# Integrating public health goals with biodiversity conservation priorities - Infectious disease, community livelihoods, and ecosystem health


## Kathleen Alexander PhD DVM

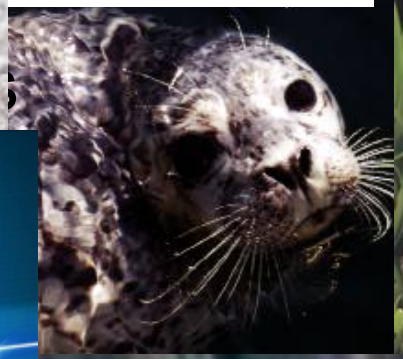
College of National Resources/CARACAL

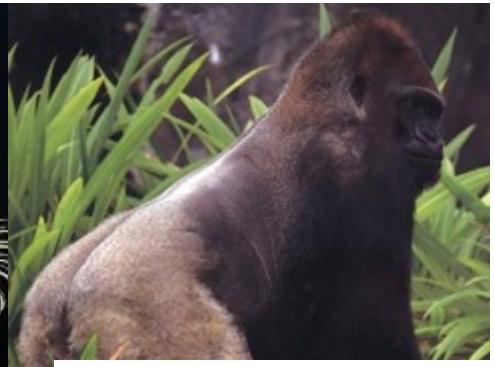


VirginiaTech
Invent the Future


With collaborative assistance from the Botswana Ministry of Health and Ministry Environment Wildlife and Tourism

Phocine Distemper





Gorillas, Chimpanzee and Ebola

White Nose Syndrome


ic Wasting Disease

Viral Haemorrhagic Septicaemia

Rabies Ethiopian Wolves &
Wild dogs

Frog Populations Declining
Chytrid fungus

# global issues


# AIDS

The Threat to W

# Linkages between public health and biodiversity

Human and animal health are intimately connected.
Biodiversity and ecosystem services are key to these interactions.

## The case for integration

# Making the Case: Integrating biodiversity into public health

## Why bother?

**In many African countries, institutional workloads challenge existing resources (human and economic).**

**Benefit must be identified that exceeds the cost of adding another institutional burden.**

**Is there real value in the joint consideration of biodiversity and public health?**

**Proximal verses distal drivers of public health problems.**

**Human mediated impacts on biodiversity and ecosystem function.**

**Can we secure improved public health through better management of biodiversity and ecosystem services?**

*Int. J. Environ. Res. Public Health* **2013**, *10*, 1202-1230; doi:10.3390/ijerph10041202

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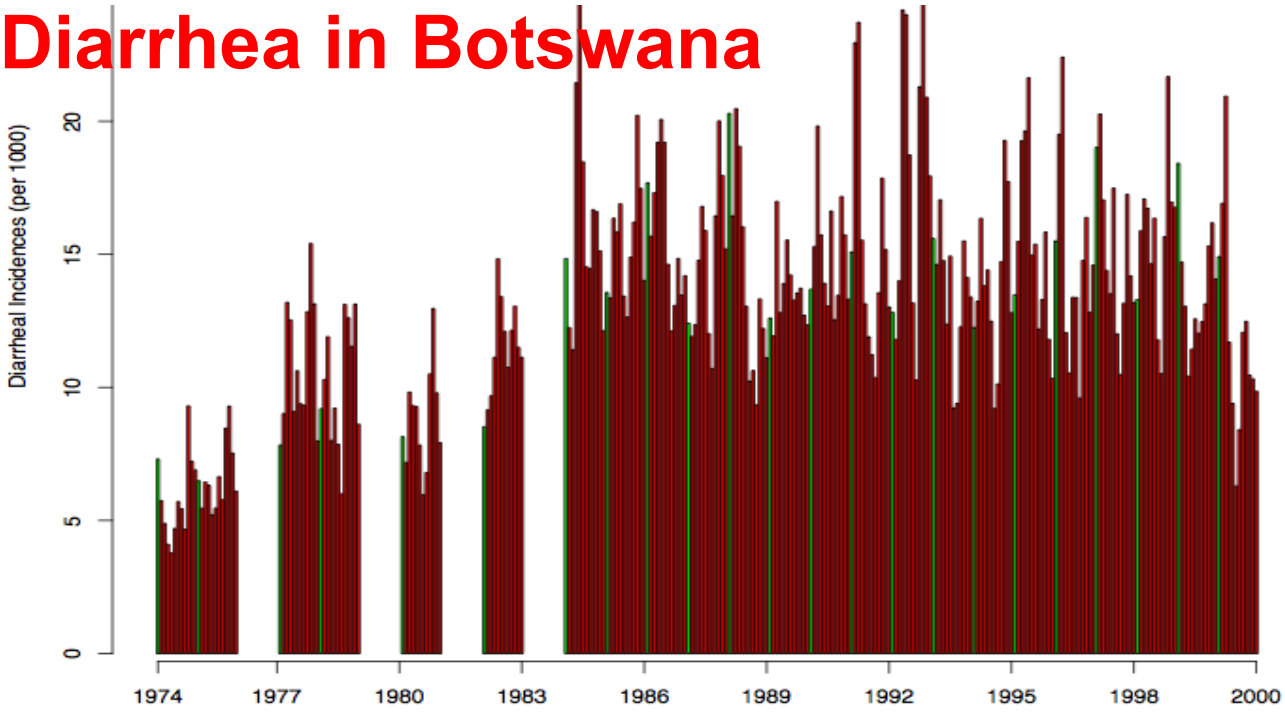
www.mdpi.com/journal/ijerph

*Article*

# Climate Change is Likely to Worsen the Public Health Threat of Diarrheal Disease in Botswana

## Case study 1: Diarrhea in Botswana

Diarrhea incidence in Botswana 1974-2003



## Primary disease syndrome
## Diarrheal disease

- Diarrhea is a global health threat.
- HIV/AIDS direct and indirect influences.
- What drives this disease syndrome?

