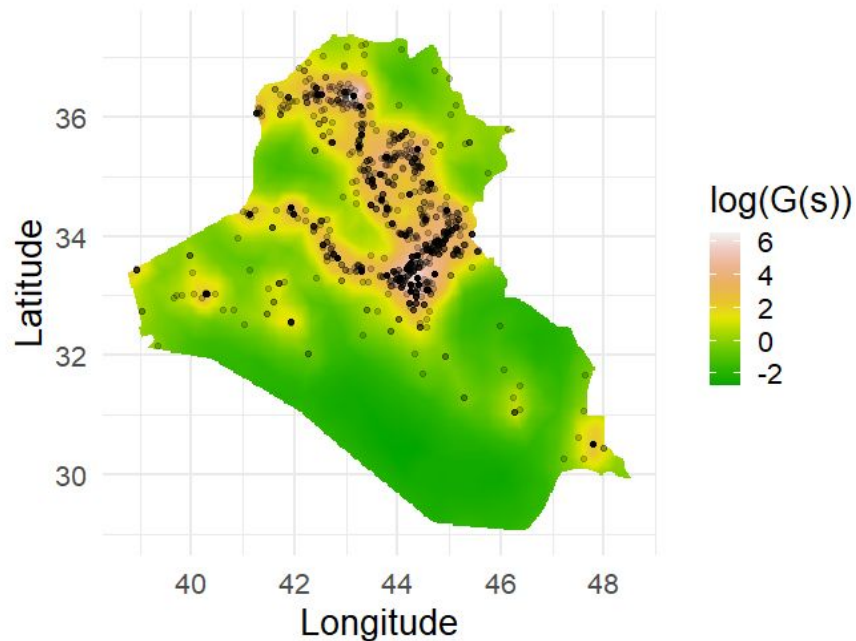


Fixed effects:

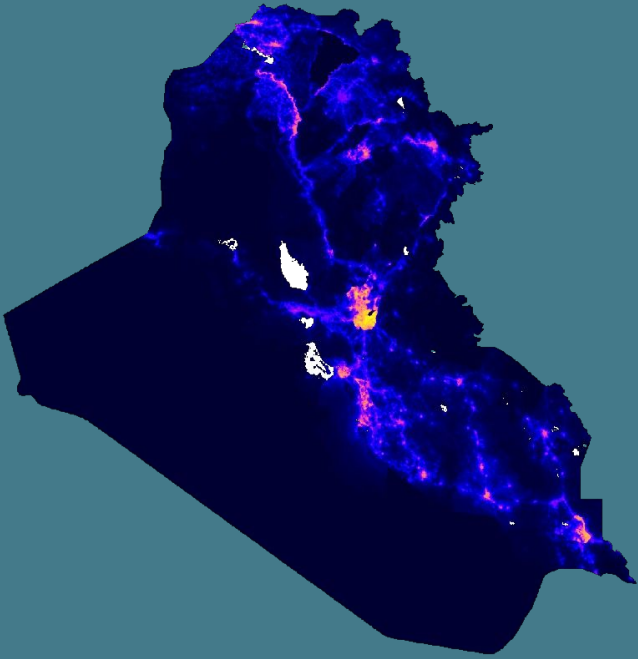
	mean	sd	0.025quant	0.5quant	0.975quant	mode	kld
Intercept	1.411	0.357	0.69	1.418	2.098	1.43	0

Model hyperparameters:

	mean	sd	0.025quant	0.5quant	0.975quant	mode
Range for field	1.44	0.119	1.22	1.43	1.69	1.42
Stdev for field	1.52	0.093	1.35	1.51	1.71	1.51

