Spatial distribution of Rift Valley fever, *Brucella* spp. and *Coxiella burnetii* in Kenya

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Introduction

- The distribution of most infectious diseases influenced by climatic, geologic, topographic and a wide range of biotic factors

- Many of the diseases cluster in common ecologies because:
  - They share common reservoir hosts
  - They respond to similar drivers and risk factors

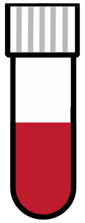
- This knowledge being used in multiple ways:
  - Develop risk maps that can guide the deployment of risk-based surveillance and control measures
  - Impact assessments

- A DTRA-funded project that investigates ecological factors that influence the distribution of Rift Valley fever, *Brucella* spp. and *Coxiella burnetii* in humans and animals in Kenya

Objectives

- To develop risk maps for Rift Valley fever virus, *Brucella* spp and *Coxiella burnetii* and their co-infections in Kenya based on serological analysis of human and livestock samples

- To build capacity on biosafety and biosecurity practices among human and animal health workers for better management and control of EDPs and related pathogens



Methods

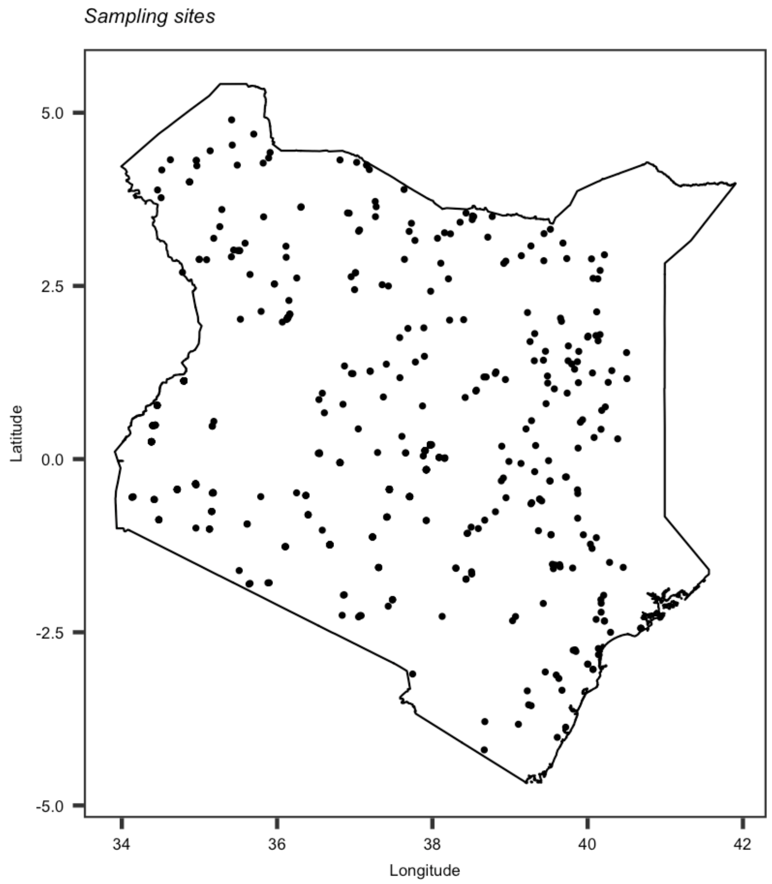
Study design

- National serosurvey using a cross sectional study design
- Sampling focussed on cattle
- Sample size of 8,000 stratified by agroecological zones and cattle distribution
- Random coordinates generated and used to identify specific sampling sites

Sample collection and laboratory analysis

- 25 cattle sampled in each point and serum samples processed
- Laboratory analysis conducted at ILRI Nairobi using commercial ELISA kits
- Data managed in an on-line platform