**Complex**

# January – March 2006

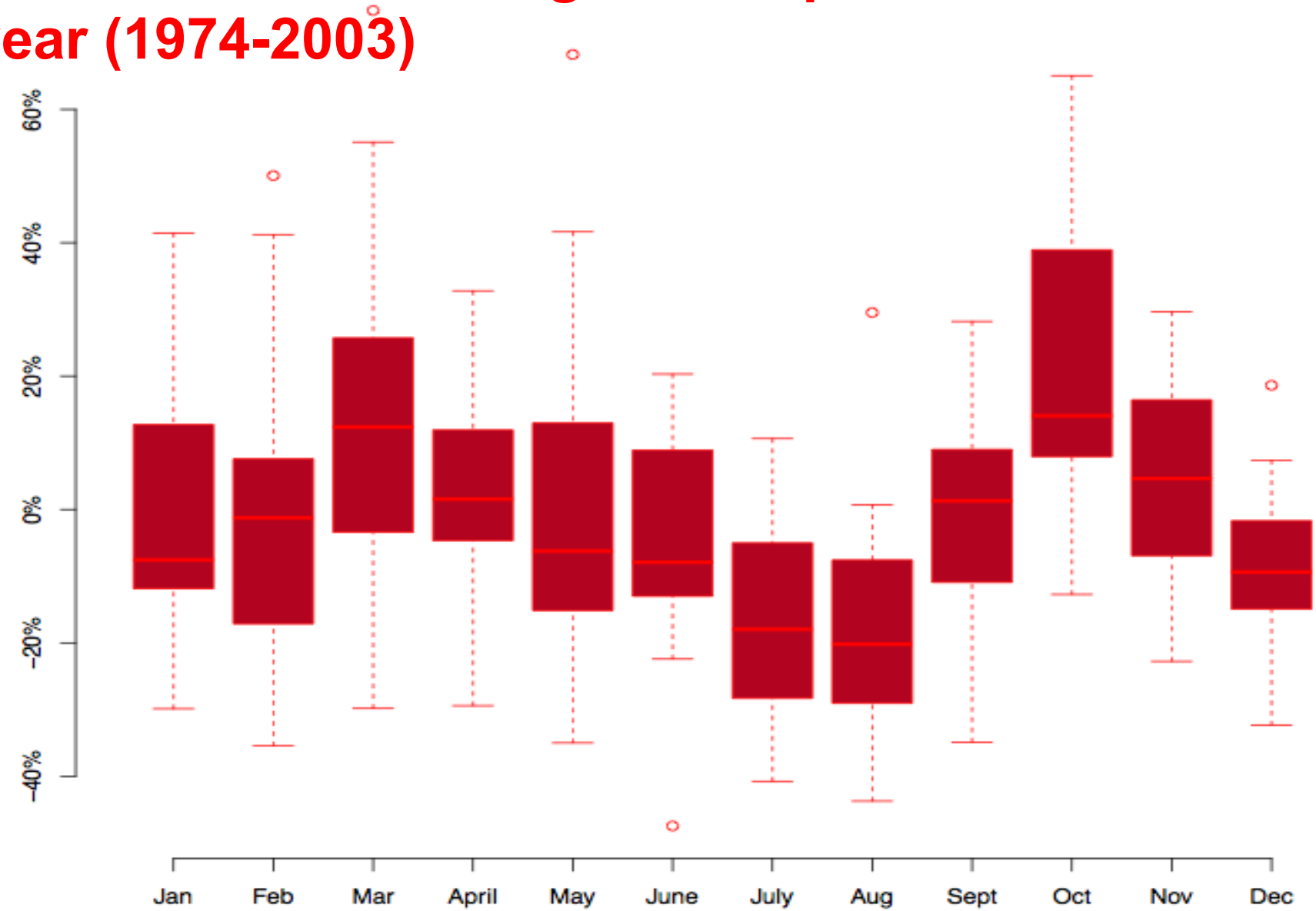
Francistown region, Botswana

**High rainfall**

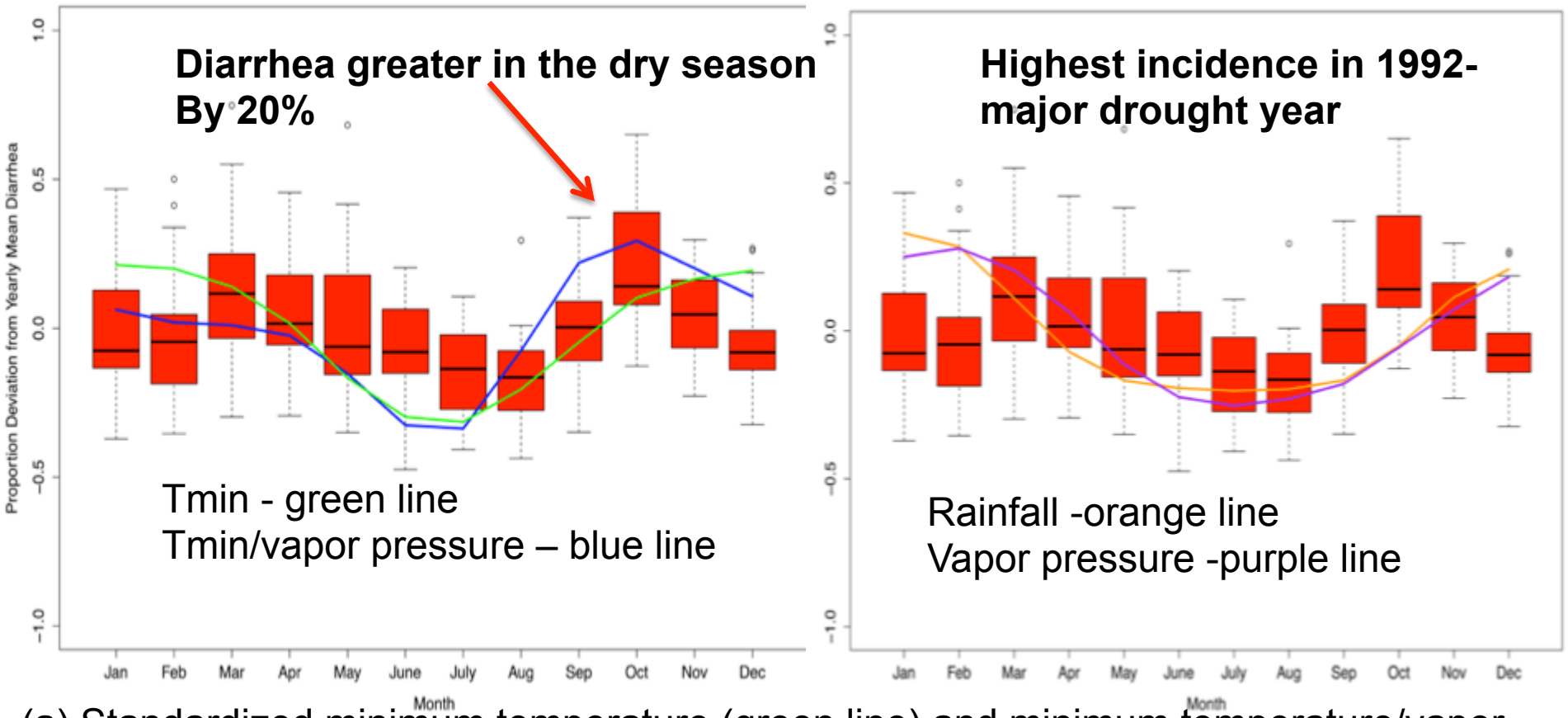
**35,000 cases of diarrheal disease**

**532 deaths of children under 5 years of age**

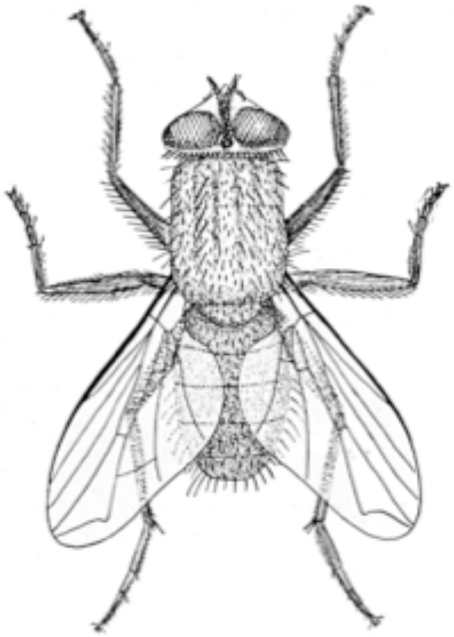
# Diarrhea exhibits a significant pattern within the year (1974-2003)



# Climatic Drivers of Diarrhea




(**a**) Standardized minimum temperature (green line) and minimum temperature/vapor pressure (blue line) are plotted over diarrhea case incidence presented as a proportion deviation from yearly mean diarrhea cases (red box plot). (**b**) Standardized rainfall (orange line) and vapor pressure (purple line) are plotted in a similar manner with diarrhea