RISK FACTORS ASSOCIATED WITH ENVIRONMENTALLY-TRANSMITTED ZOONOSES HOSPITALISATIONS IN QUEENSLAND

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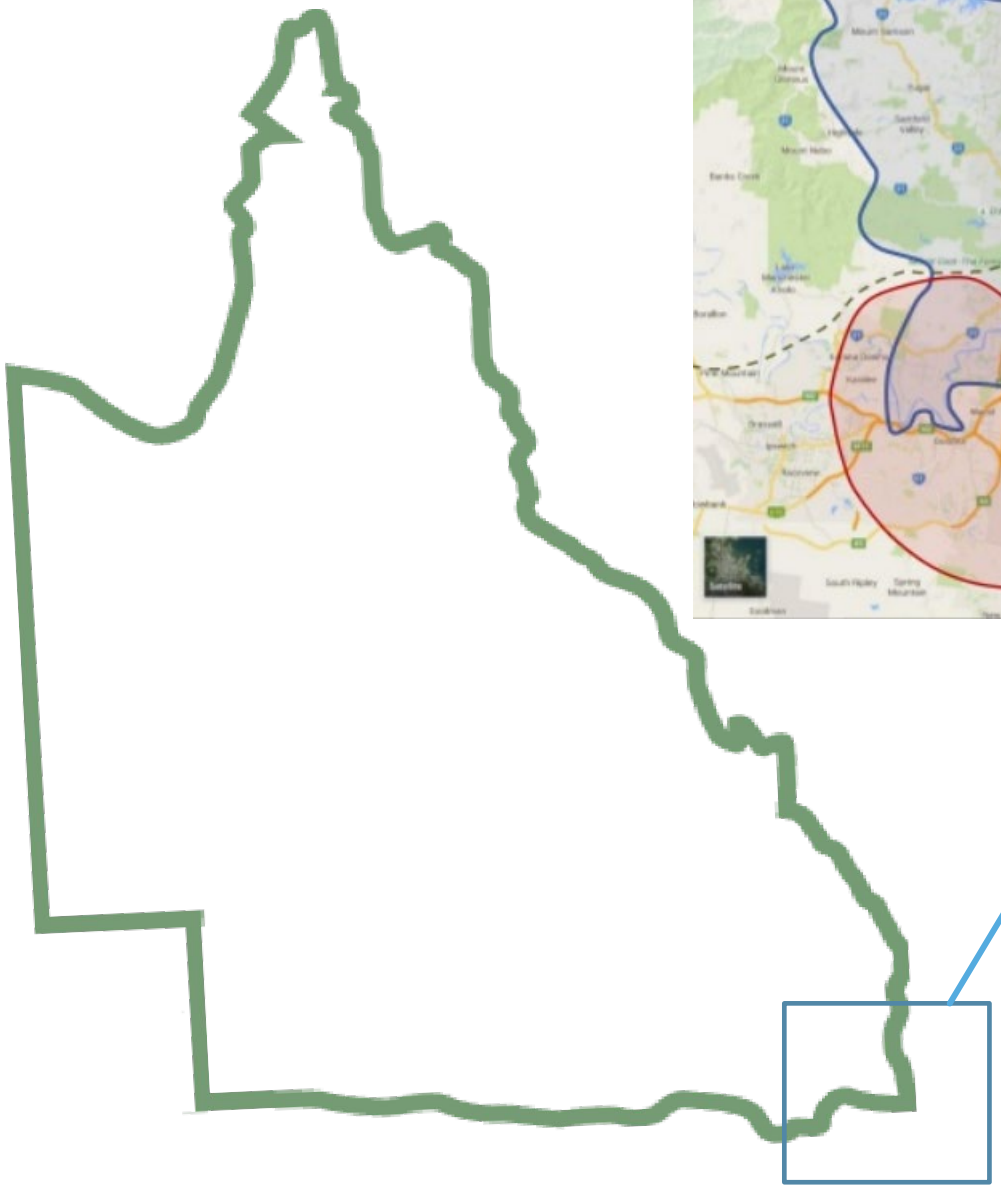
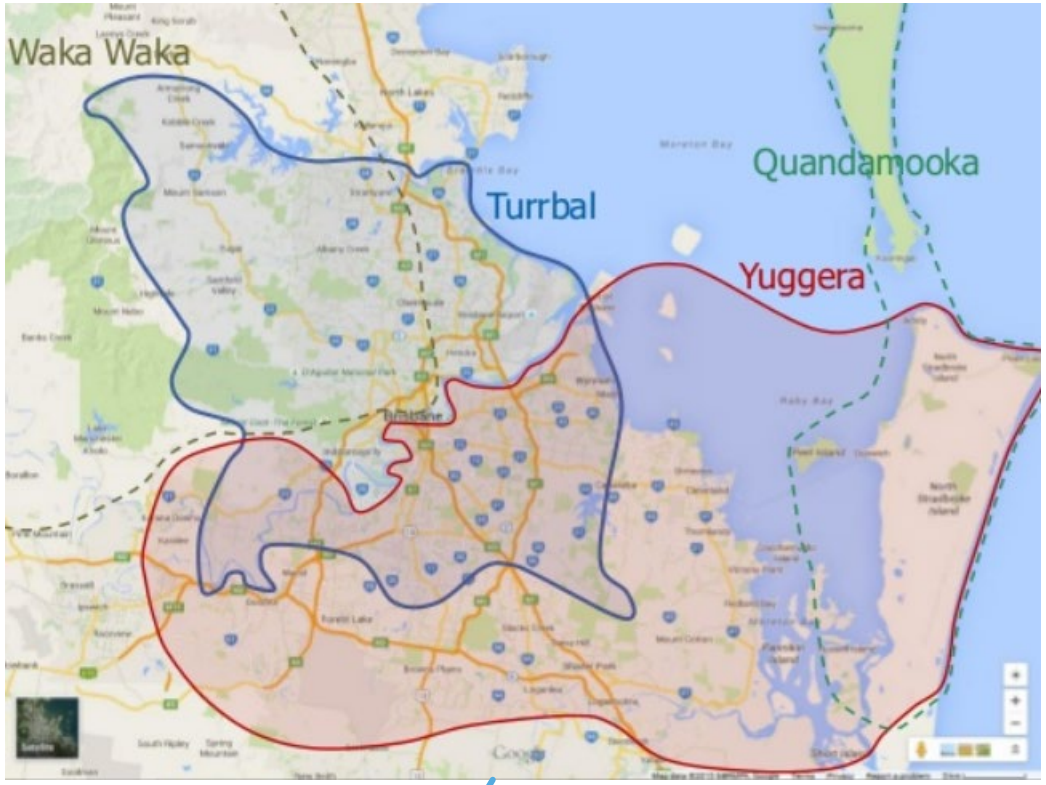




I acknowledge the traditional custodians of the land where this research was done, and pay respects to their elders past, present and emerging.

