Land use change and the risk of selected zoonotic diseases: Observations from a case study in an arid/semi-arid area in Kenya

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Introduction

- Climate and demographic changes and food insecurity
- Irrigation – being used to boost food production in arid/semi-arid areas
- Effects: major trade-offs in ecosystem services
  - More food produced (provisioning services) at the expense of biodiversity and regulatory services (disease, flooding, erosion)
  - Disease transmission contributed by:
    - Standing water masses associated with irrigation
    - Human settlements and periurban settlements
    - Livestock diversity – more small that large ruminants

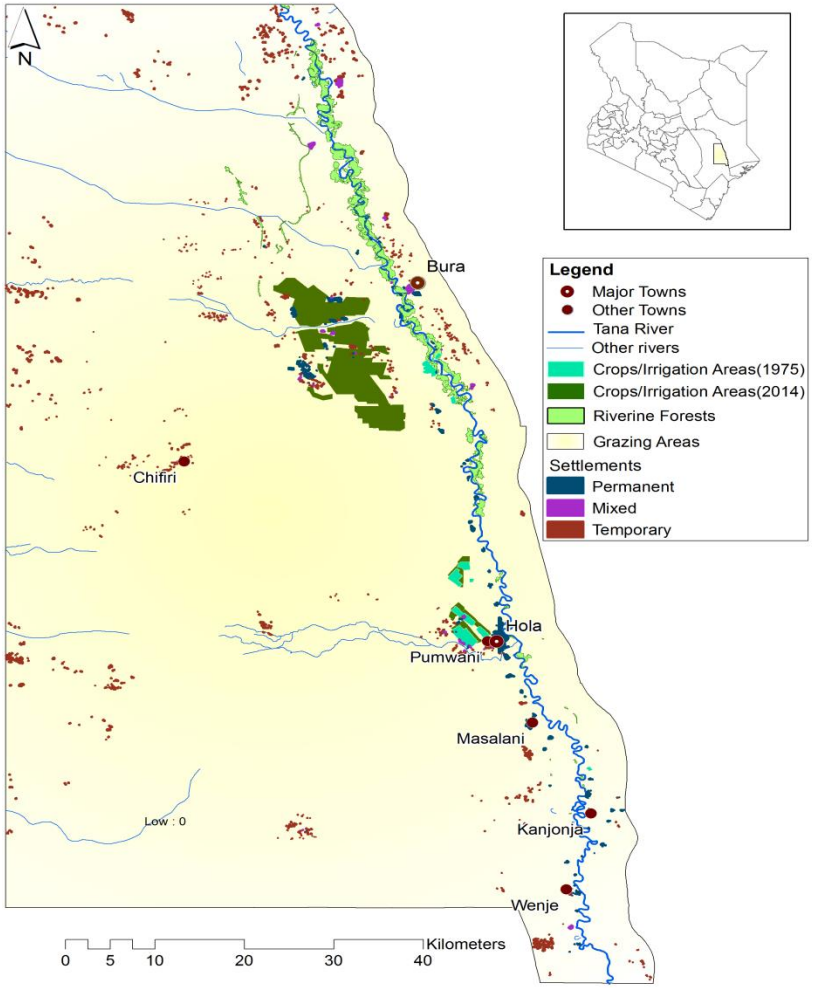
Objectives

- The effects of irrigation on:
  - Ecosystem changes – diversity of hosts
  - risk of vector-borne and other zoonotic diseases

Irrigated site with stagnant water in the drainage canals – source of water for the people but also breeding grounds for mosquitoes