cases. Together, these meteorological variables act as strong predictors of average monthly diarrhea in Botswana (1974–2003).



**Flies are an important vector of microorganisms causing diarrheal disease.**

**October – Hottest and driest time of year.**

**Conditions promote higher density – more active in dry/hot conditions**

**Flies may amplify existing sanitation deficiencies, poverty, and ecosystem service deficiencies.**

**Climate change predictions identify more than %250 increase in numbers**

# Climate Change in Botswana and the region

-**HAS ALREADY HAPPENED** – Increase annual daily temperature 0.089 °C per annum from 1981 and 2011.

**Temperature** will increase another 2.5–3 °C

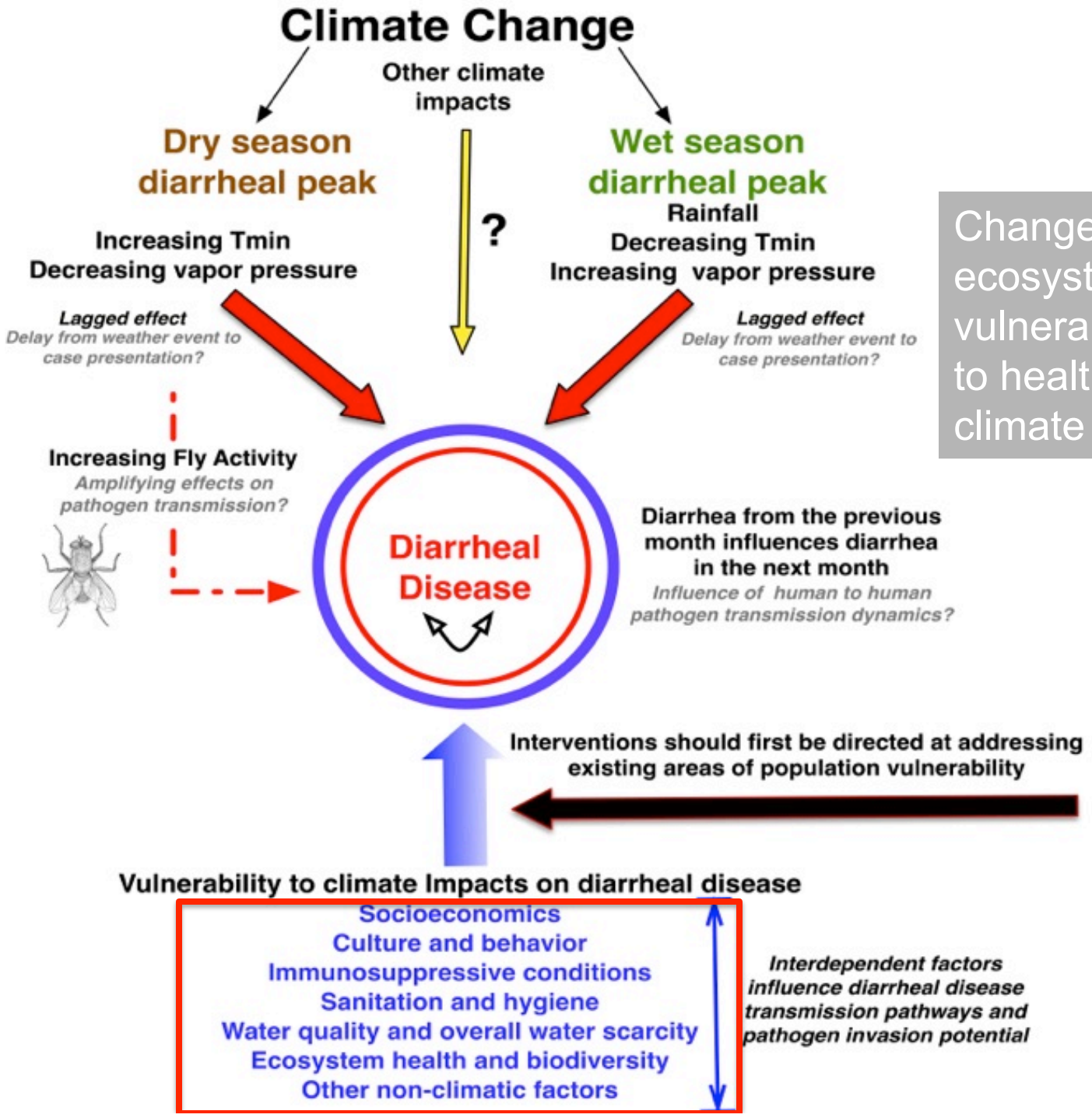
Will become **drier by 5–15%**.