I recognize that this has always been a place of teaching and learning

Zoonoses

- Infectious diseases transmitted between vertebrate animals and humans

- 60% of human infectious diseases are zoonotic in nature (Andersen et al. 2020).

Zoonotic influenza.

Salmonellosis.

West Nile virus.

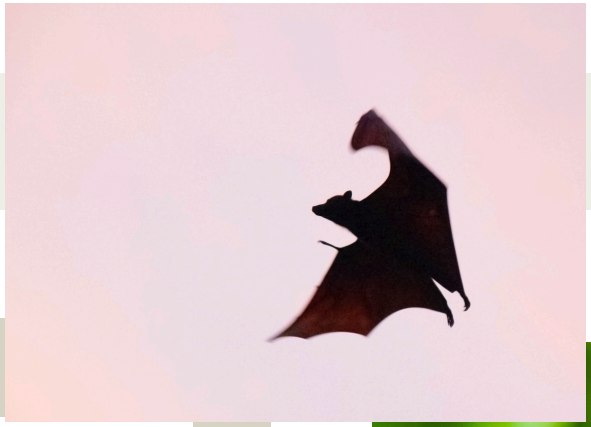
Plague.

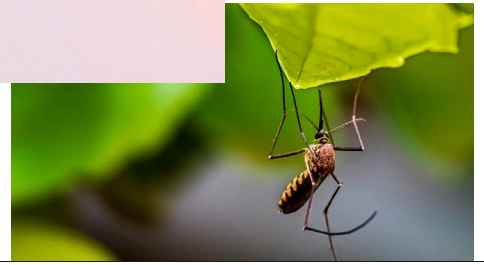
Emerging coronaviruses

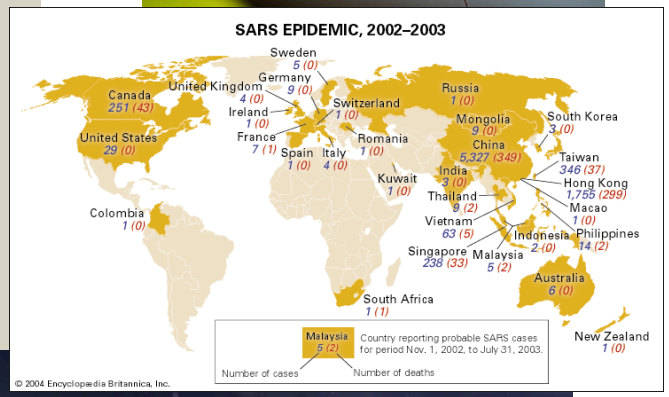
Rabies.

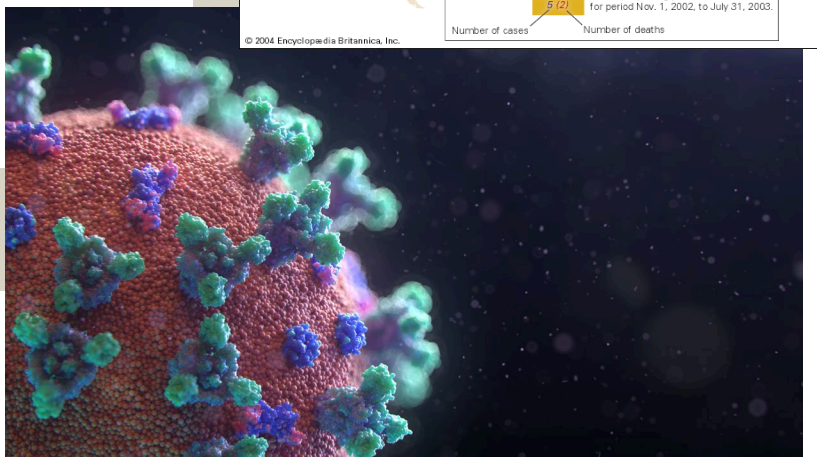
Brucellosis.

Lyme disease.









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Zoonoses

- Bacteria, viruses, protozoa and fungi
- Many transmission pathways mediated by environment conditions (waterborne, airborne, soil-transmitted and vector-borne)
- Public health impacts (BoD)

Zoonotic influenza.

Salmonellosis.

West Nile virus.

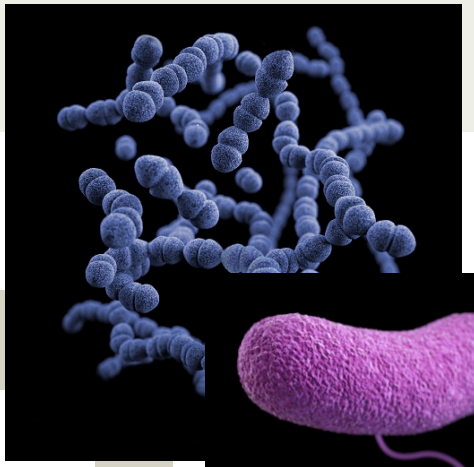
Plague.

Emerging coronaviruses

Rabies.

Brucellosis.

Lyme disease.



