Land use, biodiversity changes and the risk of zoonotic diseases: Findings from a cross-sectional study in Tana River County, Kenya

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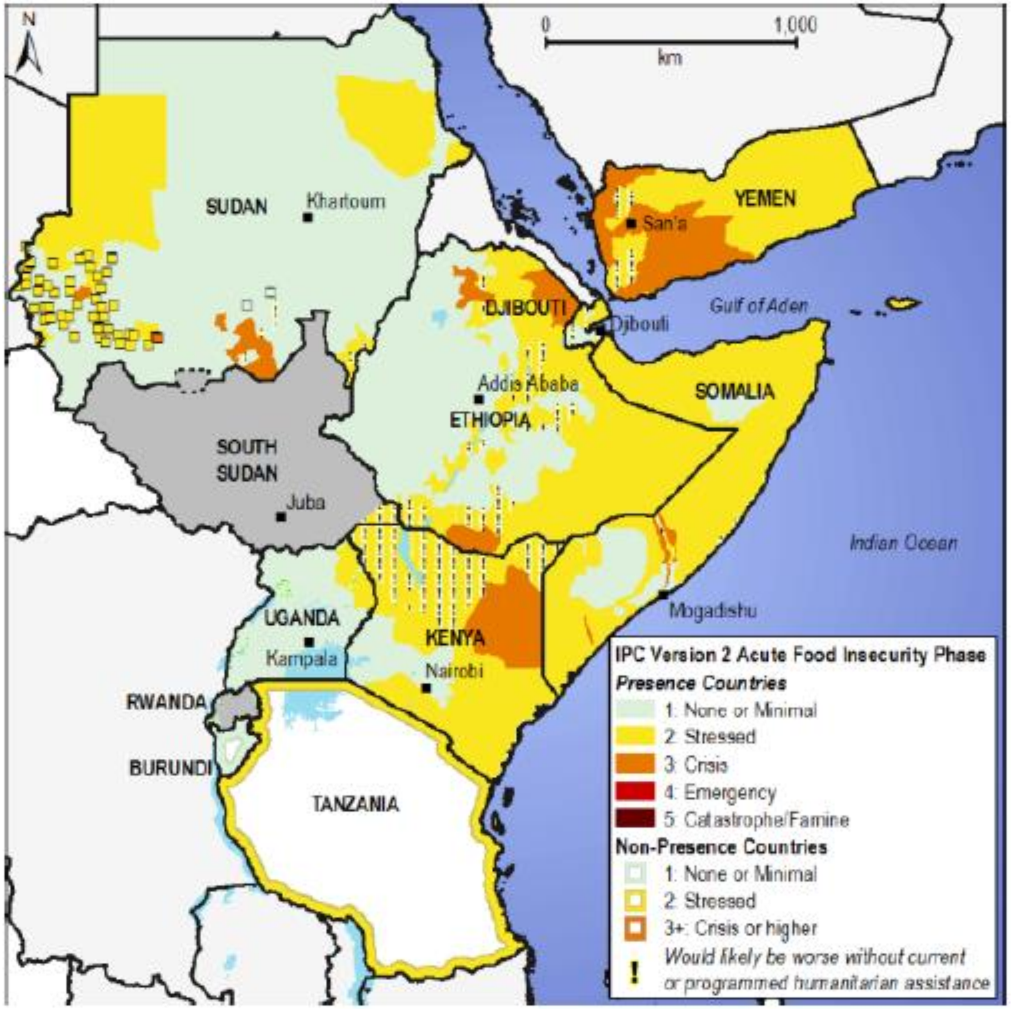
Introduction (1)



Source: FEWSNET

- About 13.3 million people in eastern Africa face severe food shortages
- Contributing factors:
  - Low productivity of the livestock sector
  - Heavy reliance on rain-fed agriculture
  - Conflicts
  - High levels of poverty

Introduction (2)

- Interventions being implemented in Kenya:
  - Development/expansion of irrigation schemes
  - Intensification of livestock production
  - Relief food – sustainability?