**Pacific El Nino Southern Oscillation (ENSO)** episodes are forecasted to increase in frequency and **droughts** will be more intense.

With a 10% reduction in rainfall, models suggest that perennial drainage will be significantly reduced, affecting already limited surface water resources.

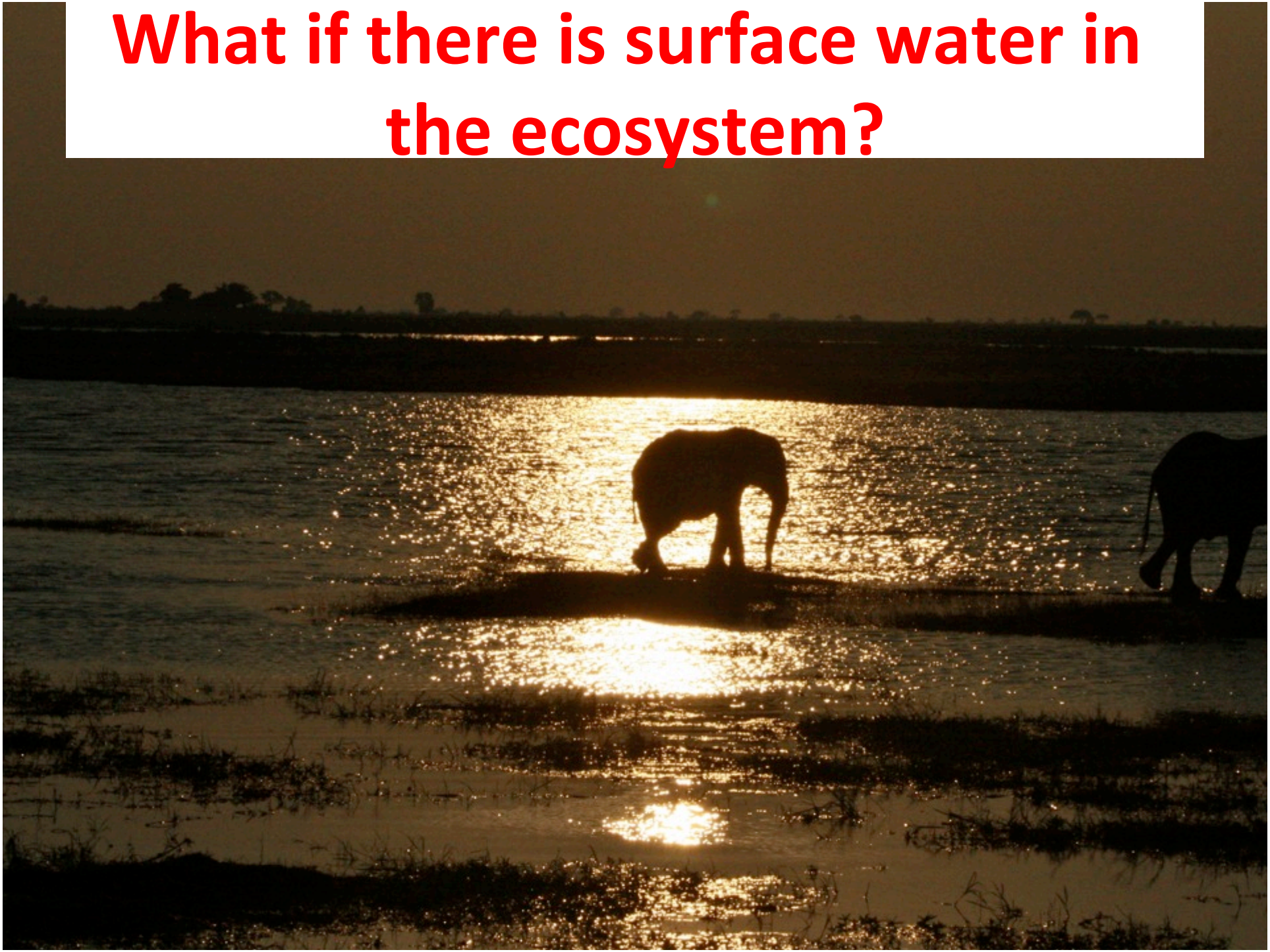
**WATER SCARCITY, CHANGE IN ECOSYSTEMS AND BIODIVERSITY, AND SERVICE PROVISION - IMPACTS ON PUBLIC HEALTH**

**SUGGEST SIGNIFICANT INCREASE IN DIARRHEAL DISEASE**




Changes to biodiversity and ecosystem services increase vulnerability of communities to health impacts and future climate change.