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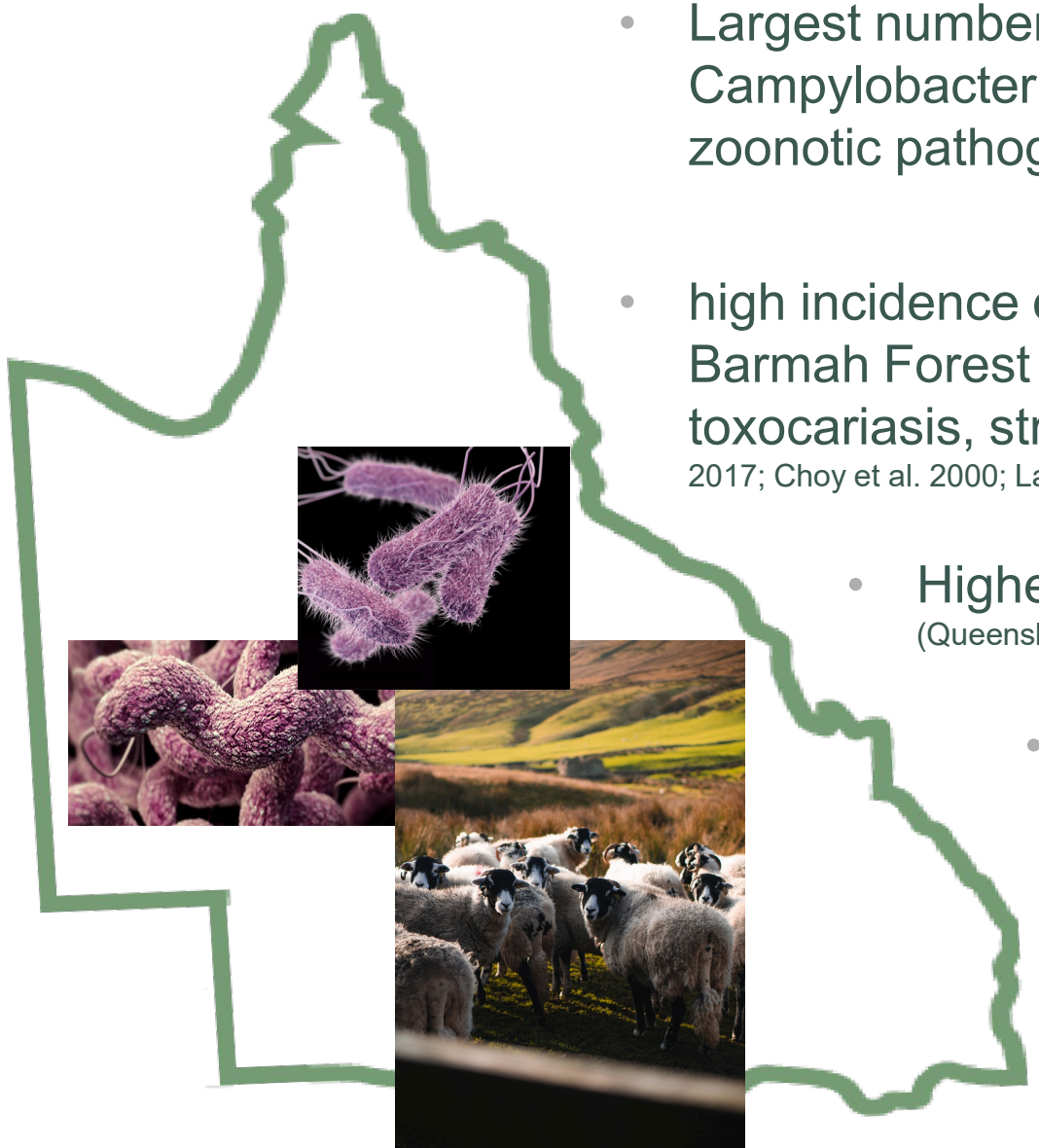
Zoonoses – Queensland



- Largest number of locally-acquired cases of Salmonellosis and Campylobacteriosis (most common foodborne diseases due to zoonotic pathogens in Australia) (OzFoodNet, 2018).

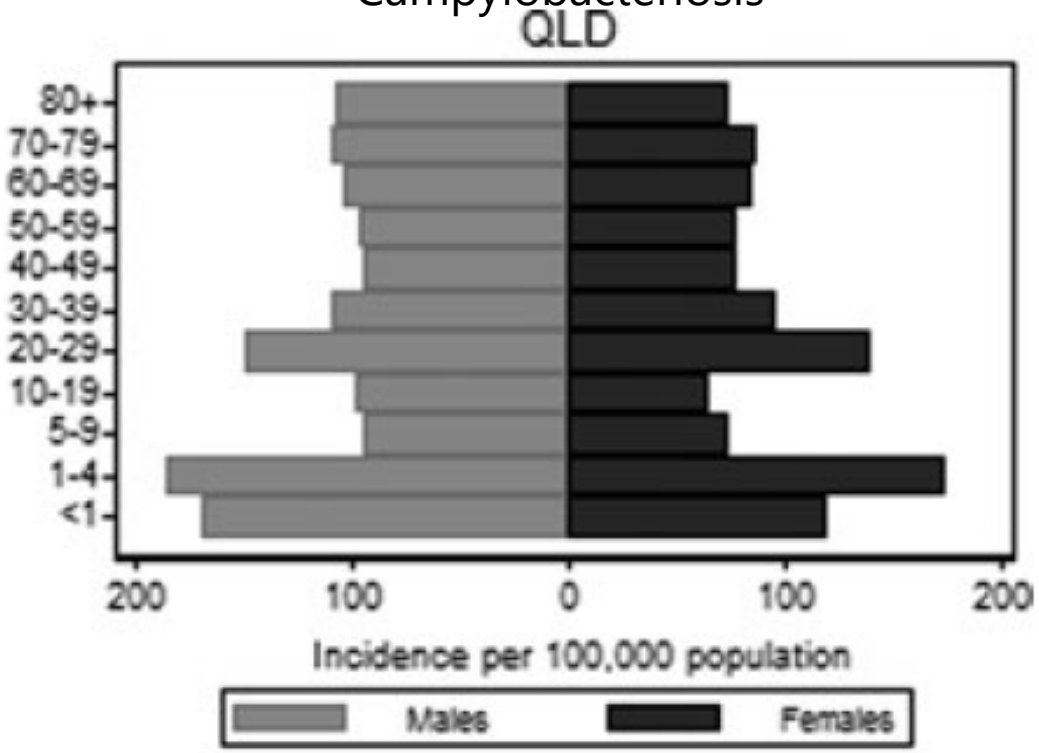
- high incidence of vector-borne diseases (Ross River Virus, Barmah Forest disease and zoonotic faecal-oral parasitic such as toxocariasis, strongyloidiasis and hookworm infections) (Chakma et al. 2017; Choy et al. 2000; Lau et al. 2010; Zahedi et al. 2018).

- Highest Q fever incidence in AU (twice + the national rate) (Queensland Health 2019).

- Transmission pathways involve contaminated environments (e.g. air, soil, water) | also for other zoonoses such as Cryptosporidiosis, Leptospirosis, Melioidosis

Zoonoses – Queensland – notifications

Campylobacteriosis



Moffat et al, (2017)

Cryptosporidium

Water Research 134 (2018) 327–340

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Water Research

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Cryptosporidium species and subtypes in animals inhabiting drinking water catchments in three states across Australia

Alireza Zahedi [a], Paul Monis [b], Alexander W. Gofton [a], Charlotte L. Oskam [a], Andrew Ball [c], Andrew Bath [d], Michael Bartkow [e], Ian Robertson [a, f], Una Ryan [a, *]

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ABSTRACT

As part of long-term monitoring of *Cryptosporidium* in water catchments serving Western Australia, New South Wales (Sydney) and Queensland, Australia, we characterised *Cryptosporidium* in a total of 5774 faecal samples from 17 known ho

Zahedi et al, (2019)

Transboundary and Emerging Diseases

Transboundary and Emerging Diseases

ORIGINAL ARTICLE

A Survey of Zoonotic Pathogens Carried by Non-Indigenous Rodents at the Interface of the Wet Tropics of North Queensland, Australia