- Expected trade-offs in ecosystem services:
  - Increase in food production – positive
  - Reduction in biodiversity – negative
  - Increased chances of disease emergence/transmission - negative

Hola Irrigation Scheme, Tana River

Source: Bernard Bett/ILRI

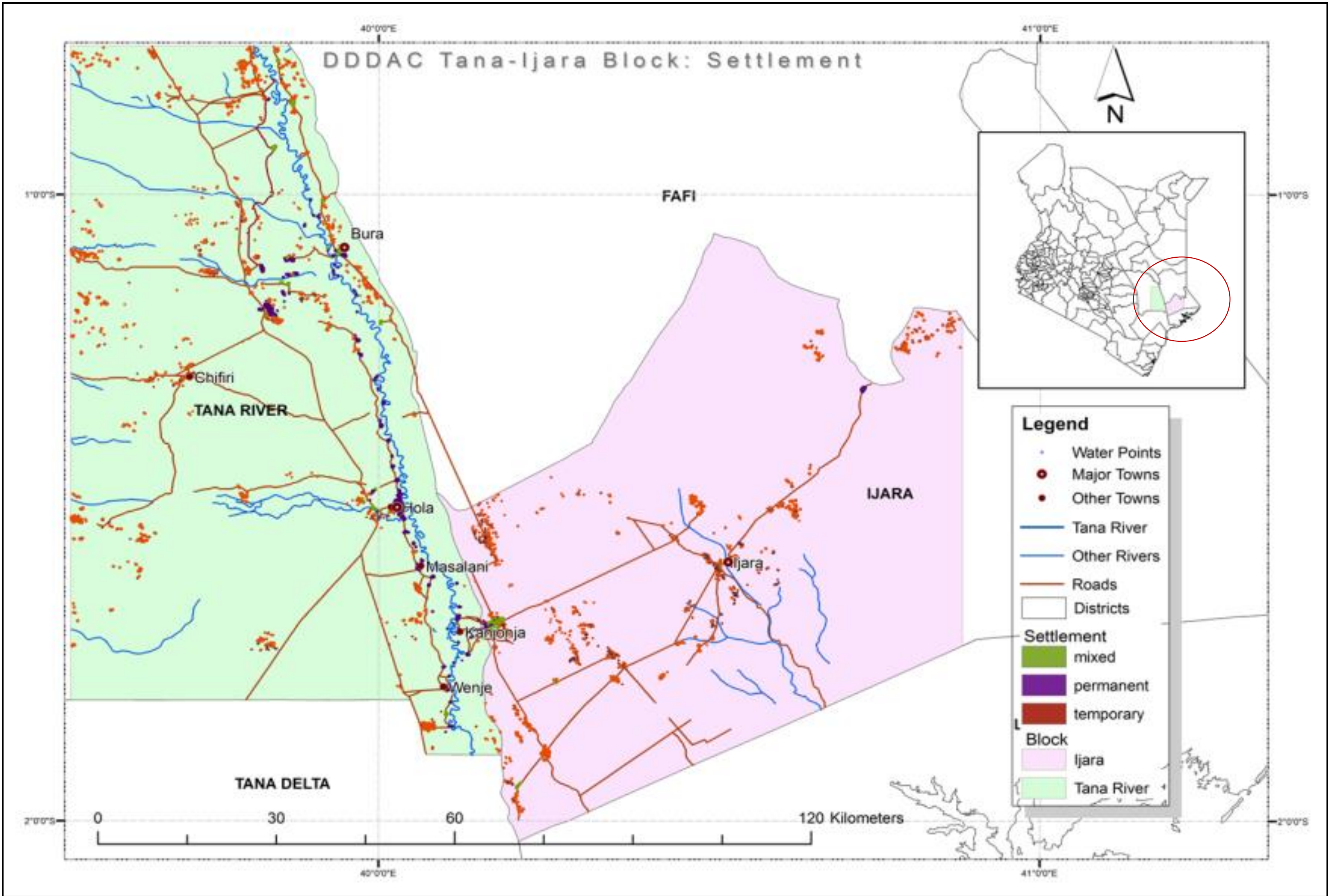
Introduction (3)

- Irrigation thought to influence pathogen transmission in people and animals in multiple ways:
  - Changes the distribution and density of hosts – small ruminants and chicken more likely to be found in irrigated areas
  - Standing water masses and high humidity support the development of many arthropod vectors e.g. mosquitoes
  - Prolonged exposure to agrochemicals reported to decrease immunity in people/animals
  - Increases pest infestation (e.g. rodents – due to good access to feed from the farms and decline in population densities of predators)
  - High temperatures in most irrigated areas – shorten vectors’ feeding intervals
  - Changes in socio-economic practices – e.g. farm activities predispose people to mosquito bites depending on vectors’ activity periods

The study objective

Does irrigation influence the distribution of zoonotic diseases [such as Rift Valley fever, Q fever, brucellosis, West Nile virus, dengue fever and leptospirosis] in Tana River County?