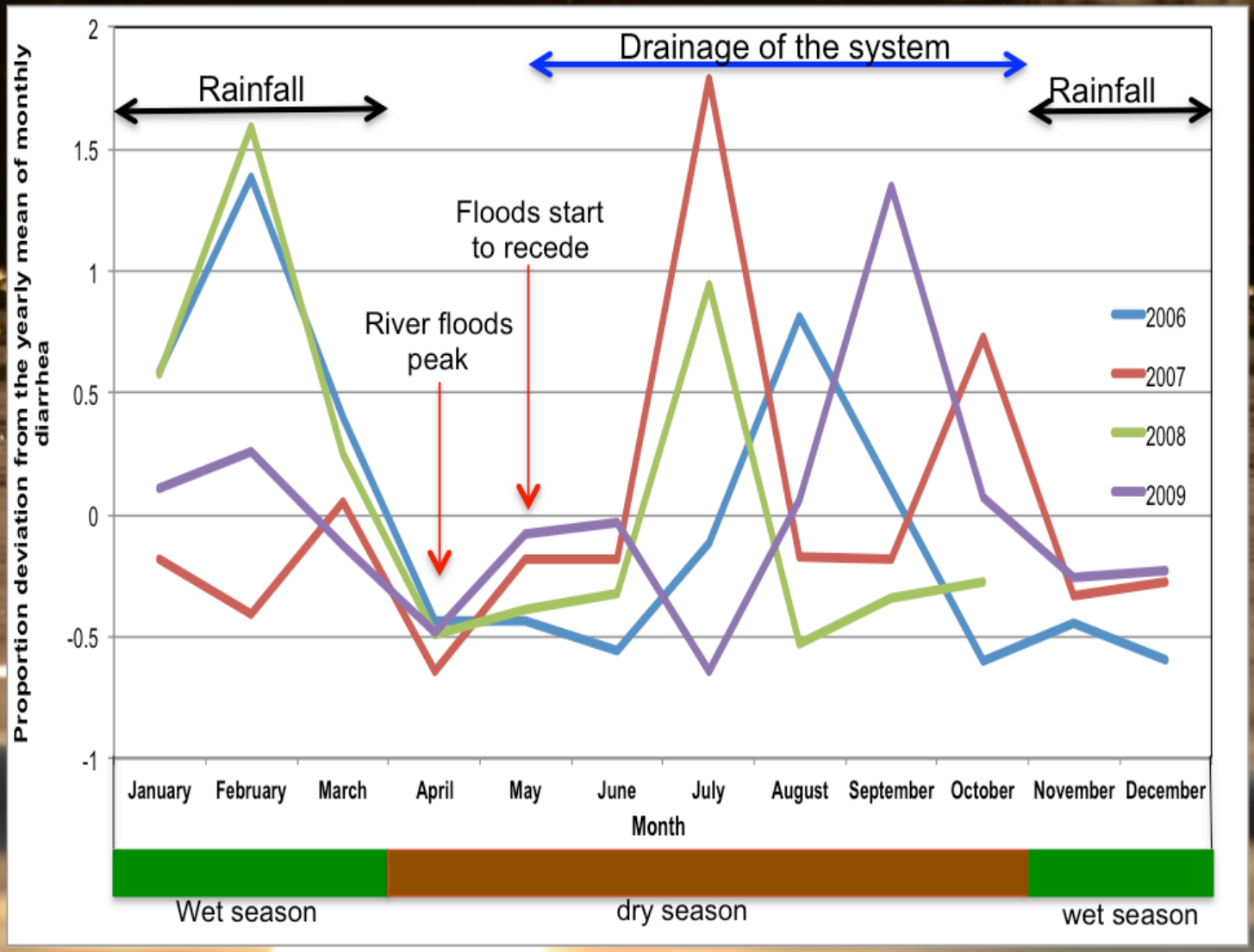
# What if there is surface water in the ecosystem?