Random coordinates

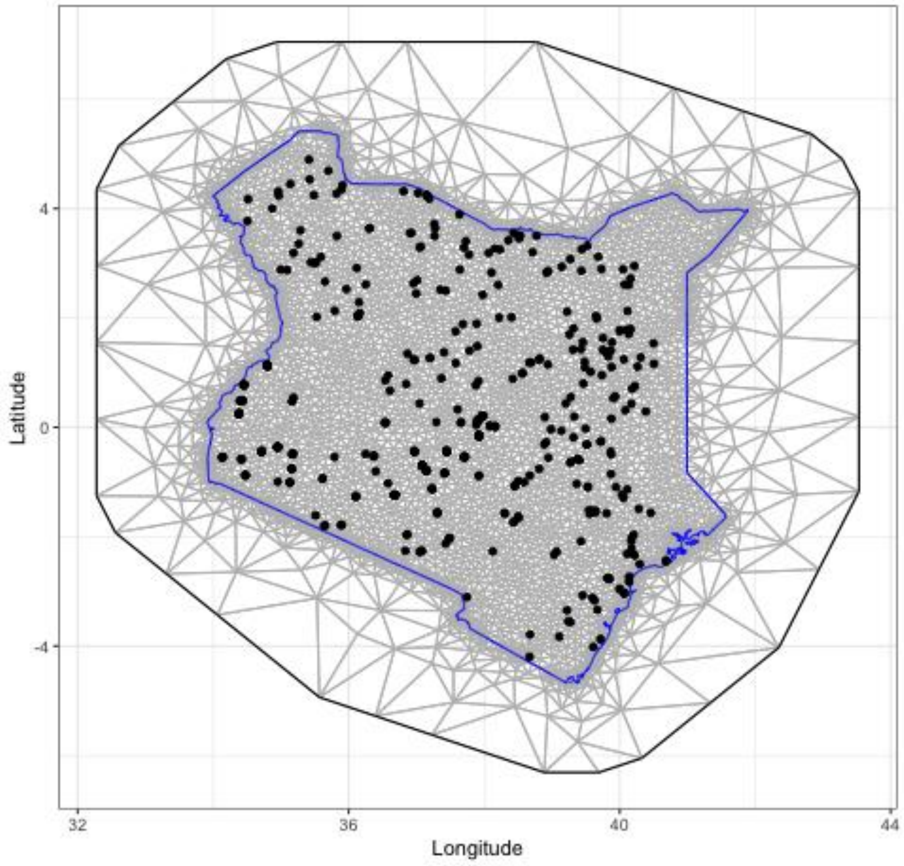


Methods

Data analysis

- 6,593 samples received – insecure areas were not sampled
- Subject specific and herd-level variables – age, sex, breed, herd size etc. obtained -- but not subject for this discussion
- Spatial data – climate variables, livestock distribution, land cover, soil types obtained from various on-line databases (FAO etc.)
- Spatial analysis conducted using R-INLA (Integrated Nested Laplace Approximation)
    - Spatial autocorrelation
    - Fit a random-effects multivariable model to the data