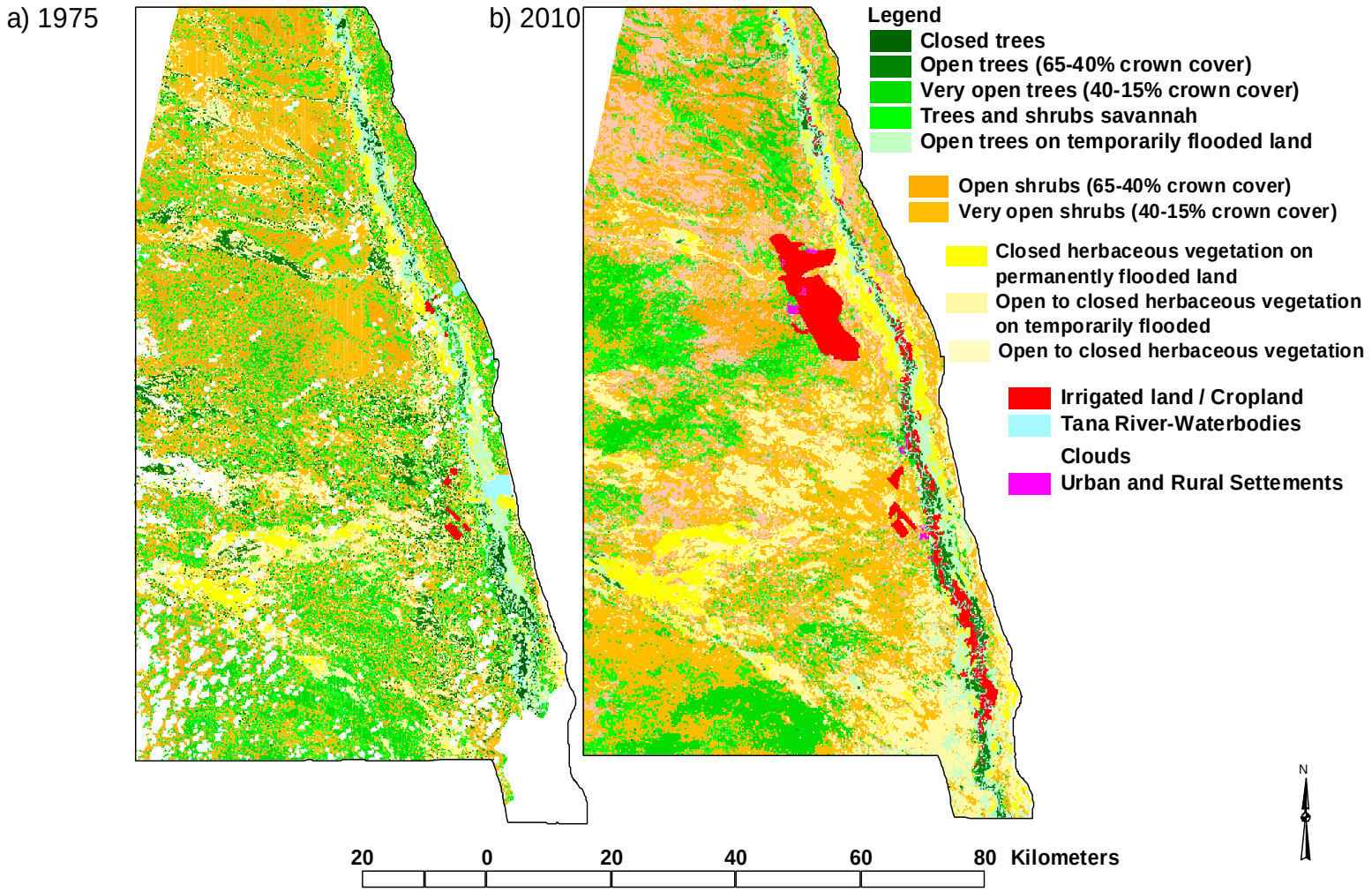
Methods

- The study site:
  - Arid/semi-arid region in northeastern Kenya
  - Two irrigation schemes and pastoral areas around them
  - Studies:
    - Ecological/GIS analyses – secondary data
    - Entomological surveys
    - Sero-epidemiological surveys in livestock and people



Study site in Kenya, GIS team, ILRI

Ecological analyses: Land cover changes between 1975 and 2010



Field surveys

- Mosquito sampling
- Livestock and human sampling
  - Sample size determination
  - Serum samples analyzed using various ELISA kits

Pathogen	Samples used
Rift Valley fever virus, *Brucella* spp., and *Coxiella burnetii*	Livestock and people
West Nile virus, dengue fever virus, *Leptospira* spp.	People

CDC light trap for mosquitoes
(photo: B. Bett, ILRI)

Animal sampling
(photo: B. Bett, ILRI)