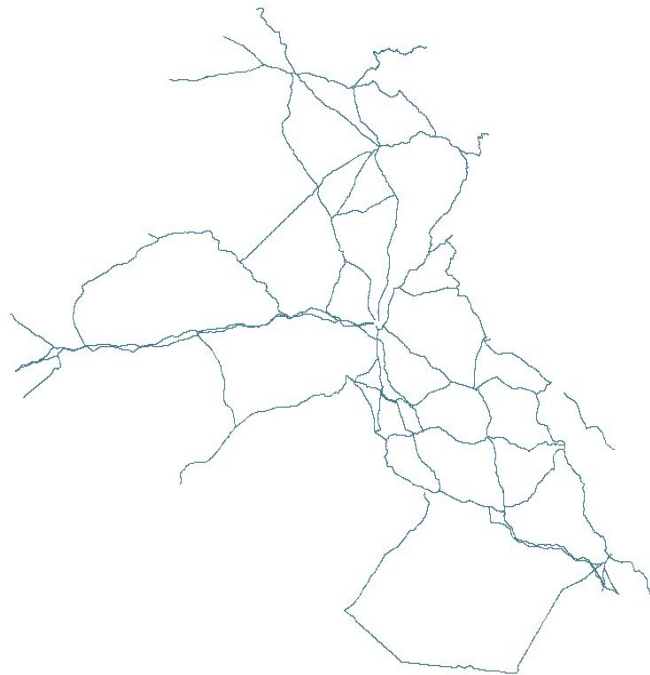
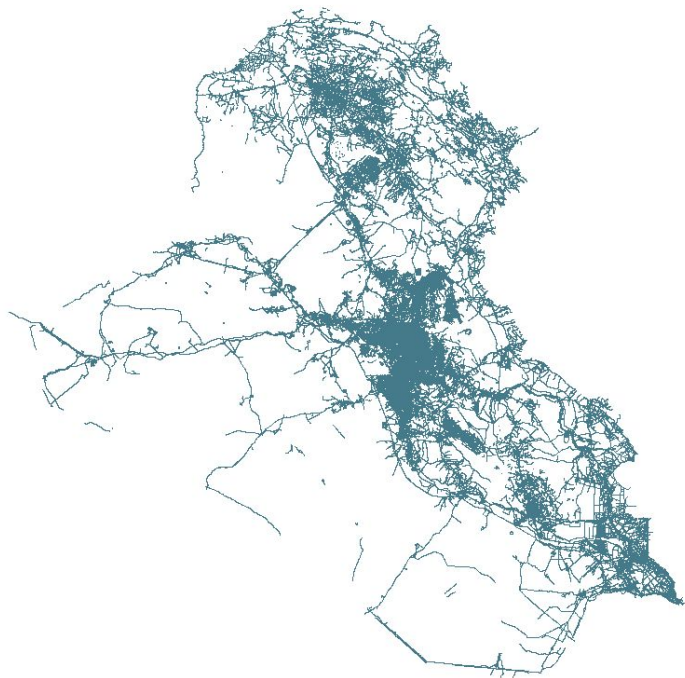


Spatial Model with Covariates - Population

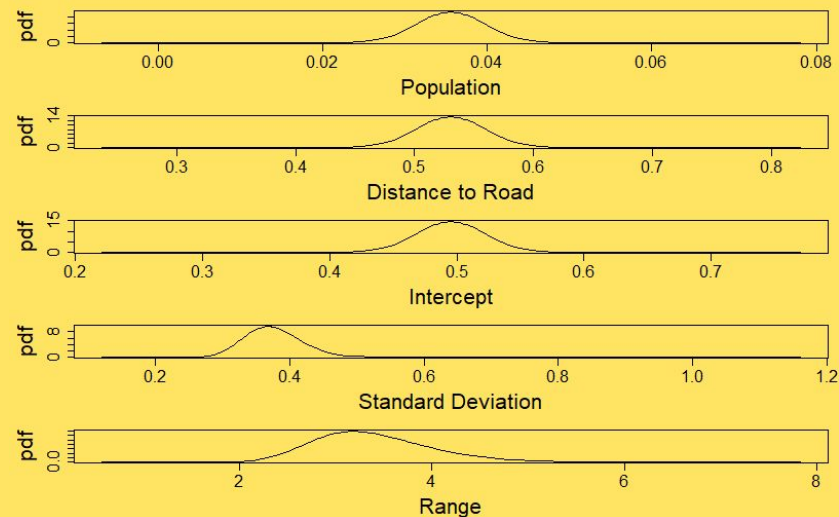
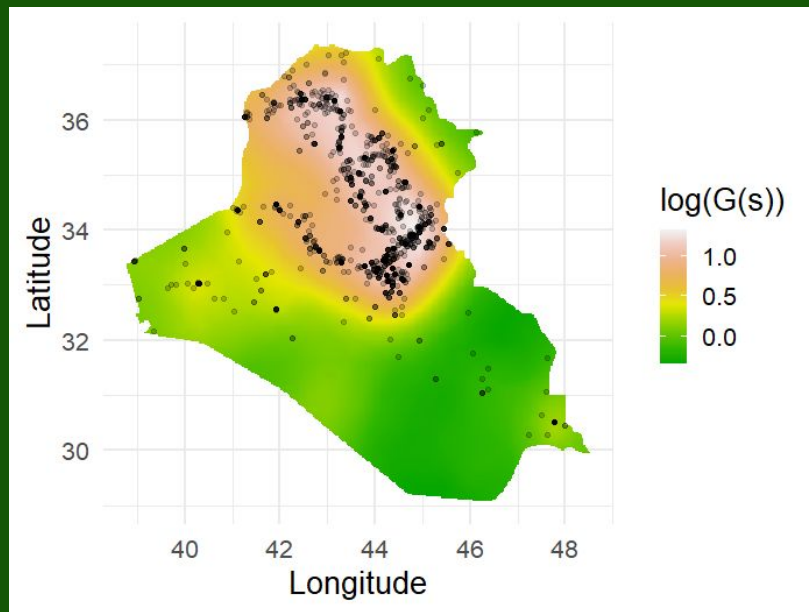