Delaunay triangulation for spatial analysis

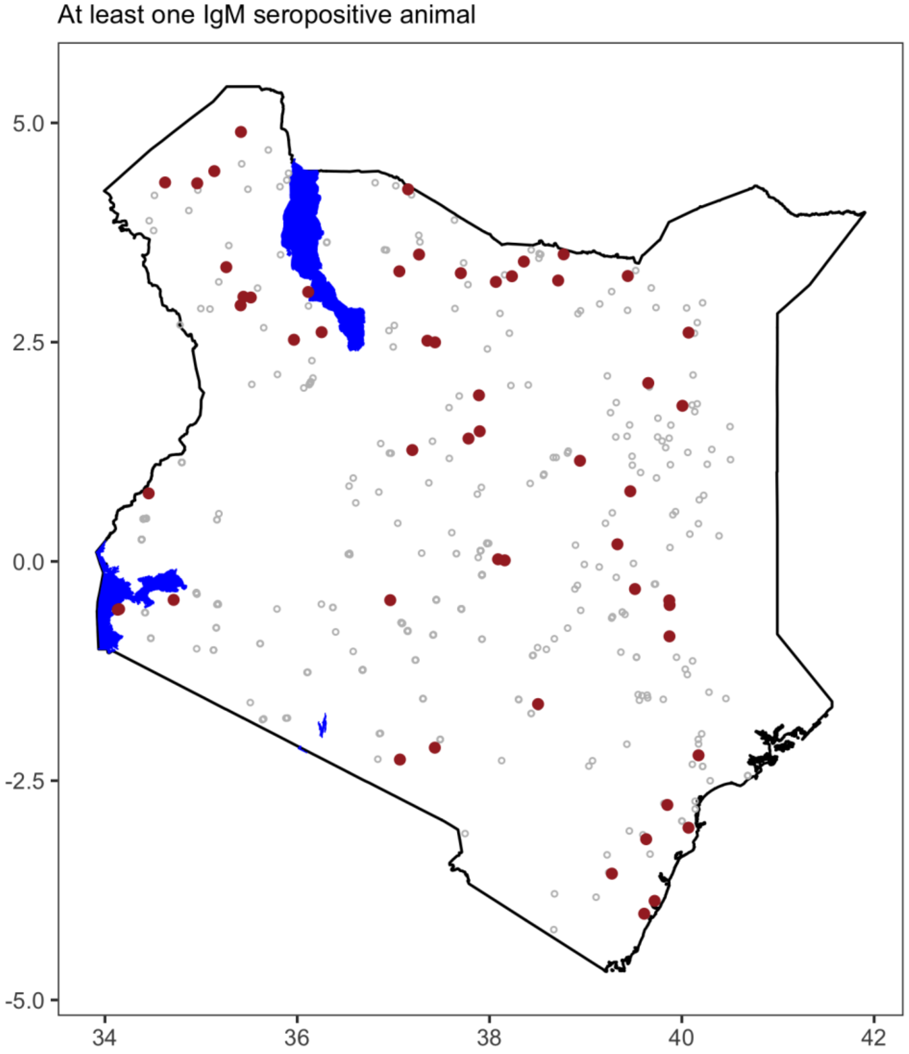


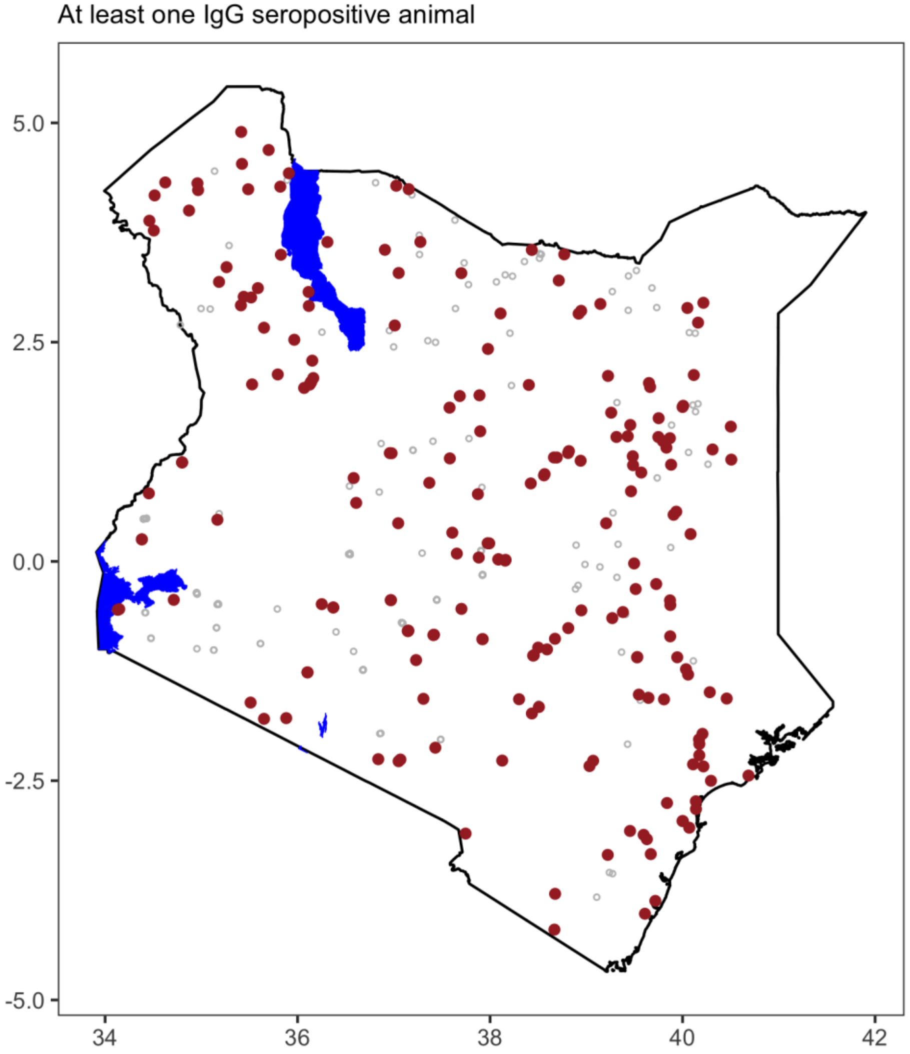
Results

- Descriptive results
  - Survey period: November 2020 to August 2021
  - Seroprevalences

Pathogen	Number sampled	Number positive	Seroprevalence (95% confidence)
RVFV -- IgM	6,593	64	0.97% (0.76 – 1.24%)
RVFV-- IGG	6,493	649	9.99% (9.29 – 10.75%)
Brucella spp	6,593	446	6.76% (6.18 – 7.40%)
Coxiella burnetii	6,593	518	7.86% (7.23 – 8.53%)