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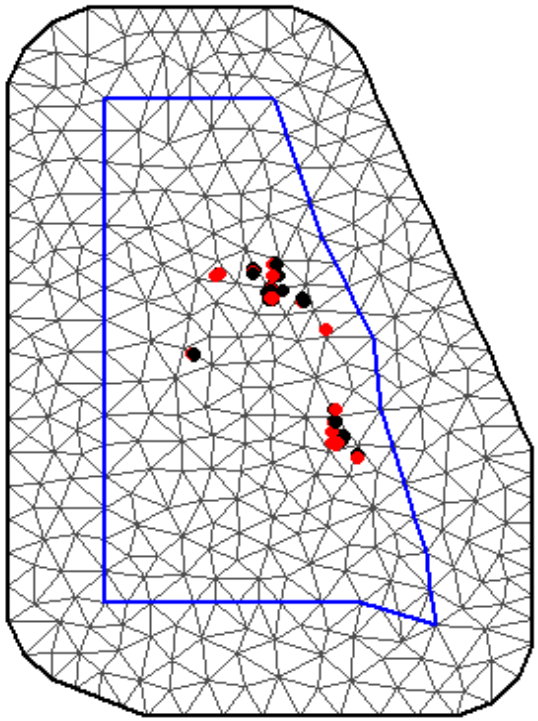
Data analysis

- Ecosystem changes – GIS analysis to determine habitat rarity
- Entomology and sero-prevalence data
  - Treated as point-referenced data
  - Analyzed using stochastic partial differential equation implemented in R INLA

(Rue et al., 2009)

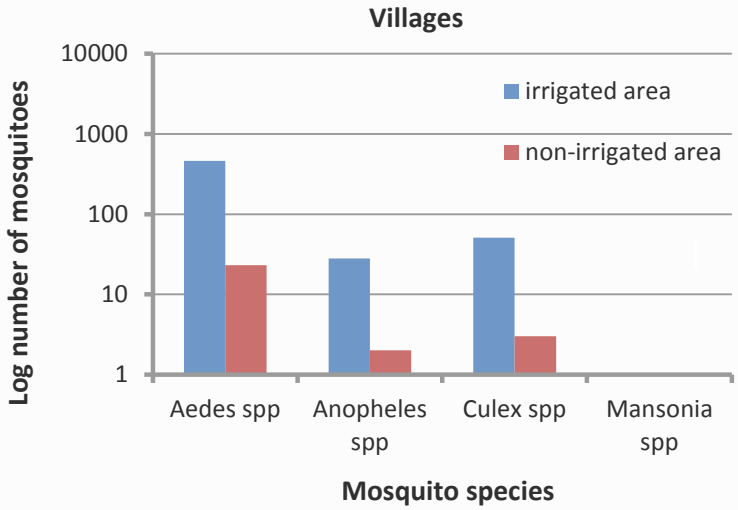
  - Significance of the spatial effect -- DIC