Methods – Study site



Field activities

- Study design – used standard procedures for sample size estimation, subject identification and recruitment
- Mosquito sampling – CDC light traps
- Participatory studies (FGDs) to collate perceptions on:
  - Drivers of disease
  - Livelihood patterns in relation to disease exposure
- Livestock and human sampling – Samples screened using various ELISA kits
- Ethical approval -AMREF

Livestock sampling – with DVS Credit Bernard Bett/ILRI

Human sampling – with MoH; Credit Damaris Mwololo/ILRI

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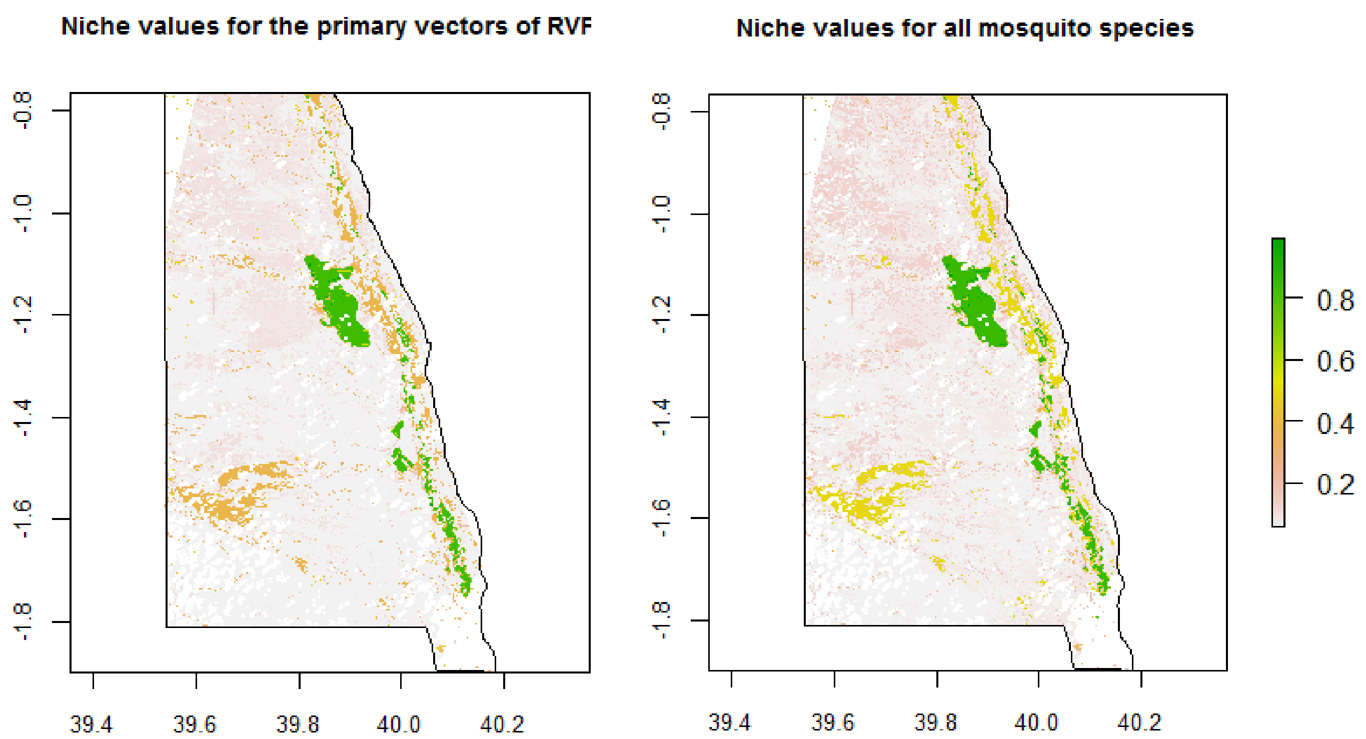
Results