Rift Valley fever seroprevalence





Animal level variables

Results from anti-RVFV IgM ELISA

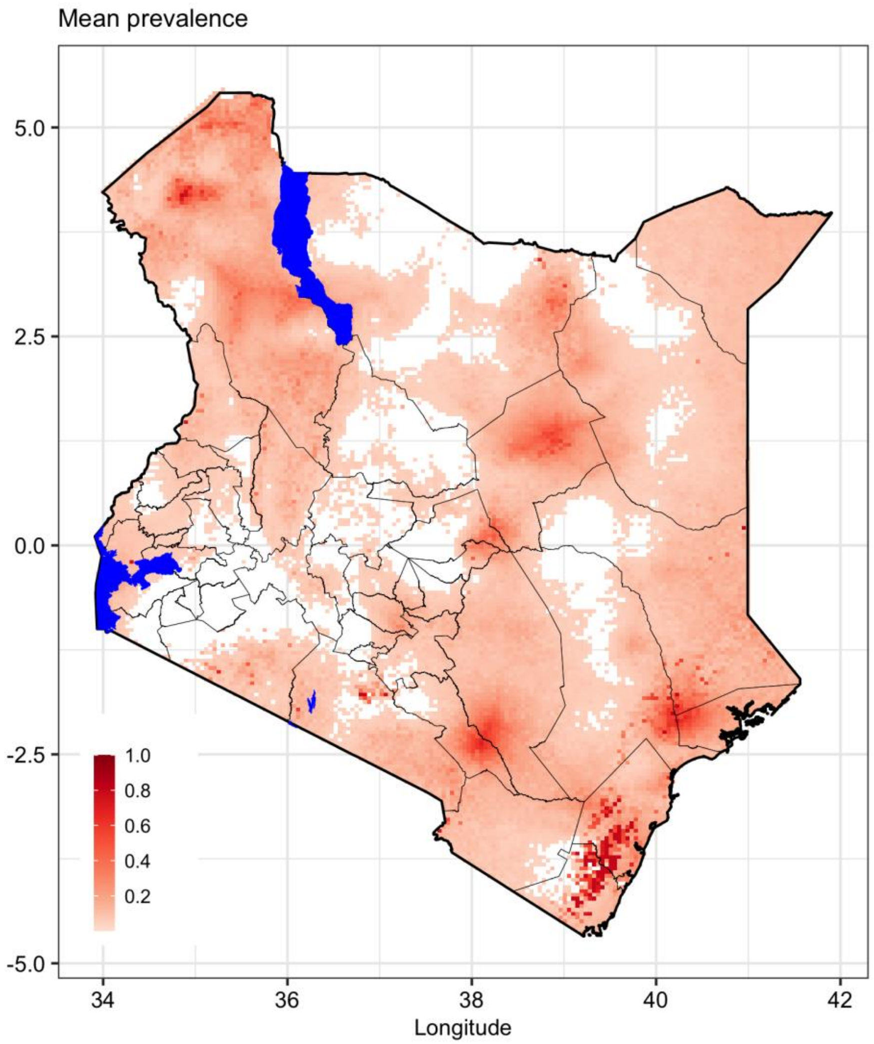
Variable	Levels	Number sampled	Prevalence (95% CI)	χ^2 (p)
Sex	Male	1,580	0.94 (0.53 – 1.56)	0.08 (0.76)
	Female	4,439	1.04 (0.76 – 1.38)	
Age	Adult	3,101	1.16 (0.81 – 1.60)	NS
	Yearlings	856	1.64 (0.89 – 2.72)	
	Weaners	974	0.51 (0.17 – 1.19)	
	Suckling	1,088	0.55 (0.20 – 1.20)	

Results from anti-RVFV IgG ELISA

Variable	Levels	Number sampled	Prevalence (95% CI)	χ^2 (p)
Sex	Male	1,569	8.98 (7.62 – 10.51)	3.25 (0.07)
	Female	4,400	10.59 (9.69 – 11.51)	
Age	Adult	3,078	13.42 (12.23 – 14.67)	76.92 (0.00)
	Yearlings	852	8.33 (6.57 – 10.40)	
	Weaners	959	5.94 (4.53 – 7.63)	
	Suckling	1,080	6.11 (4.76 – 7.71)	