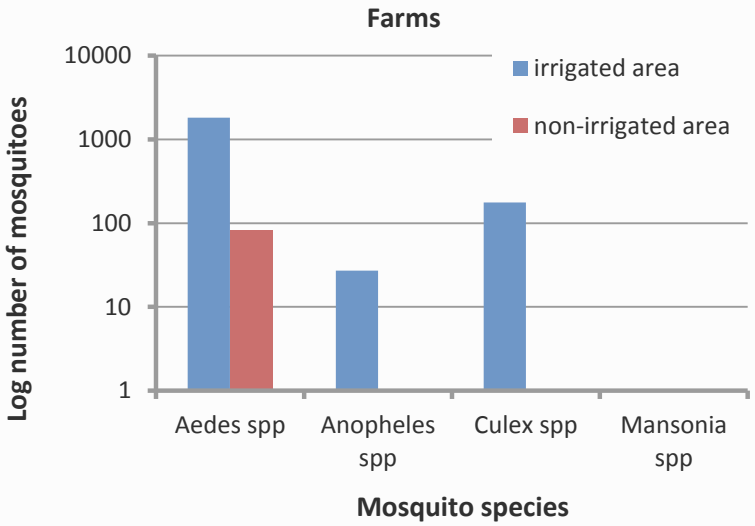


Triangulation in R INLA to capture spatial effects

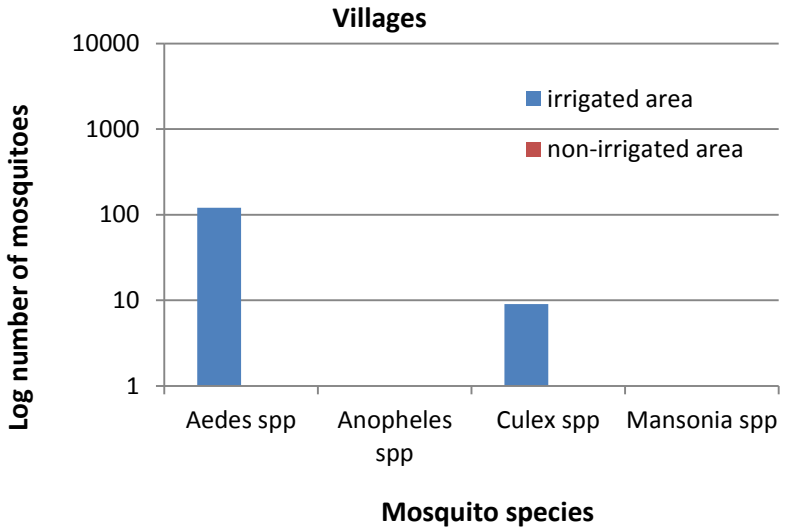
Results: Apparent densities of mosquitoes trapped

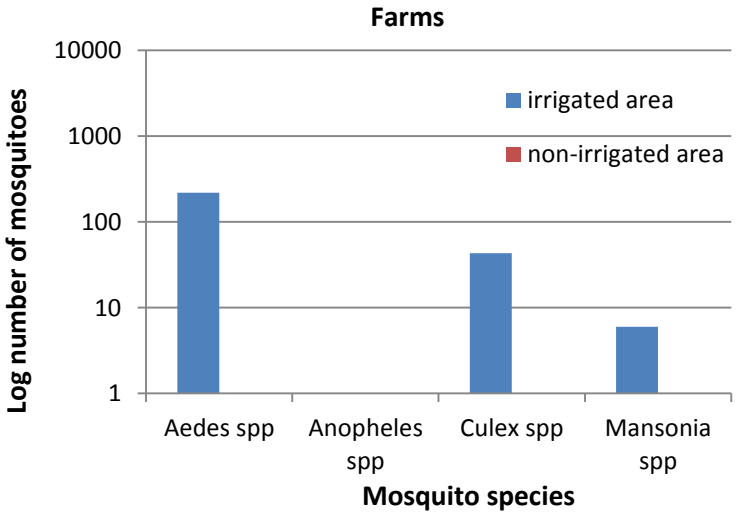
Irrigation season





Fallow period





Outputs of a regression model used to analyse the effects of rainfall and irrigation on mosquito densities

Variable	Levels	All mosquitoes trapped				Primary RVF vectors			
		Mean	SD	Credible interval		Mean	SD	Credible interval	
				2.50%	97.50%			2.50%	97.50%
Land use	Irrigation	1.23	0.38	0.46	1.94	1.47	0.19	1.10	1.85
	Other	0.00				0.00			
Rain		0.03	0.00	0.02	0.03	0.03	0.00	0.02	0.03
Hyper-parameters									
Theta 1		-3.03	1.97	-6.79	0.95	-3.53	3.16	-9.75	2.68
Theta 2		1.87	1.53	-1.23	4.75	2.26	3.16	-3.95	8.46
DIC					1099.57				641.39