*Population density in number of
people per 1000km, on a log scale*

Spatial Model with Covariates - Distance to Road



Spatial Model with Covariates



	mean	sd	0.025quant	0.5quant	0.975quant	mode
pop	0.036	0.004	0.027	0.036	0.044	0.036
distance	0.531	0.029	0.473	0.531	0.588	0.531
Intercept	0.495	0.027	0.442	0.495	0.549	0.495

	mean	sd	0.025quant	0.5quant	0.975quant	mode
Range	3.399	0.618	2.378	3.331	4.797	3.191
Stdev	0.375	0.042	0.299	0.373	0.465	0.369

$$\Lambda(x, y) = \exp\{\beta_0 + \beta_1 * Population + \beta_2 * Distance + G(x, y) + \varepsilon(x, y)\}$$

Spatio-Temporal Model

$$\Lambda_i(x, y) = \exp\{\beta_0 + \beta_1 * Population + \beta_2 * Distance + G_i(x, y) + \varepsilon(x, y)\}$$

Gaussian Random Field
this year (year i)

Residual (temporal)
correlation

Gaussian Random Field
for last year (year i-1)

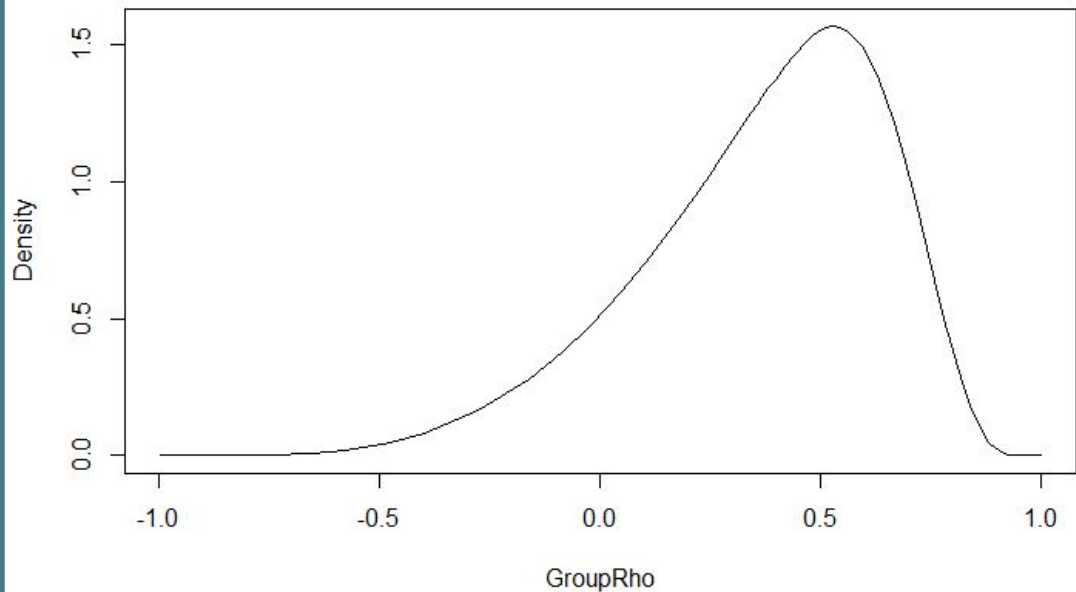
Error
term

$$G_i(x, y) = \rho \cdot G_{i-1}(x, y) + \varepsilon'(x, y)$$

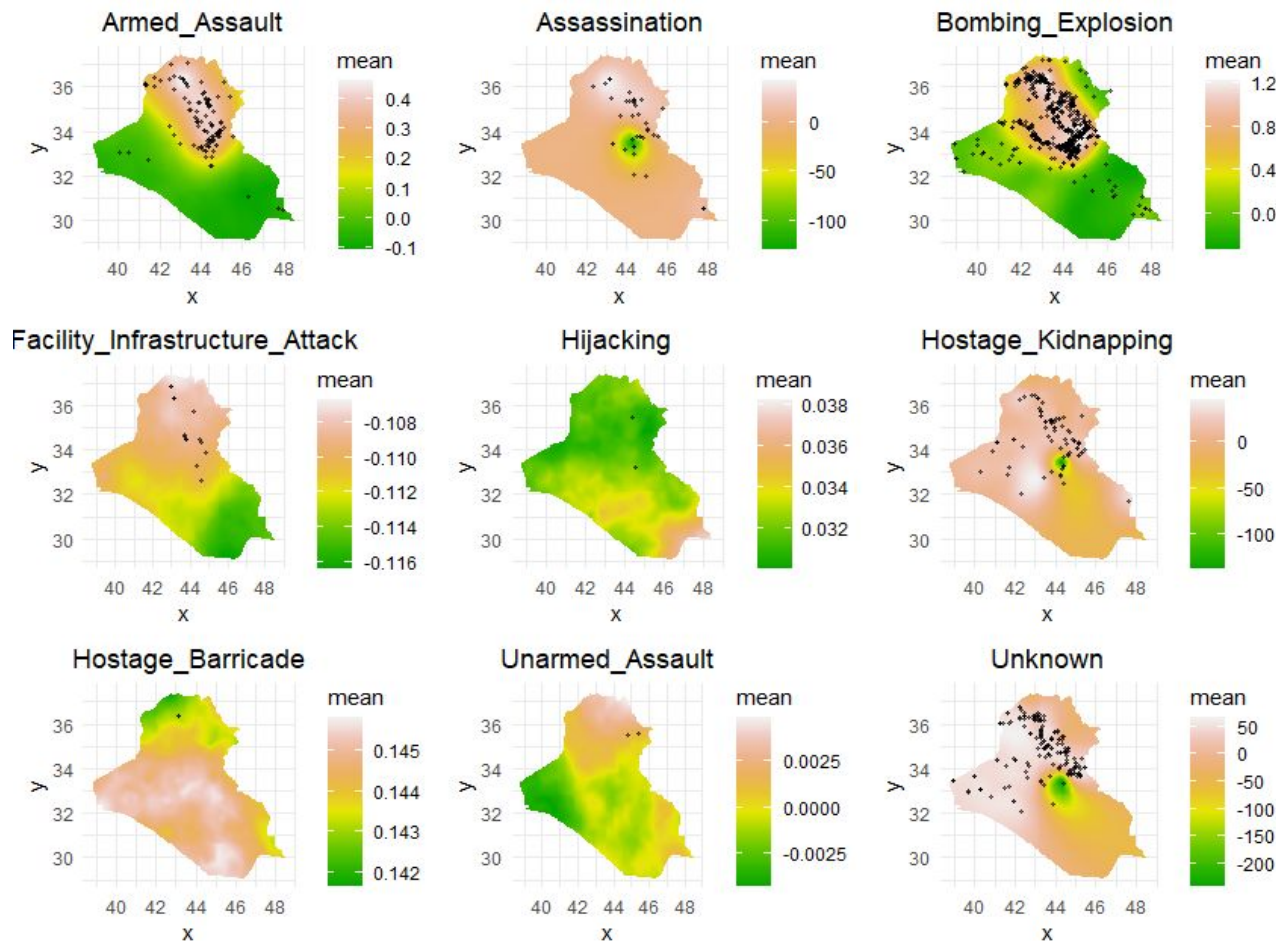
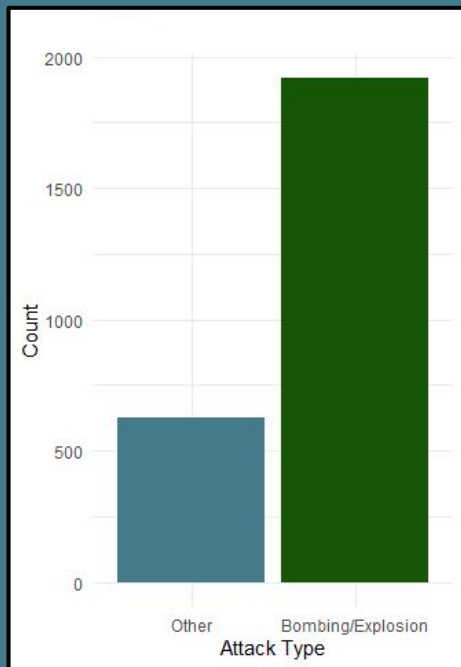
	mean	sd	0.025quant	0.5quant	0.975quant	mode	kld
distance	0.579	0.011	0.557	0.579	0.601	0.579	0
pop	0.029	0.003	0.024	0.029	0.034	0.029	0
Intercept	0.554	0.010	0.534	0.554	0.574	0.554	0