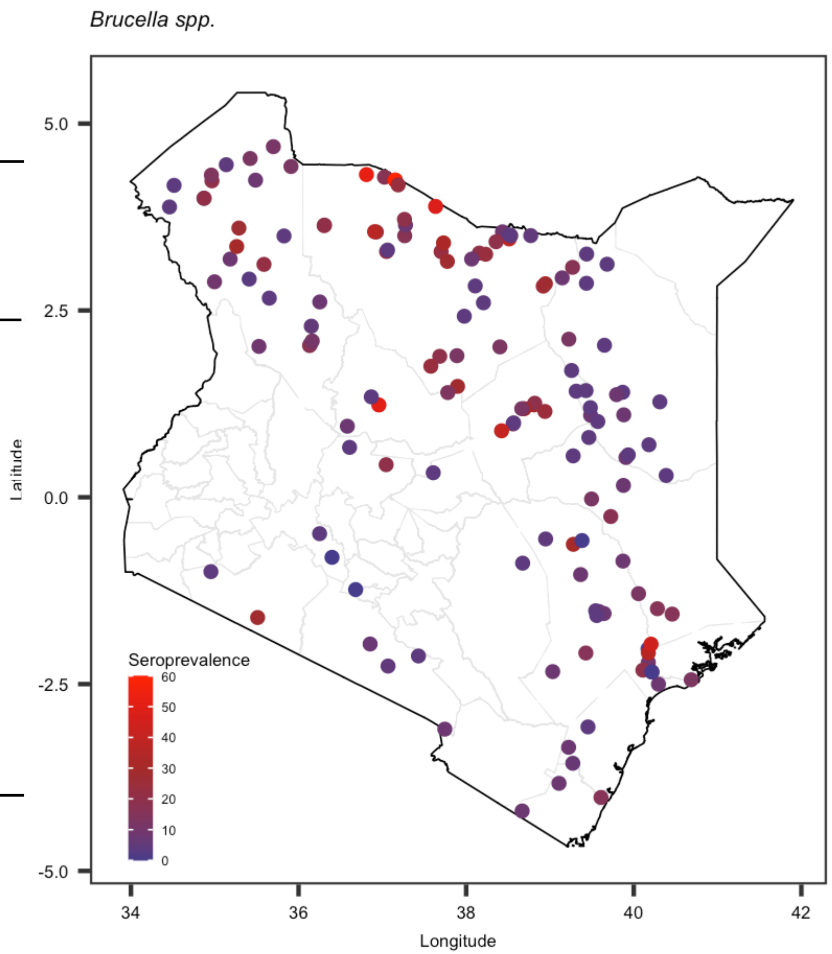
RVF prevalence map

Variable	Mean	SD	2.5% quantile	97.5% quantile
Intercept	-4.47	1.65	-7.70	-1.21
Annual mean temperature	1.47	1.41	-1.32	4.23
Precipitation - driest quarter	-0.41	0.37	-1.19	0.27
Slope	-3.10	0.99	-5.05	-1.15
Calcic vertisols	0.27	0.09	0.09	0.46
Mollic solonetz	0.26	0.08	0.10	0.43



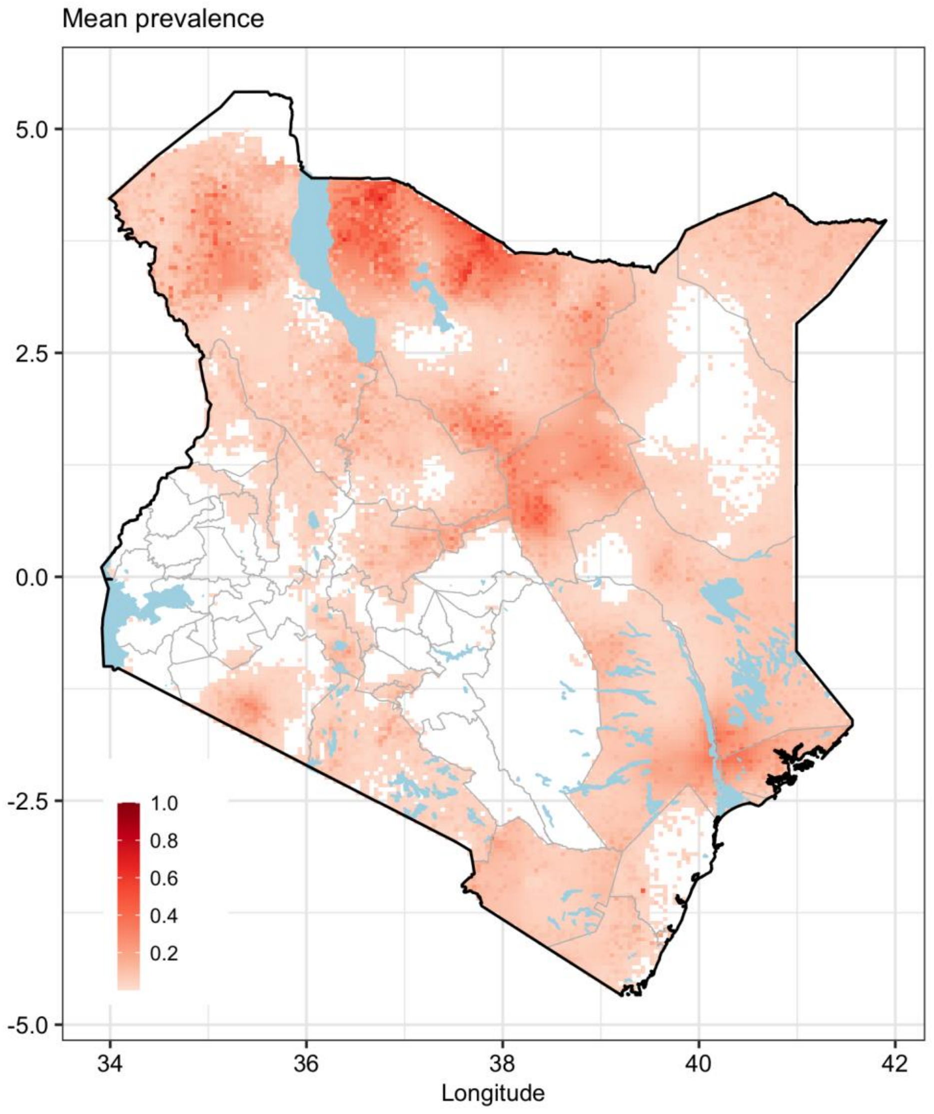
Brucella seroprevalence

Variable	Levels	Number sampled	Prevalence (95% CI)	χ^2 (p)
Sex	Male	1,707	4.28 (3.40 – 5.37)	25.46 (0.00)
	Female	4,886	8.35 (7.57 – 9.19)	
Age	Adult	3,063	11.20 (10.13 – 12.36)	123.11 (0.00)
	Yearlings	957	2.82 (1.95 – 4.07)	
	Weaners	1,028	3.02 (2.13 – 4.25)	
	Suckling	1,093	4.12 (3.09 – 5.46)	