S. Chakma[1], J. Picard[1], R. Duffy[2], C. Constantinoiu[1] and B. Gummow[1,3]

[1] College of Public Health, Medical and Veterinary Sciences, James Cook University, Townsville, Qld, Australia
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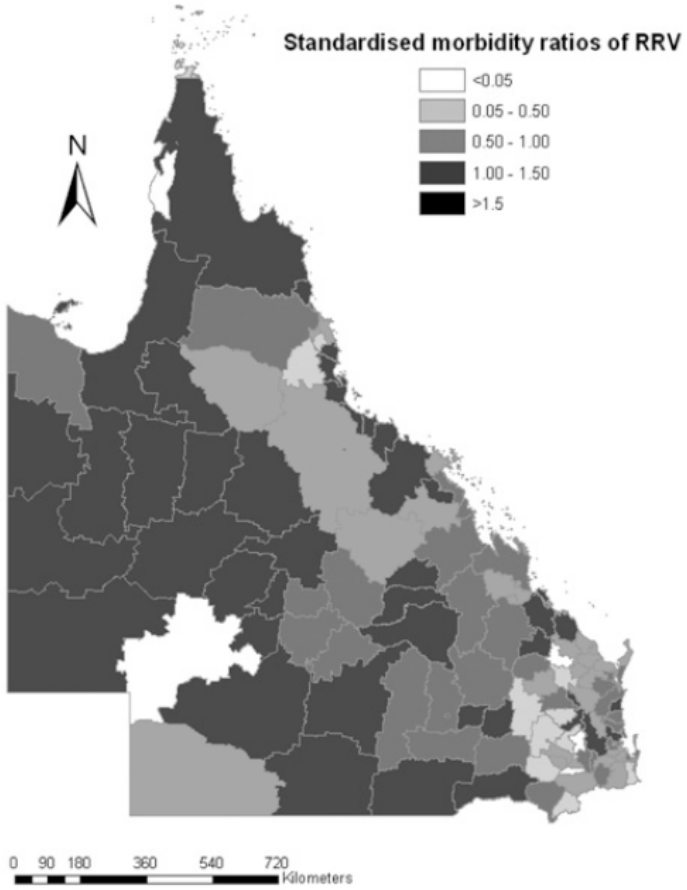
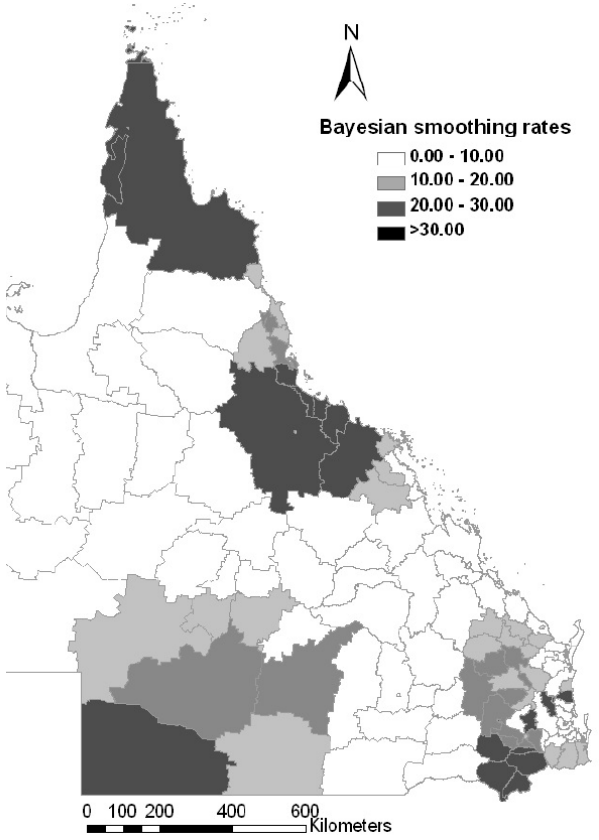
[3] Department of Production Animal Studies, Faculty of Veterinary Science, University of Pretoria, Pretoria, South Africa

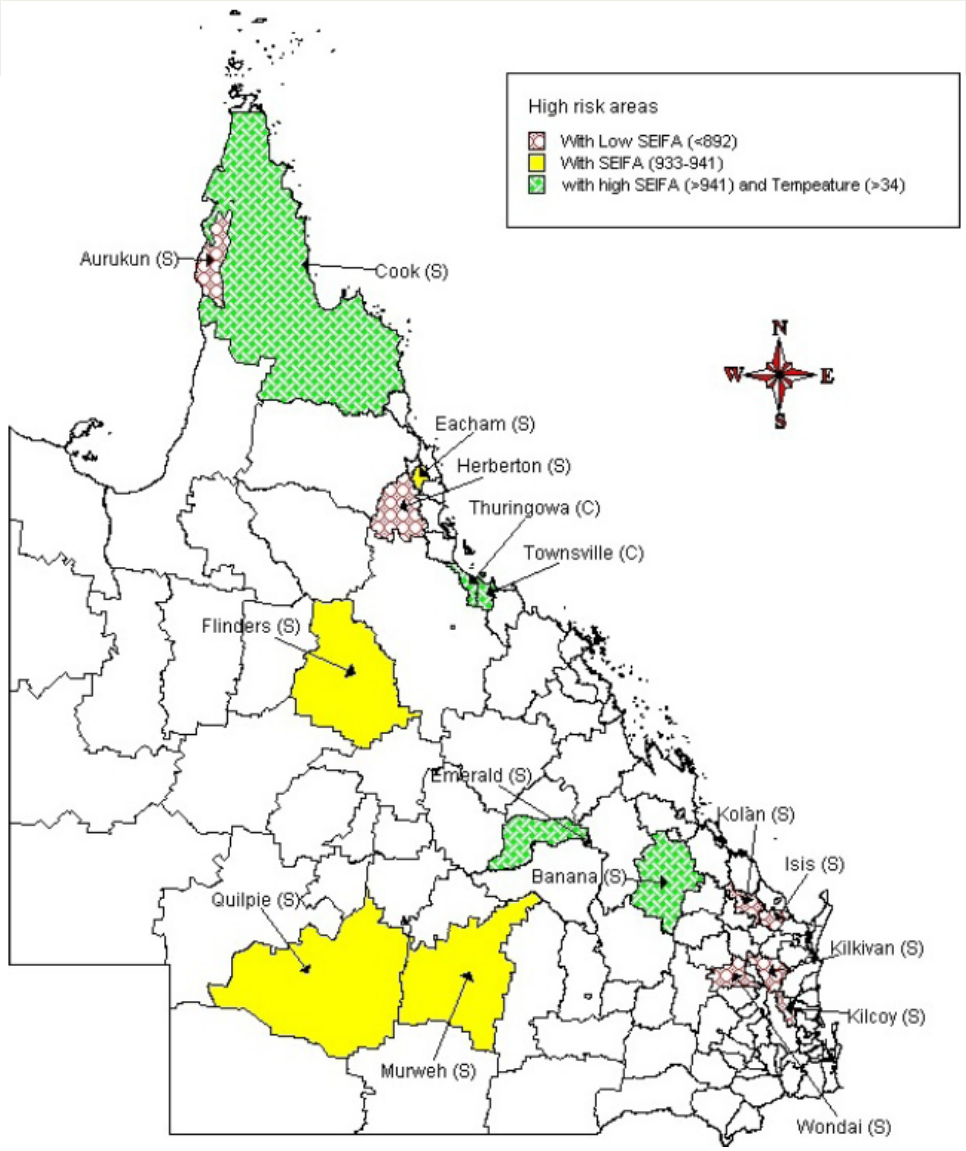
Chakma et al, (2017)

Zoonoses – Queensland – spatial





Hu et al, (2010)



What environmental and sociodemographic factors are determinant of hospitalisations due to environmentally-transmitted zoonoses in Queensland?