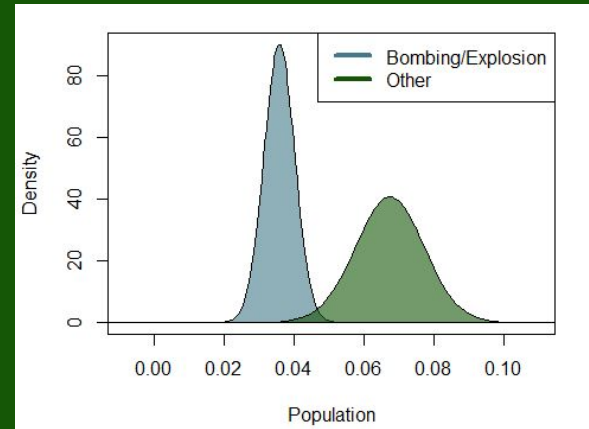
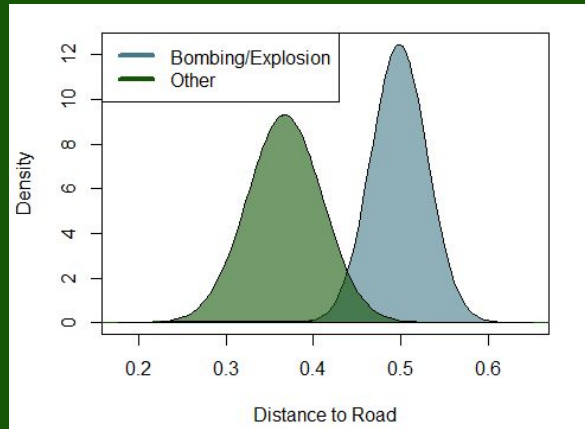
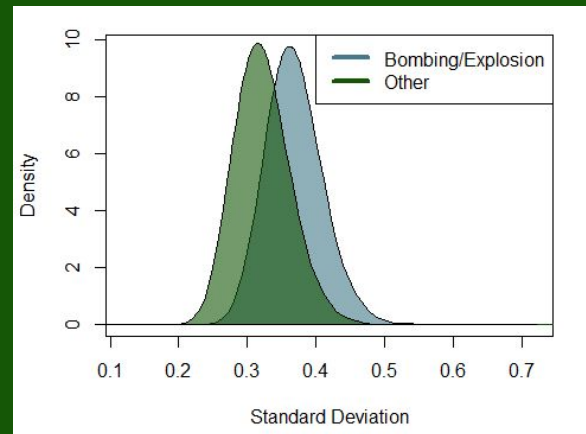
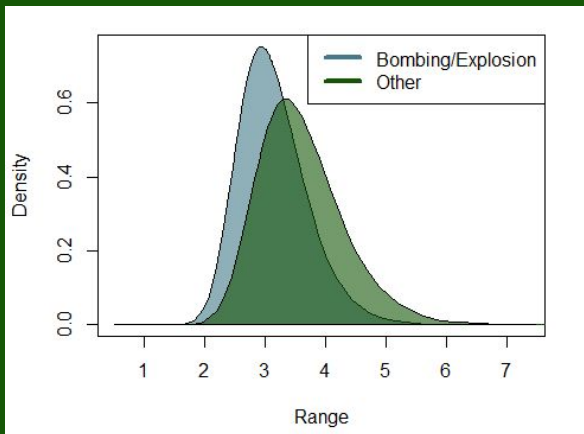
	mean	sd	0.025quant	0.5quant	0.975quant	mode
Range for field	2.611	0.295	2.105	2.584	3.259	2.519
Stdev for field	0.356	0.023	0.309	0.357	0.398	0.363
GroupRho for field	0.365	0.277	-0.278	0.411	0.780	0.527