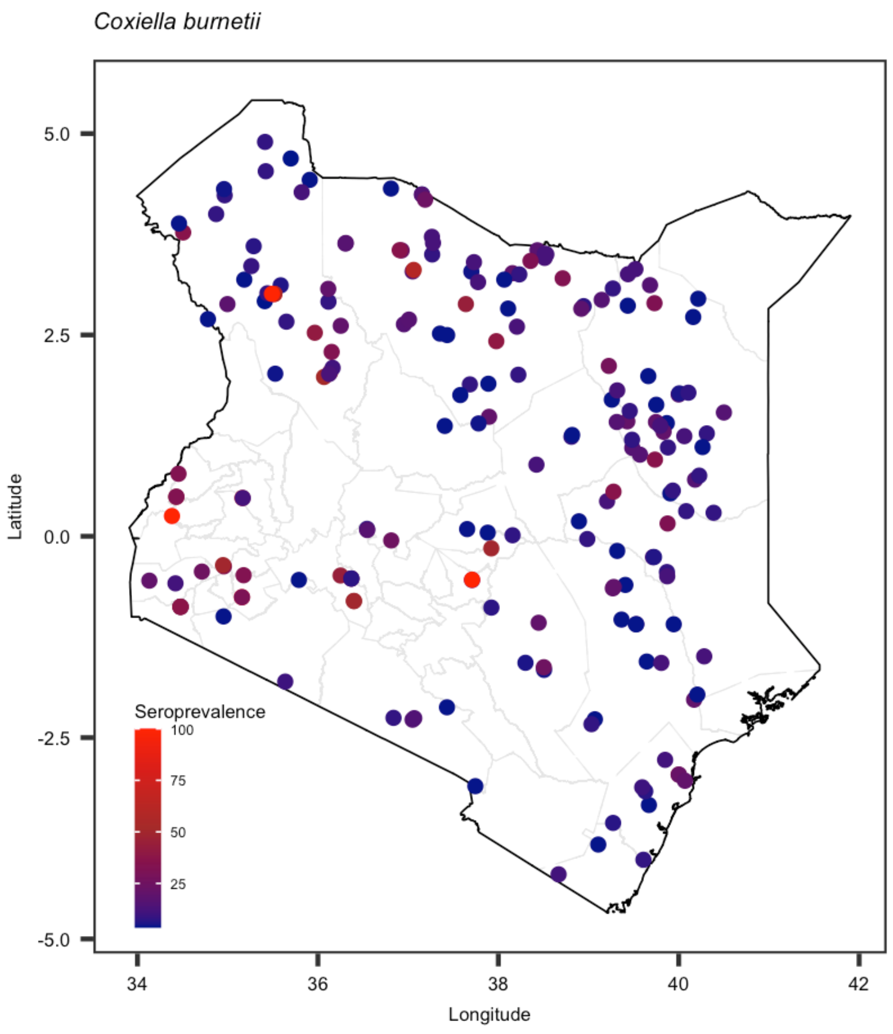
Brucella prevalence map

Variable	Mean	SD	2.5% Quantile	97.5% Quantile
Intercept	-3.47	0.22	-3.93	-3.05
Annual precipitation	-1.74	0.49	-2.76	-0.83
Goats	-0.82	0.23	-1.29	-0.39
Calcic kastanozems	0.26	0.11	0.03	0.48
Haplic chernozems	0.19	0.08	0.04	0.34
Haplic calcisols	-0.14	0.06	-0.27	-0.02



Coxiella burnetii seroprevalence

Variable	Levels	Number sampled	Prevalence (95% CI)	χ^2 (p)
Sex	Male	1,707	5.39 (4.41 – 6.56)	18.98 (0.0
	Female	4,886	8.72 (7.96 – 9.54)	
Age	Adult	3,412	10.67 (9.68 – 11.75)	86.01 (0.0
	Yearlings	984	6.30 (4.95 – 7.99)	
	Weaners	1,059	5.48 (4.26 – 7.02)	
	Suckling	1,138	2.99 (2.15 – 4.15)	