- Mosquito distribution – ecological niche models



Outputs from ecological niche models showing suitable habitats for mosquitoes in the Tana River study site

- Multiple mosquito species found in irrigated areas and areas along the river (with small-scale farming)

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Results – biodiversity changes

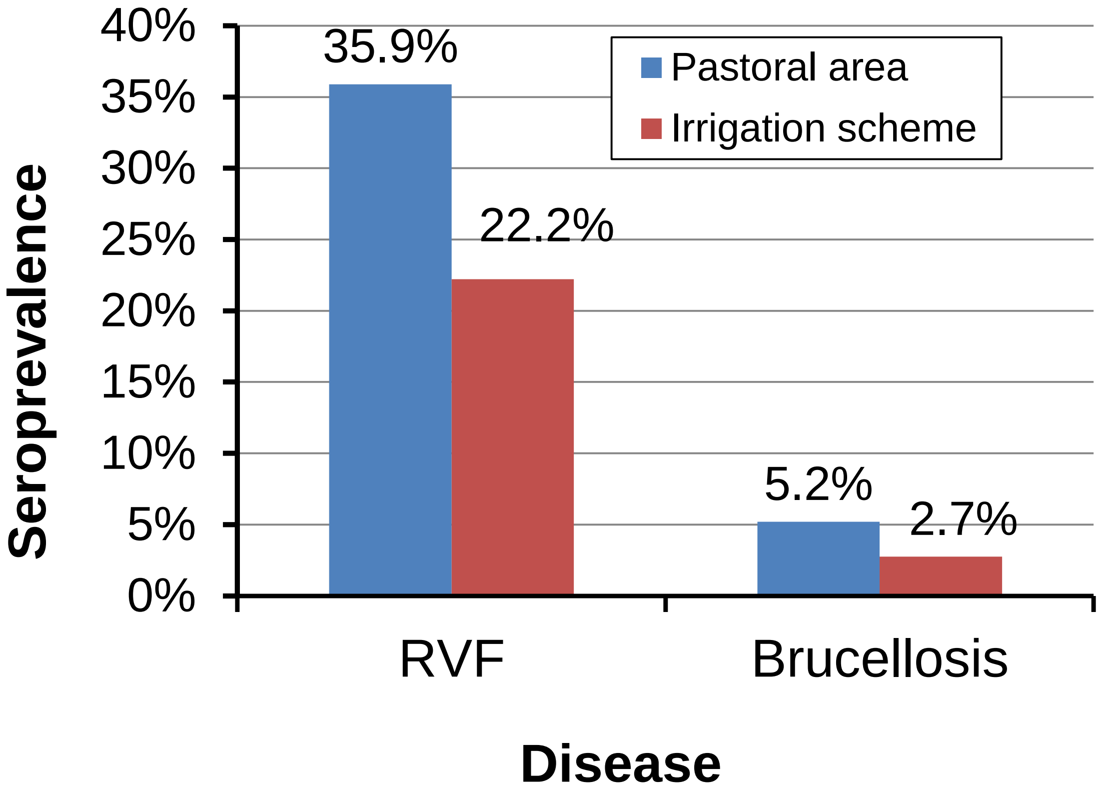
- Changes in the population densities of large mammals between 1970s – 2000s

Species	PE 1970s	SE 1970s	PE 2000s	SE 2000s	d	P value
Cattle	46,919	9,862	40,820	9,354	-0.45	0.326355
Camel	1,621	789	4,391	1,082	2.07	0.019226
Donkey	926	386	779	314	-0.30	0.488033
Shoats	45,348	10,357	71,435	9,614	1.85	0.032157
Buffalo	384	235	0	0	-1.64	0.050503
Elephant	41	40	0	0	-1.02	0.153864
Grant's gazelle	1,341	384	145	77	-3.05	0.001144
Gerenuk	618	157	643	144	0.12	0.452242
Giraffe	833	230	114	62	-3.02	0.001264
Hunter's hartebeest	97	84	83	64	-0.13	0.448283
Impala	247	239	0	0	-1.03	0.151505
Lesser kudu	209	110	177	59	-0.26	0.397431
Oryx	697	209	84	47	-2.86	0.002118
Ostirch	629	195	123	47	-2.53	0.005703
Warthog	2,567	468	103	43	-5.25	0.000000
Burchell's zebra	5,178	1,558	0	0	-3.32	0.000450