# Case Study 2: Landscape dynamics and Water quality in the Chobe River Basin of Botswana

Interactions between climate, ecosystem degradation, and human and animal health

# Diarrheal Disease in Chobe District Botswana



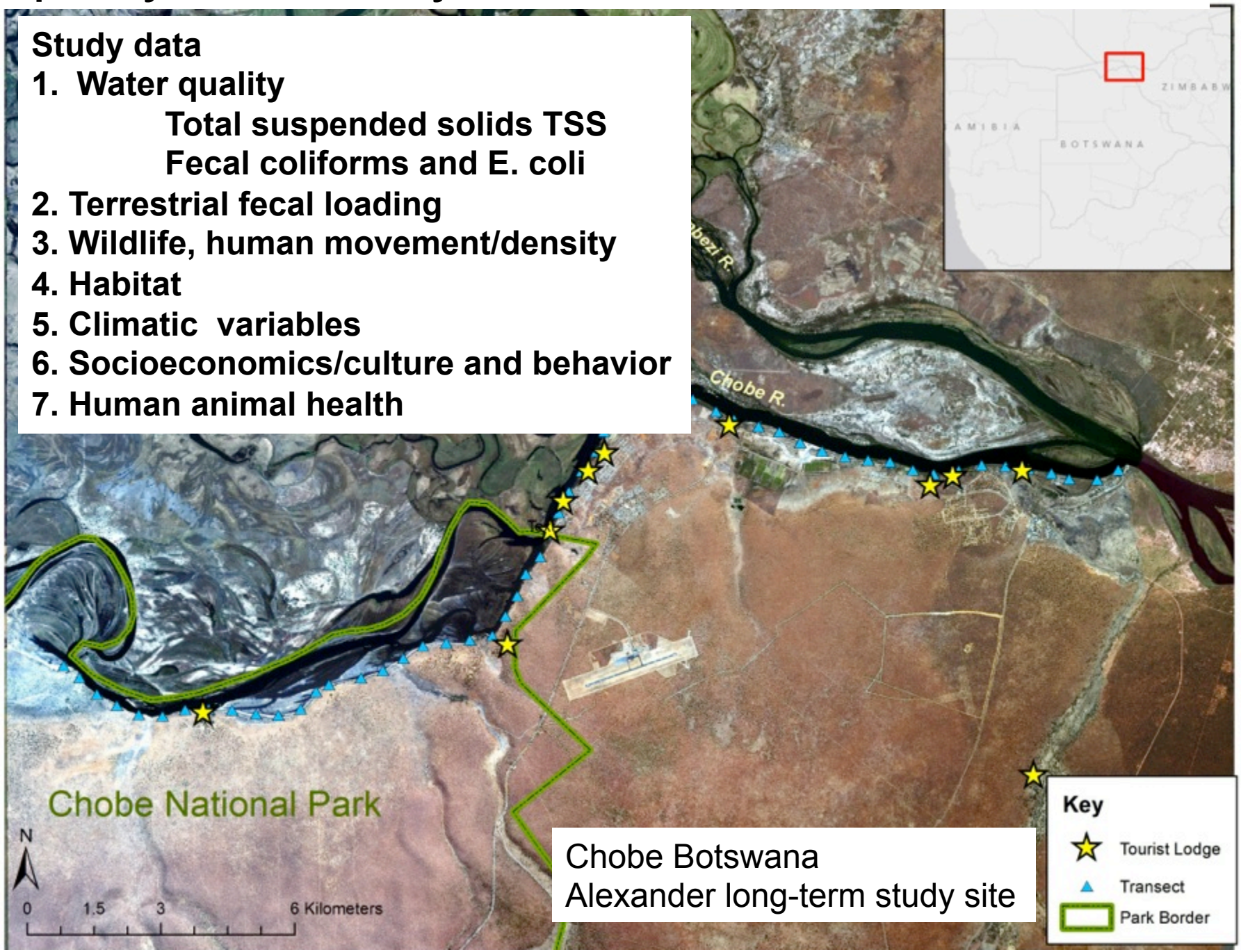

Alexander and Blackburn 2013, BMC Public Health – Under Re

# What drives the diarrheal disease outbreaks?

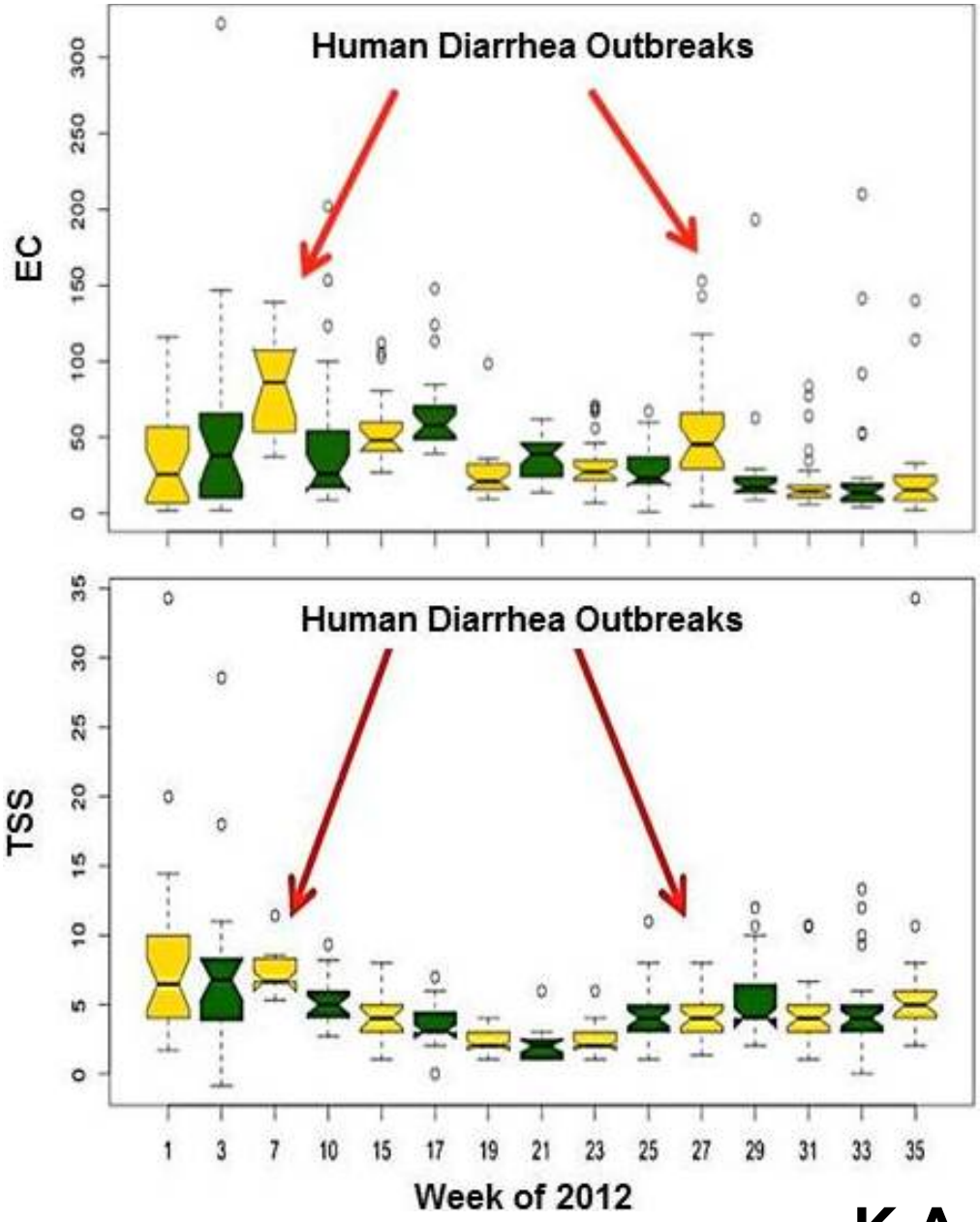
**Environmental degradation at the terrestrial- water interface**