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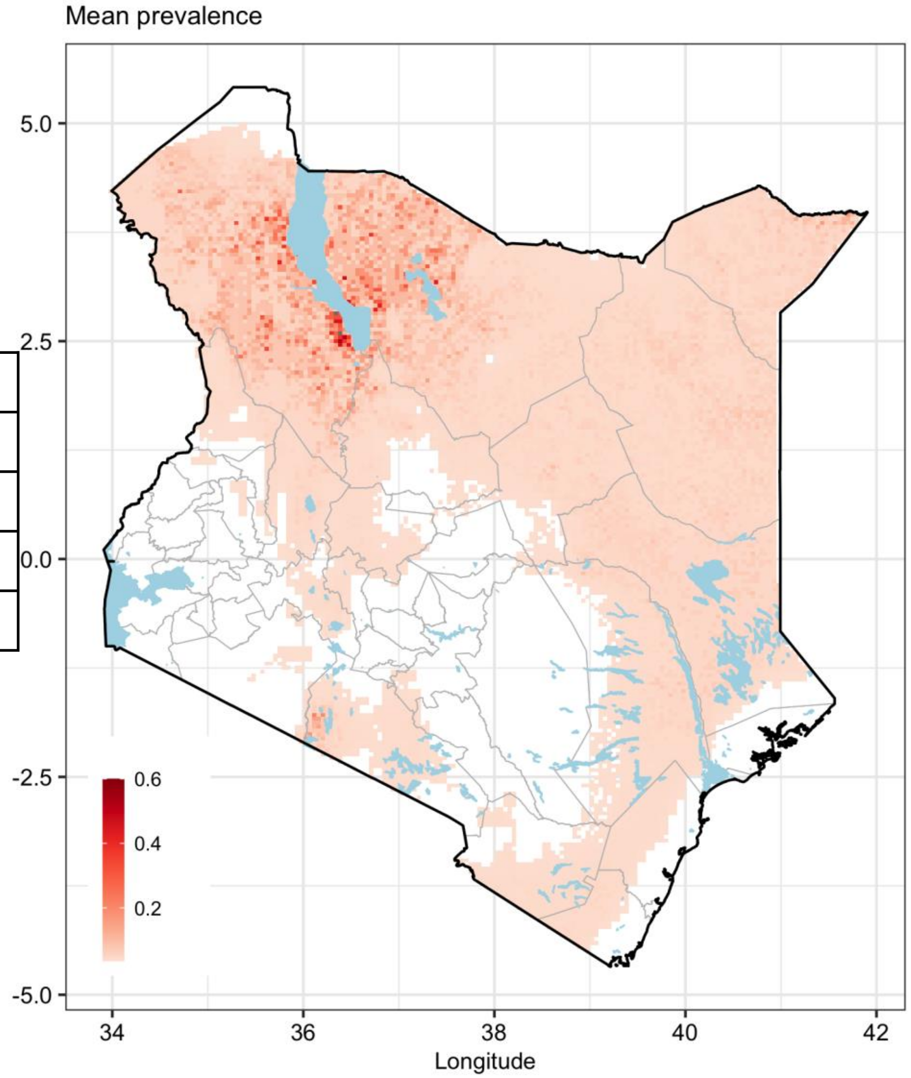
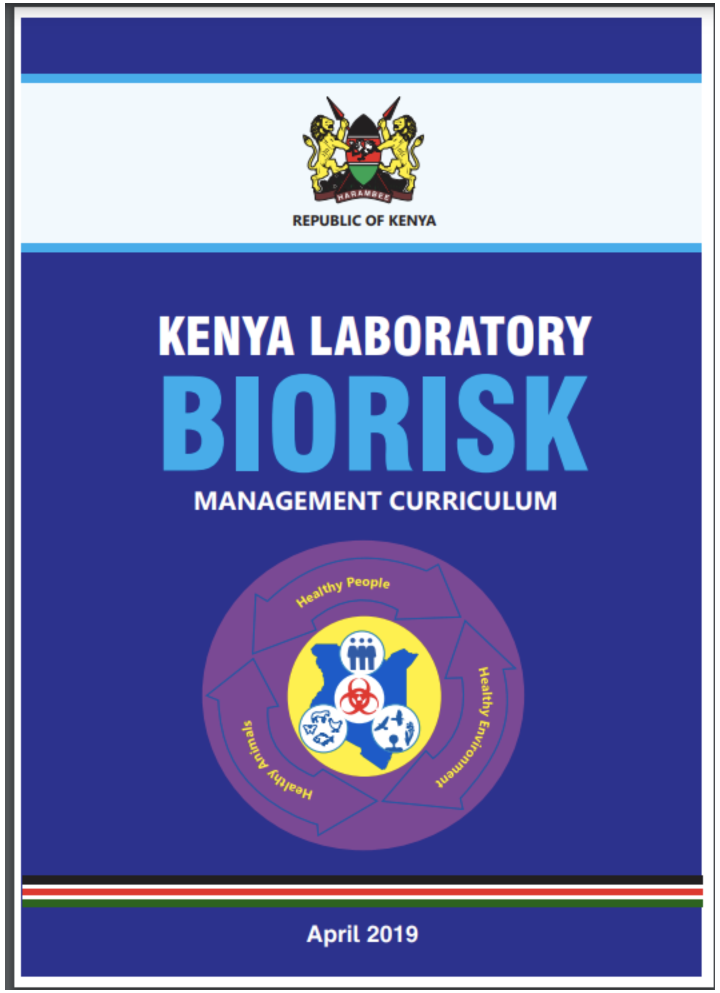
Coxiella burnetii prevalence map