- Except shoats and camels, populations of most (large) mammals have declined in the region

Sero-prevalence of RVF and brucellosis in sheep and goats

- Number of samples screened – 2,103



- Statistical analyses: significant differences in RVF sero-prevalence between sites, but not for brucellosis

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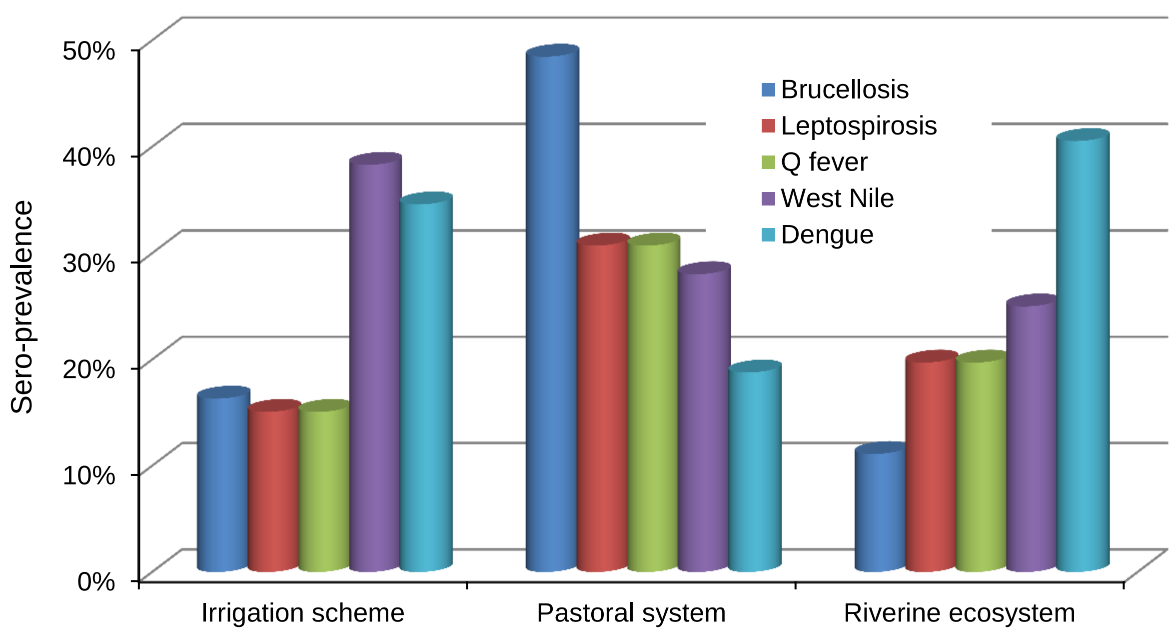
Sero-prevalence of multiple pathogens in people

Number of people sampled – 1141



- Emerging patterns:
  - Significantly higher sero-prevalence of brucellosis and leptospirosis in pastoral than irrigated areas
  - Significantly higher sero-prevalence of West Nile/dengue viruses in irrigated compared to pastoral areas
  - No differences in the sero-prevalence of RVF and Q fever by site

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Discussion

- Irrigation predictably causes a decline in biodiversity – wildlife niches are cleared for crop farming
- Linkages between biodiversity and disease risk are unclear [some positive others negative] and could vary with the scale of analysis. Key observation from our study:
  - Areas with rich diversity of hosts have higher prevalences of multiple zoonotic pathogens than those with lower host diversity
  - Irrigated areas are infested with multiple species of mosquitoes (including primary vectors of RVF) but their high population densities, on their own, are not enough to sustain the transmission of pathogens – reservoir hosts (e.g. birds for WNV) or other persistence mechanisms are required
- Better management of dynamic ecosystems required:
  - Environmental impact assessments should give practical recommendations on how to manage trade-offs in ecosystem disservices rather than as processes to satisfy requirements for project implementation

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