Methods

Regression model *

$$y_i \sim Poisson(\lambda_i)$$

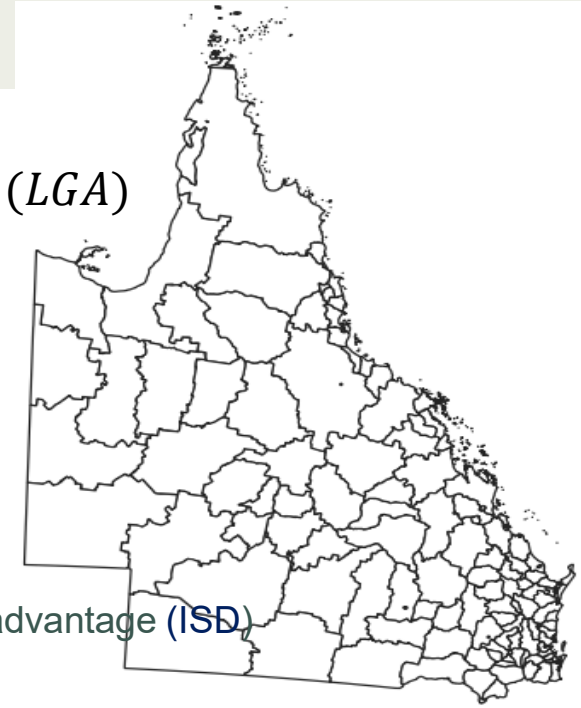
i^{th} *Local Goverment Area* (LGA)

$$\rho_i = \frac{\log(\lambda_i)}{\log(pop_i)} = \ standardised\ rate\ of\ zoonoses\ hospitalisation\ (zHR)$$

$$\eta_i = \log(\rho_i) = \alpha + \beta_x X_{xi} + s_i + u_i$$

$\beta_x X_{xi}$ = list of risk factors and coefficients:

- Index Social Disadvantage (ISD)
- zHR – females
- sR – at risk occupations
- Temperature
- Rainfall



s_i = spatial structured component – spatial distribution of the LGAs | u_i = unstructured component (random effects)

A mixed effects regression model - Bayesian approach using the R-INLA package [1]

1. Rue, H., Martino, S., & Chopin, N. (2009). Approximate Bayesian inference for latent Gaussian models by using integrated nested Laplace approximations. *Journal of the royal statistical society: Series b (statistical methodology), 71*(2), 319-392.

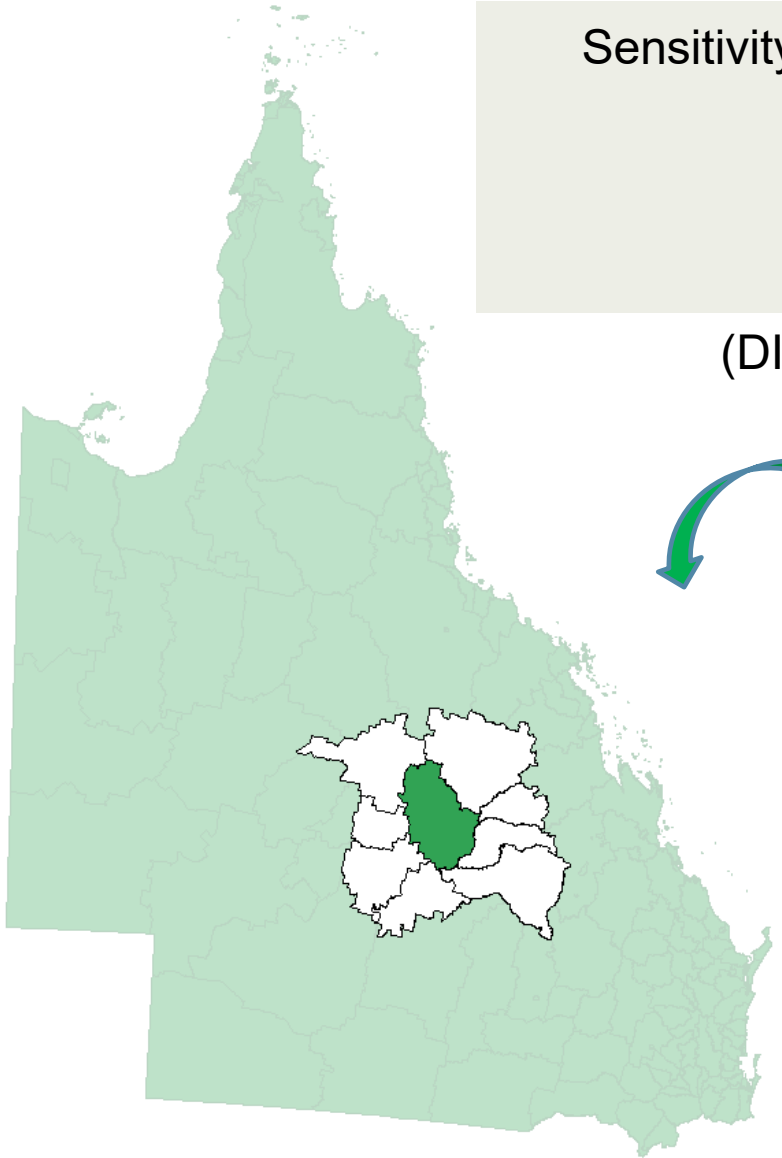
* ZIP

Sensitivity analysis of the spatial matrix:

Queen Vs

KNN 5, 7, 9, 11

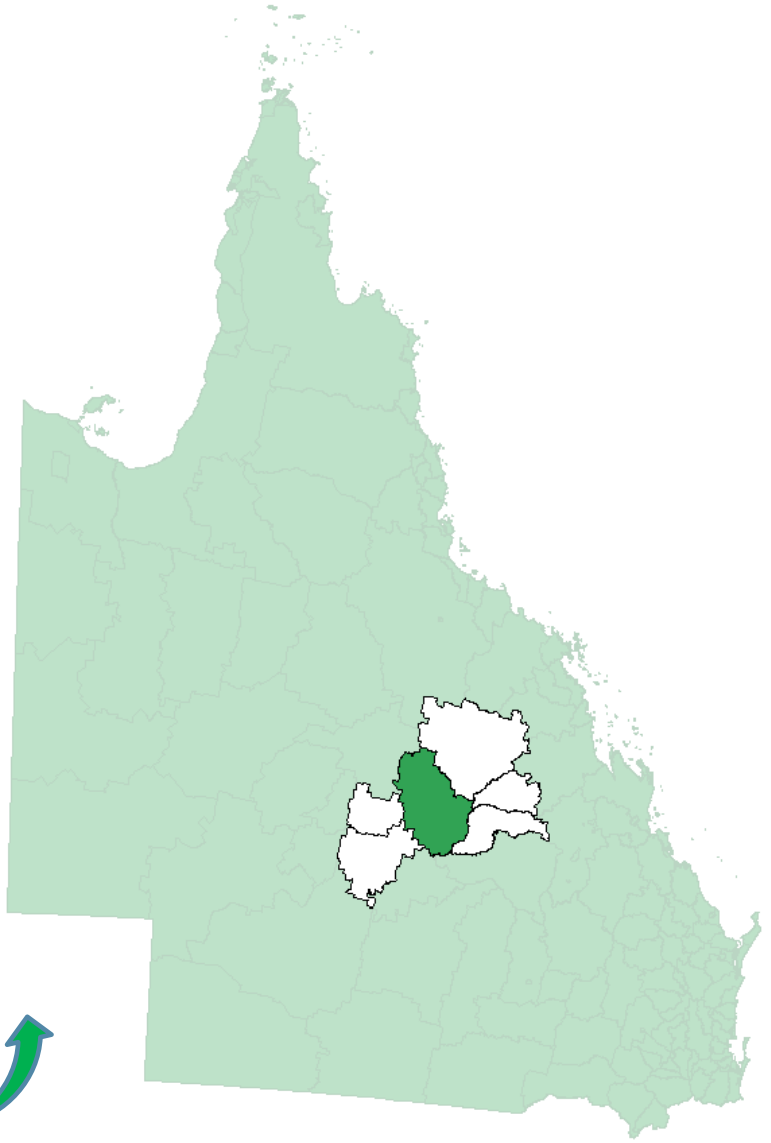
(DIC to identify the best fit)



$Queen$

?

knn



Deviance Information Criterion of the models compared

	Prior 1	Prior 2	Prior 3
Bayesian spatial model using a queen AM	831.419	812.9744	818.0272
Bayesian spatial model using a KNN=5 AM	1286.908	1286.798	1287.077
Bayesian spatial model using a KNN=7 AM	1286.971	1286.814	1287.075
Bayesian spatial model using a KNN=9 AM	1286.966	1286.823	1286.714
Bayesian spatial model using a KNN=11 AM	1286.923	1286.956	1286.730

Notes. AM: Adjacency matrix

Results

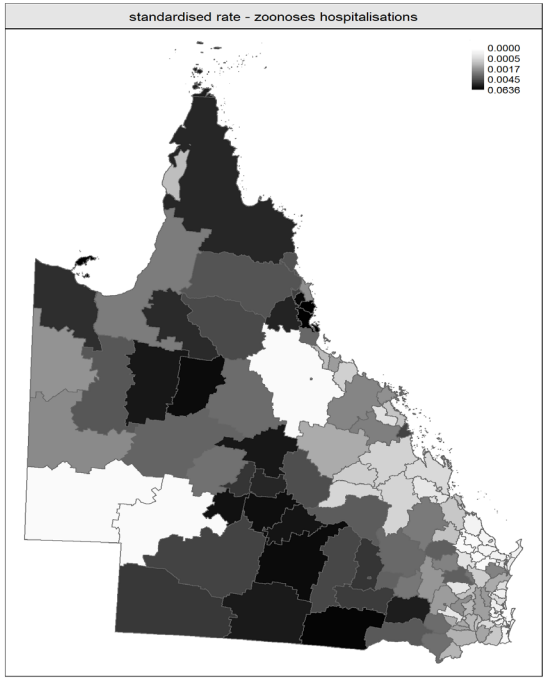
Summary statistics of zoonoses hospitalisations and socio-environmental factors by LGA in Queensland

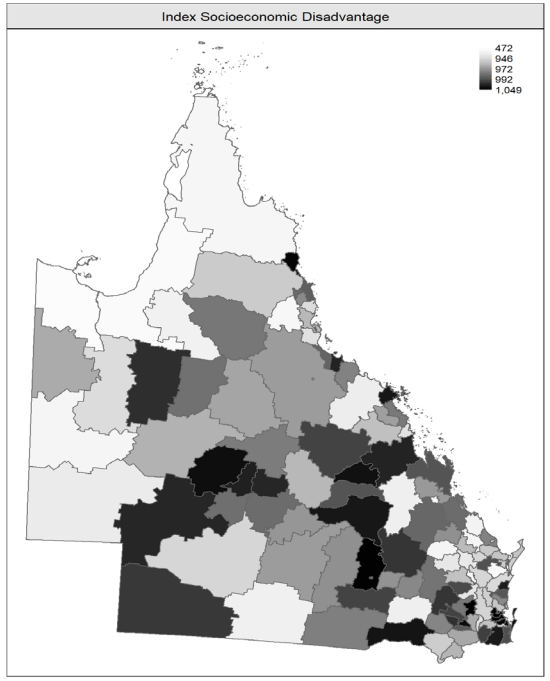
Variable	Mean	SD	Min	Q1	Median	Q3	Max
Standardised hospitalisation rate of zoonoses (zHR)	0.004	0.008	0.000	0.001	0.002	0.005	0.064
Index of Socioeconomic Disadvantage (ISD)	957.7	69.6	472.1	946.3	972.5	992.4	1,048.9
Standardised female zoonoses hospitalisation rate	0.005	0.008	0.000	0.002	0.003	0.005	0.076
Standardised rate of people in at-risk occupations	0.139	0.116	0.000	0.035	0.104	0.211	0.412
Average maximum temperature*	2.809	0.253	2.136	2.640	2.790	2.947	3.342
Average rainfall**	8.037	4.527	2.269	5.264	6.502	8.861	29.159

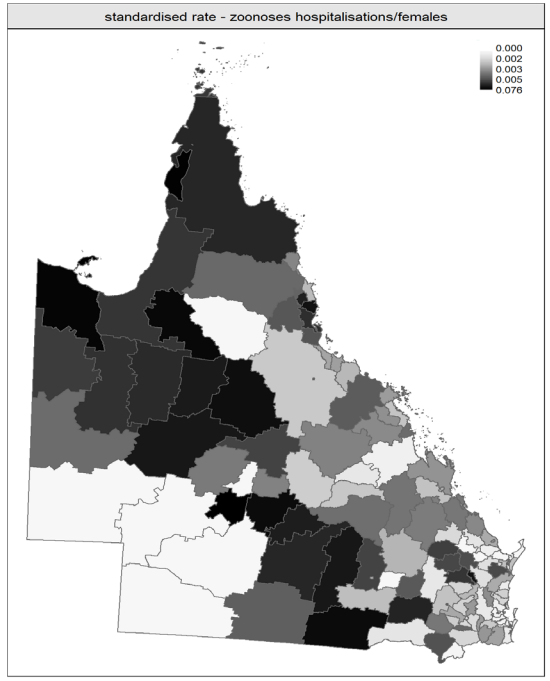
Notes. Q1: first quartile value; Q3: third quartile value; SD: standard deviation; * °C $x10^{-1}$; ** mm $x10^{-1}$