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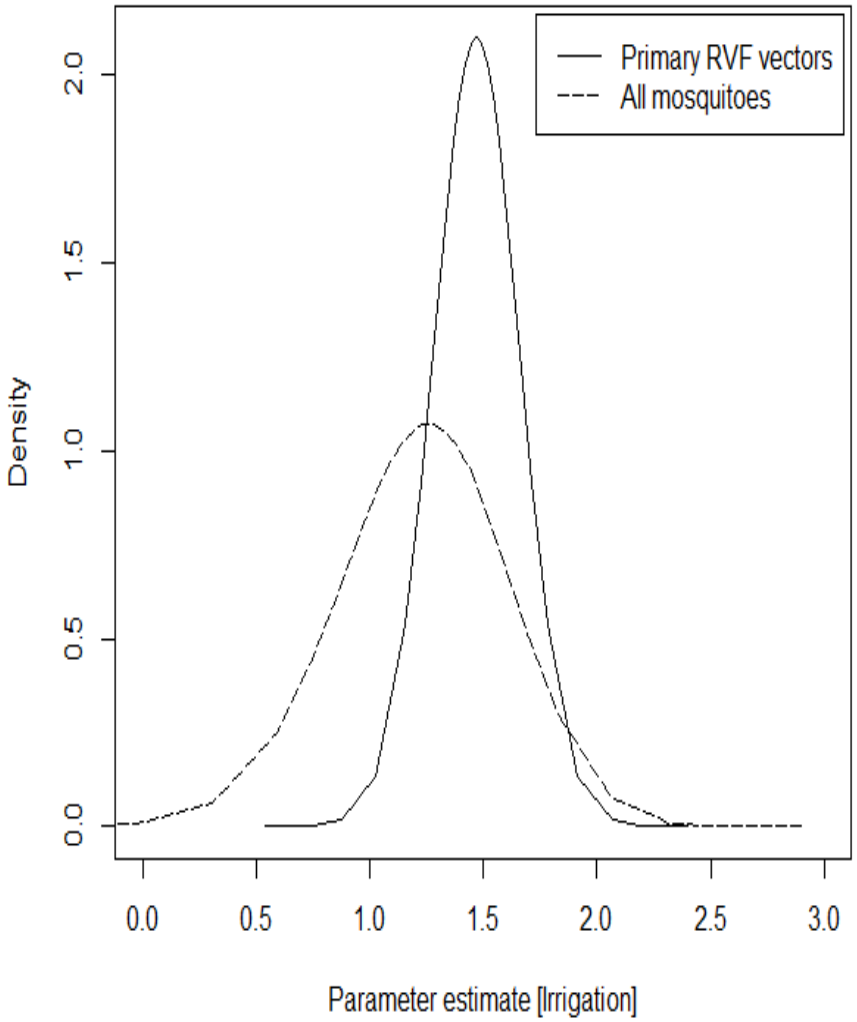
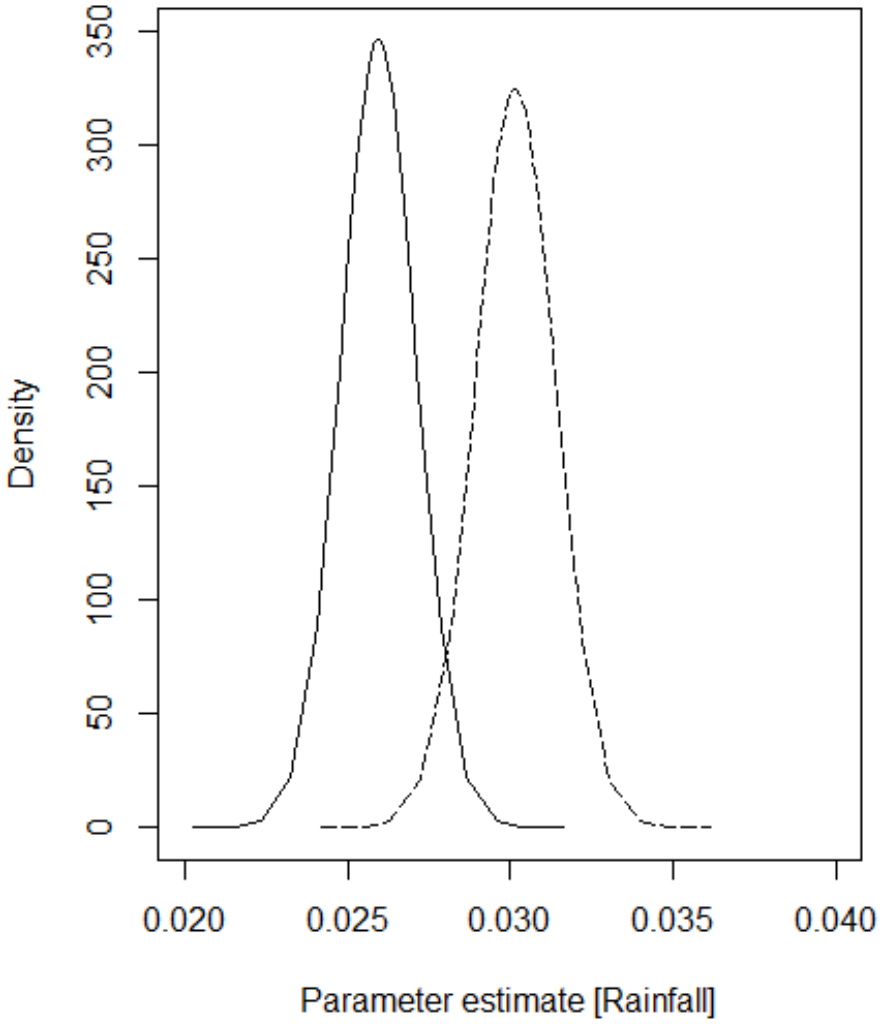
Posterior distributions of irrigation and rainfall parameters from the mosquito regression model