**Impacts on biodiversity, ecosystem services, water quality, and public health**

# Coupled dynamics of ecosystem services – human and animal health



# Water Quality Chobe River 2011-2012

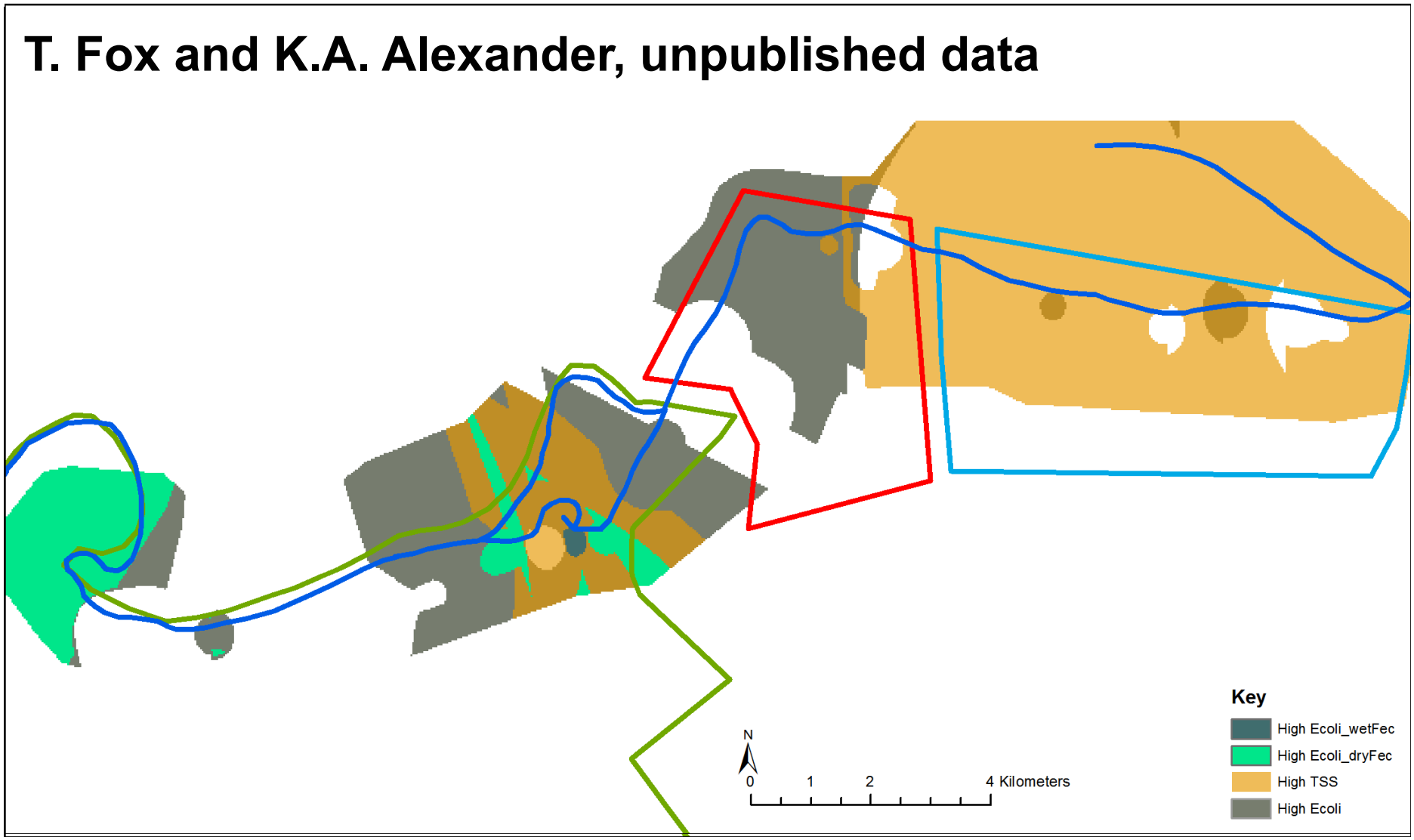



Significant relationship between higher temperatures, vapor pressure and rainfall in the wet season.