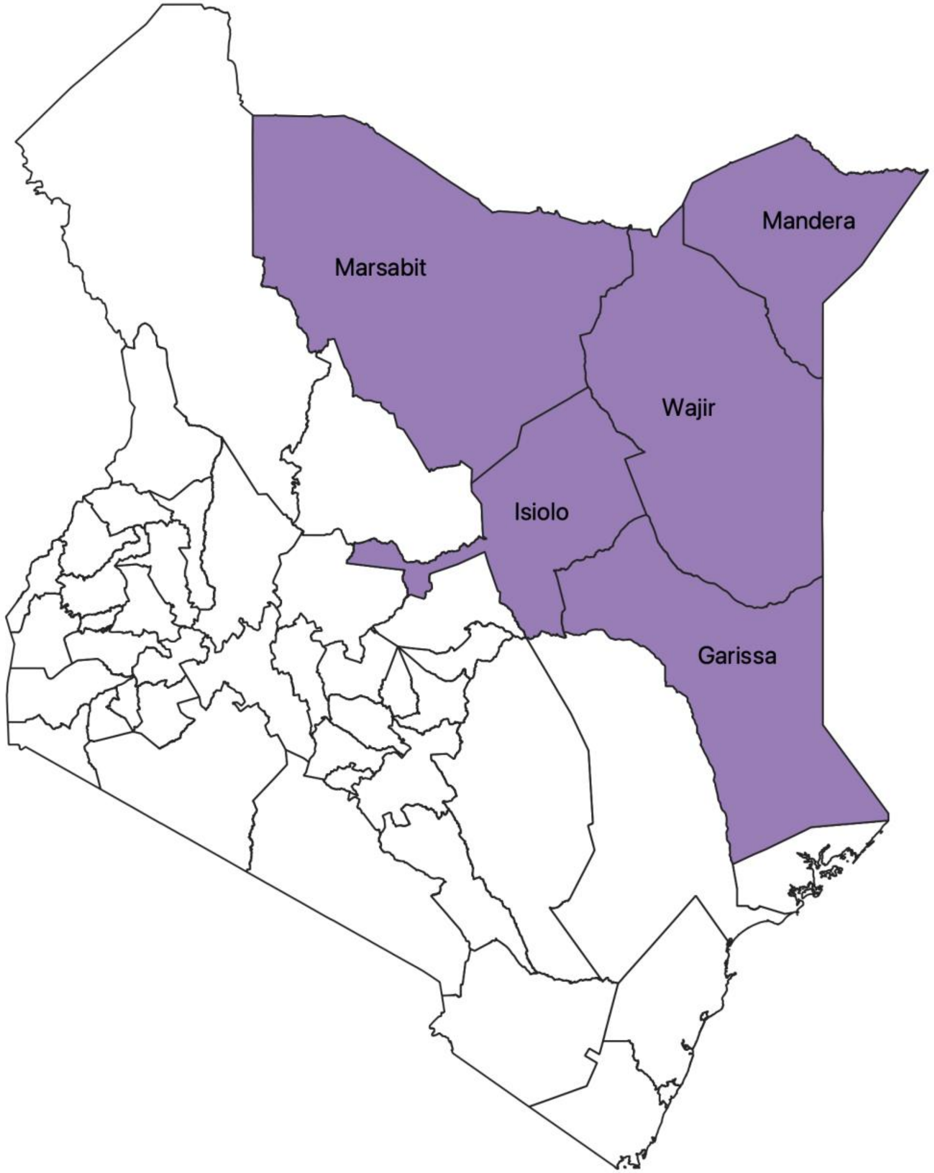
Variable	Mean	SD	2.5% quantile	97.5% quantile
Intercept	-2.94	0.16	-3.27	-2.64
Annual precipitation	-0.85	0.23	-1.31	-0.40
Petric calcisols	0.19	0.08	0.04	0.34
Precipitation*Calcisols	-0.62	0.21	-1.04	-0.22



Biosafety/biosecurity trainings

72 officers from public and animal health sectors trained





Conclusions

- Spatial analysis generates knowledge and tools such as risk maps that can help in designing risk-based surveillance and control
- Bundling of services – for improved efficiency and effectiveness
- Skills generated can be applied in other settings

Acknowledgements

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