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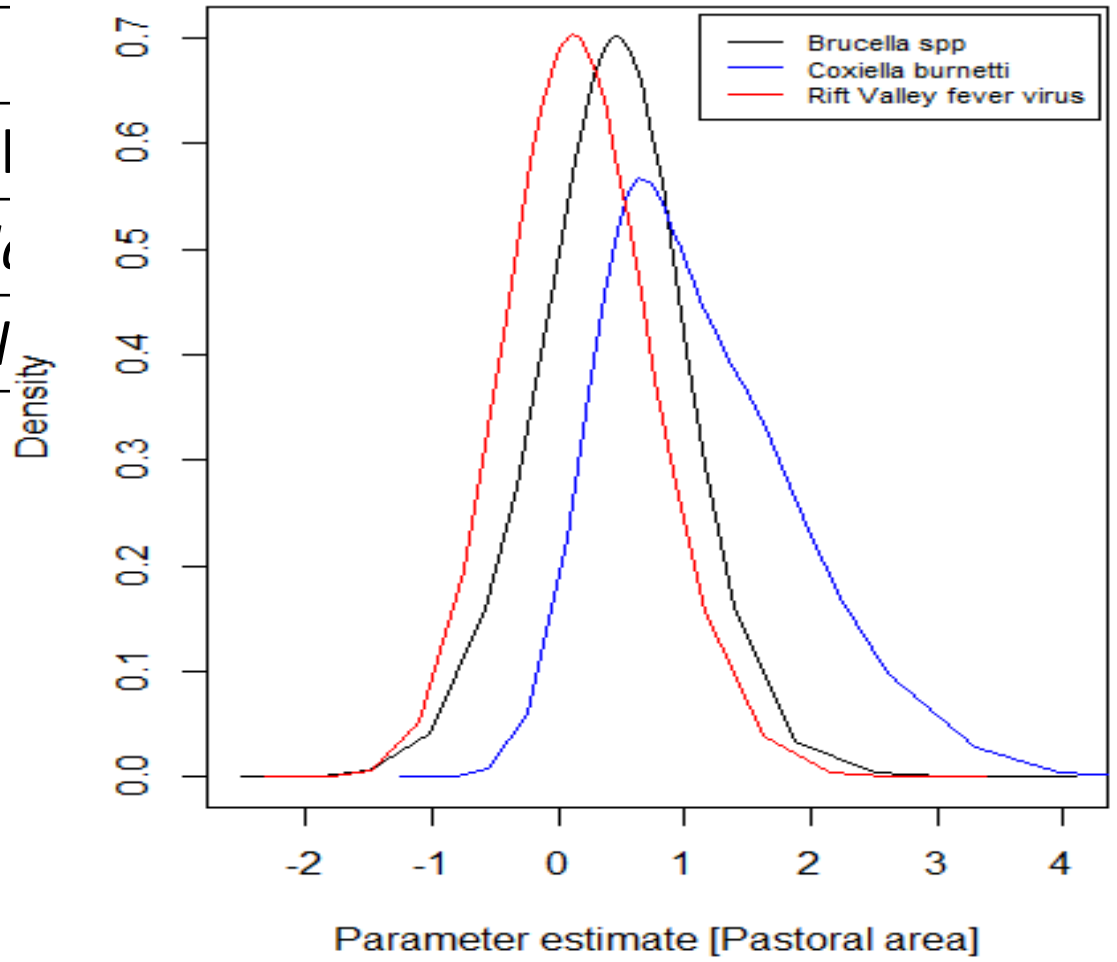
Sero-prevalences of target pathogens in livestock