We have ~11% of our
posterior density below 0 --
not a significant result!



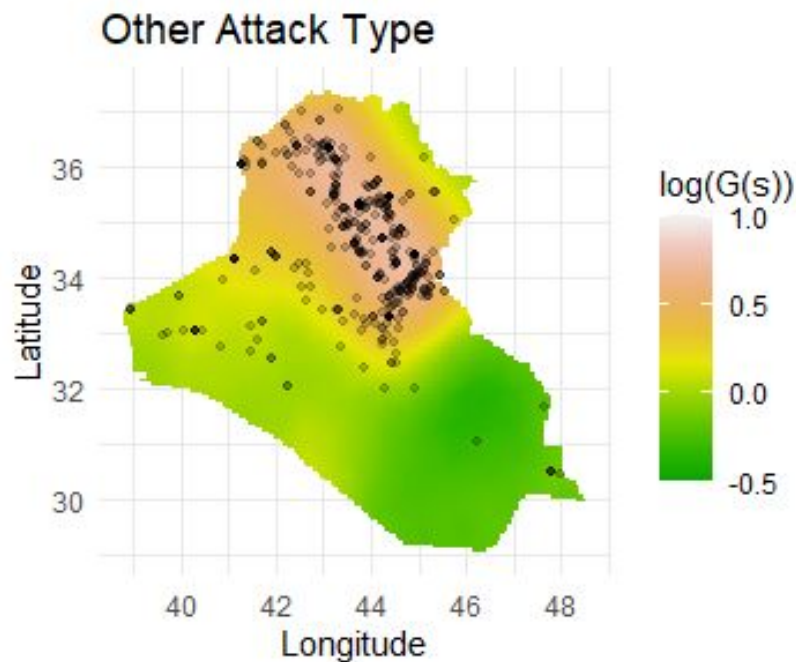
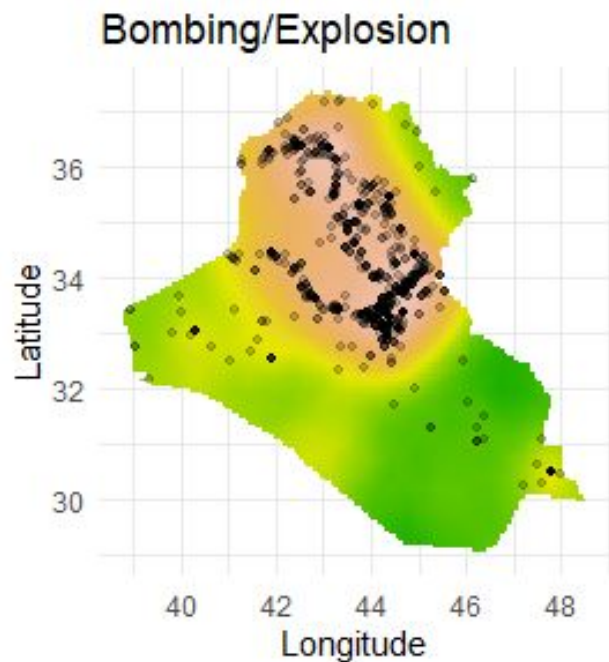
A Marked Model





$$\Lambda(x, y) = \exp\{\beta_0 + \beta_1 * Population + \beta_2 * Distance + G(x, y) + \varepsilon(x, y)\}$$

A Marked Model



Further Work / Limitations

- Covariance functions
- Other covariates
- Spatial accuracy of the data
- Other marked models

Thank you for listening!