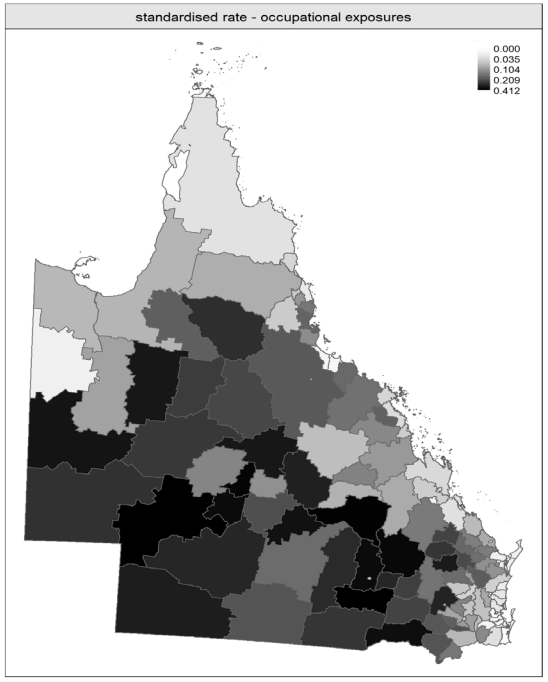
Results

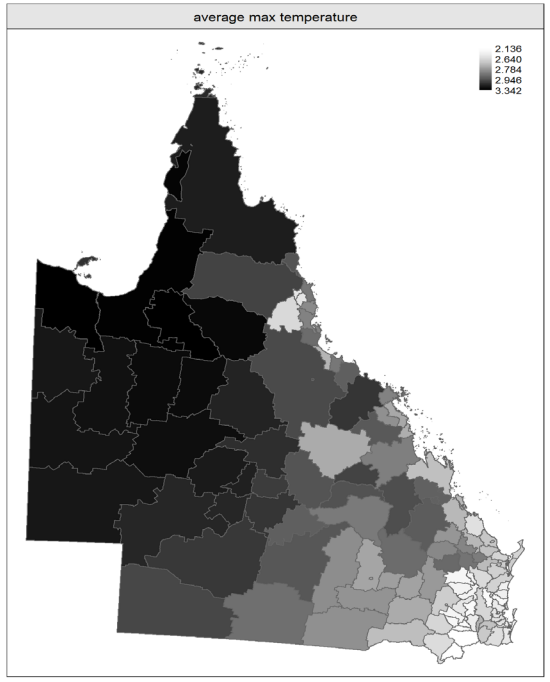
Distribution of zoonoses hospitalisations
and socio-environmental factors
in the Queensland LGAs.

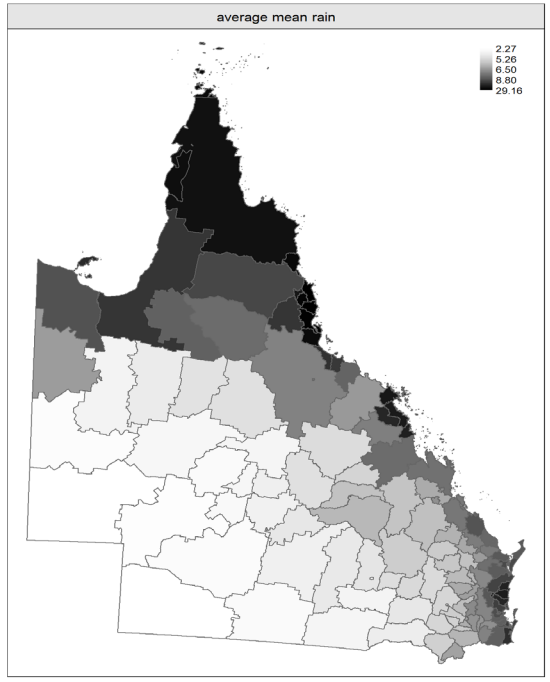












Results

Exponentiated posterior mean - spatial regression model

	Posterior mean (CI)	SD	DIC	Spatial variance
Intercept	0.001 (0.001-0.07)	10.637	812.97	0.86
Index of Socioeconomic Disadvantage	1.001 (0.998-1.004)	1.002		
Standardised female zoonoses hospitalisation rate	1.255 (1.154-1.365)	1.044		
Standardised rate of people in at-risk occupations	1.10 (1.051-1.151)	1.024		
Average maximum temperature	0.701 (0.24-2.042)	1.723		
Average rainfall	1.025 (0.973-1.078)	1.026		

Notes. CI: 95% Credible Interval; SD: Standard Deviation; DIC: Deviation Information Criterion

Results

Increase risk of 4-fold or more in 9 LGAs:

North and northeast

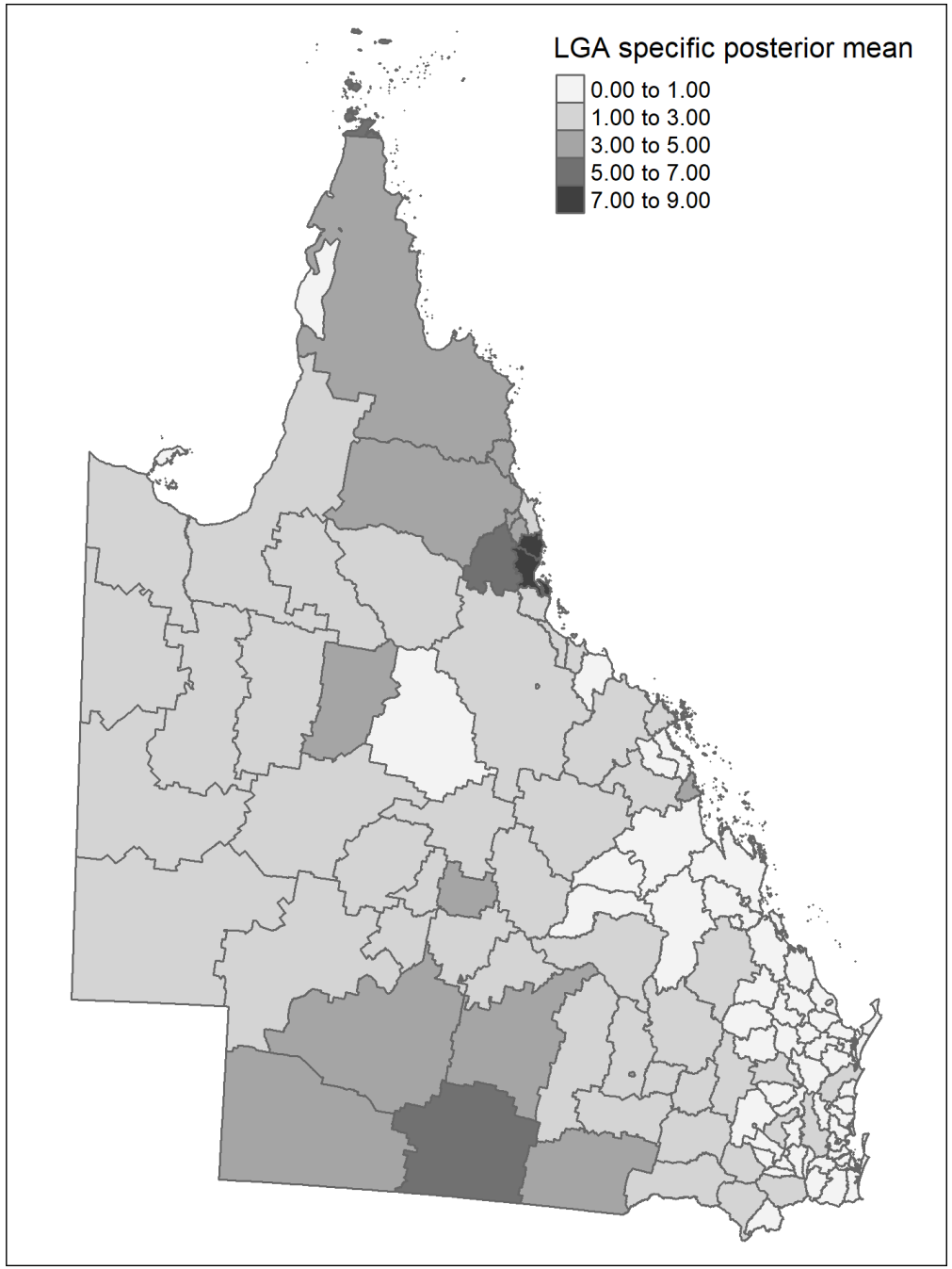
- Cardwell
- Johnstone
- Torres
- Herberton
- Eacham

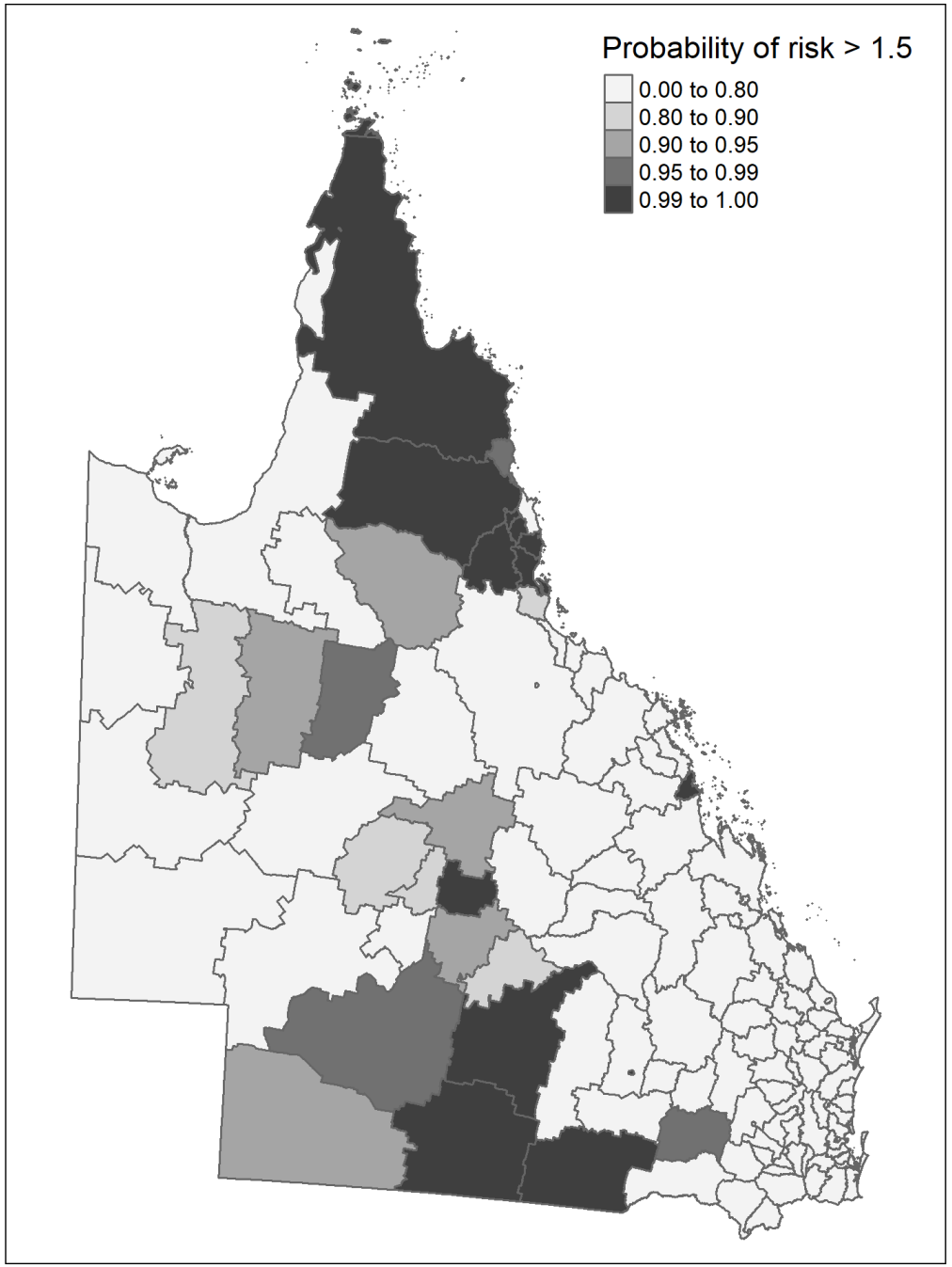
South

- Paroo
- Murweh
- Roma

Central

- Barcaldine





Conclusions

- People working in animal-associated occupations have about 10% higher risk of environmentally-transmitted zoonosis hospitalisation in Queensland
- These occupations link to commercial activities related to environmental interventions which can disrupt the ecological balance of habitats and pose a risk of exposure to zoonotic pathogens that survive for long periods in soil, water and air.
- Gender differences can play an important role in the severity of zoonotic infections. This could be associated with the presence of perinatal comorbidities and diminished immune response has found in previous research (Shaapan, R.M, 2016)

Conclusions

- Quantified geographical variation of hospitalisation risk and probability of excess of risk for specific LGAs in QLD
- Risk indicators per LGA can be used to set to support surveillance programs and design health rankings linked to public health strategies (Courtemanche C.S. et al, 2015)
- Limitations: Data limitation addressed with an ecological approach. Risk of ecological bias
- Further research is needed to identify potential biological mechanisms.

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