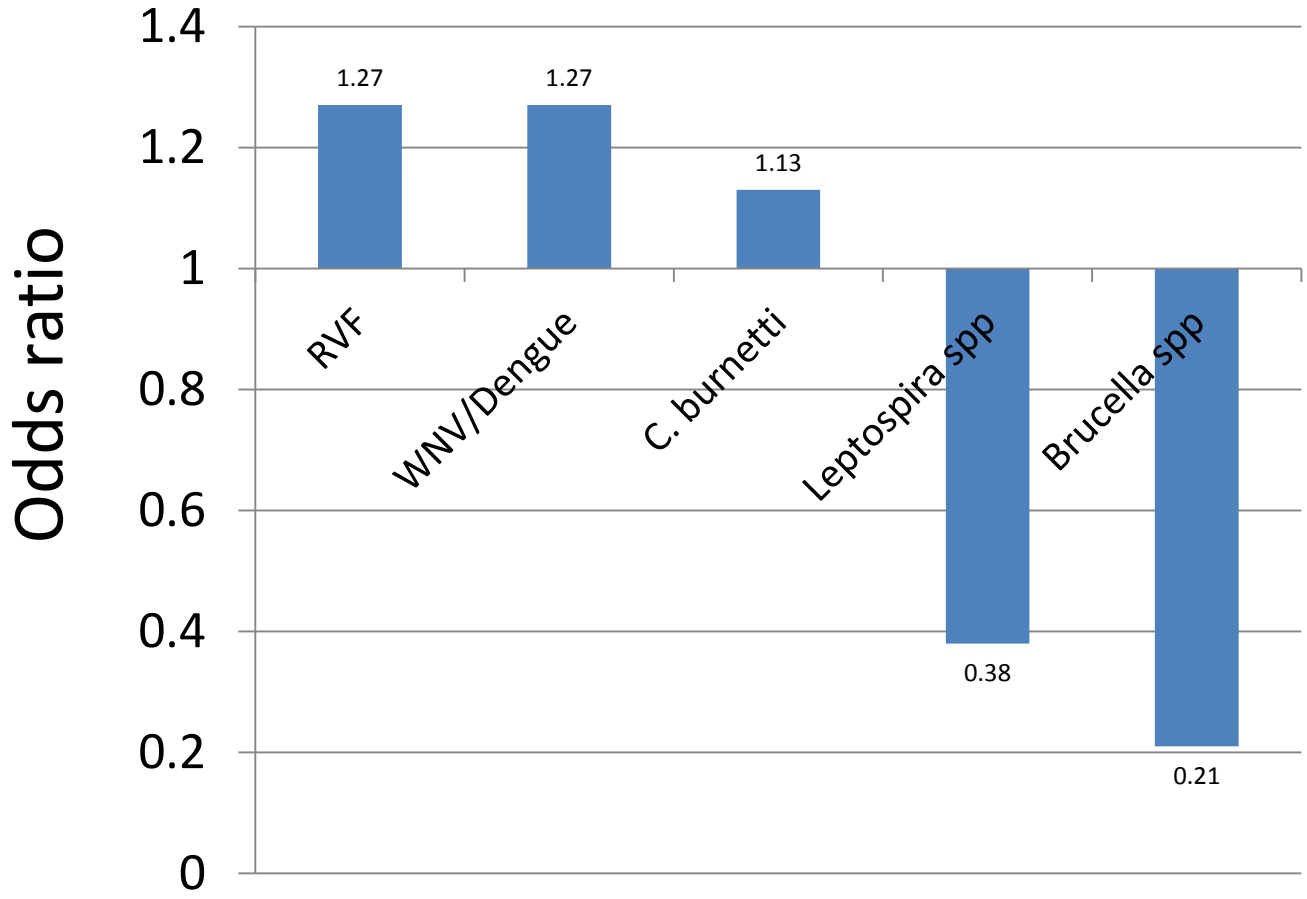
Pathog		CI)
		ated areas
Rift Val		7 – 40.5)
Coxiell		· 12.2)
Brucell		· 7.7)



Posterior distribution of the land use parameter

Odd ratios from a regression model used to analyse sero-prevalences of the zoonotic pathogens in people

- Odds of being exposed in an irrigated area compared to pastoral



Discussion and conclusions

- Irrigation – increased food production at the expense of habitat fragmentation, biodiversity conservation
- Used multiple pathogens to generate generic lessons
- Irrigation and primary vectors of RVF
- Biodiversity and disease regulation/dilution effect --- inconsistent findings
  - Results from livestock – no significant patterns – movement across areas
  - Results from people – higher risk of vector-borne diseases in irrigated area and directly transmitted zoonoses in pastoral area

Acknowledgements

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