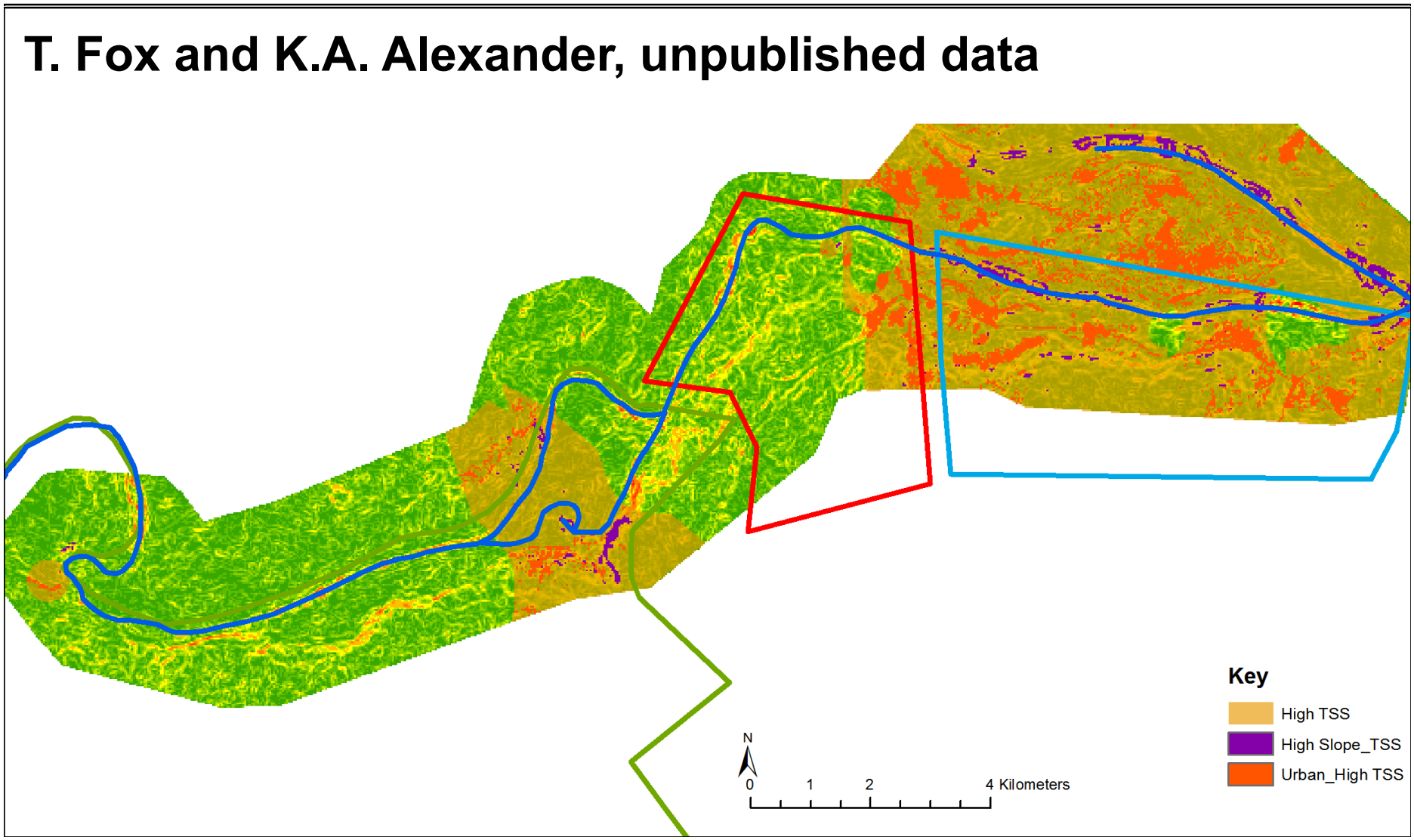
Flood height and recession in the dry season.

**K.A. Alexander, unpublished data**

# Zones of high E. coli, TSS, dry and wet season fecal counts extracted from IDW interpolations

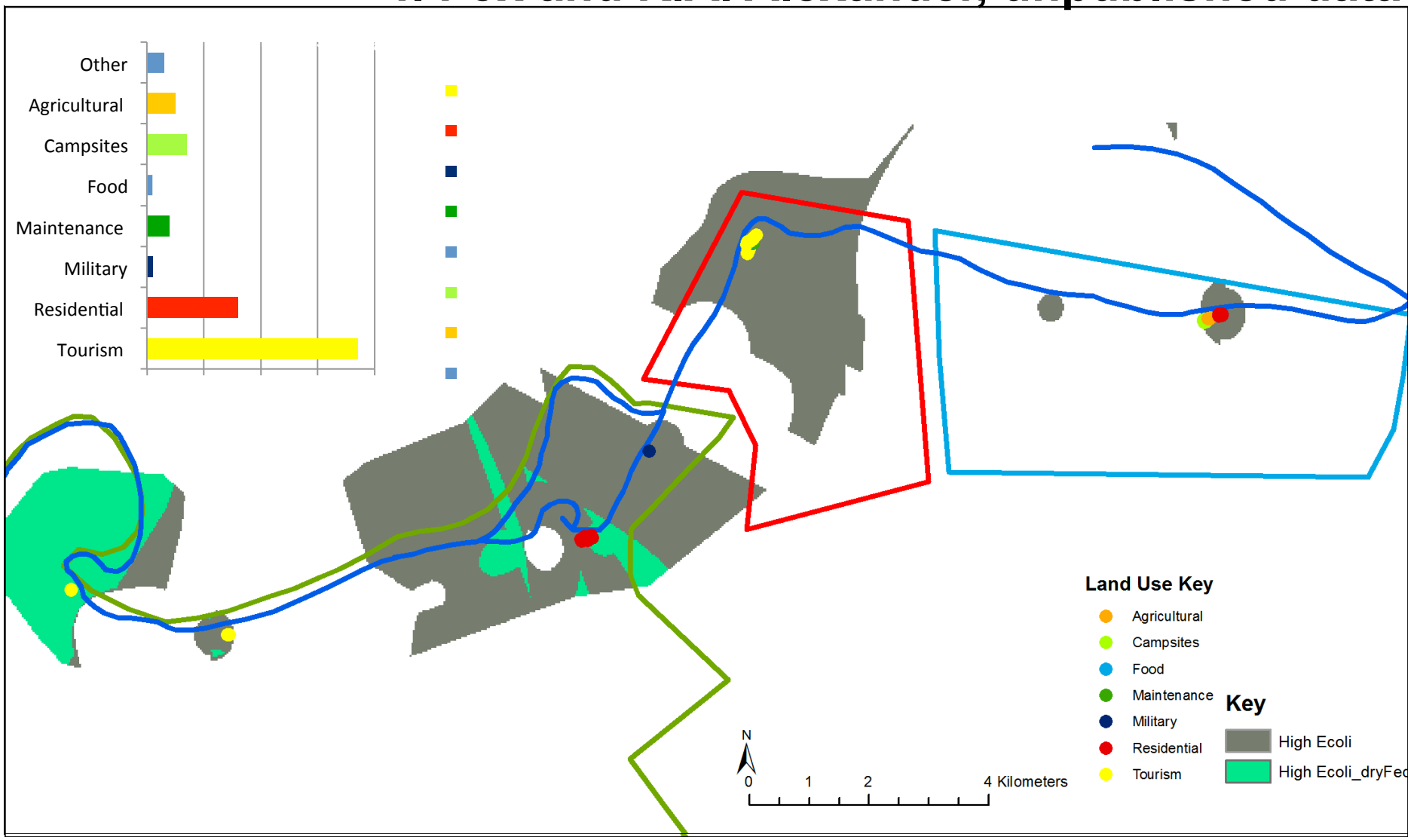


# Suspended sediments and slope (percent rise)

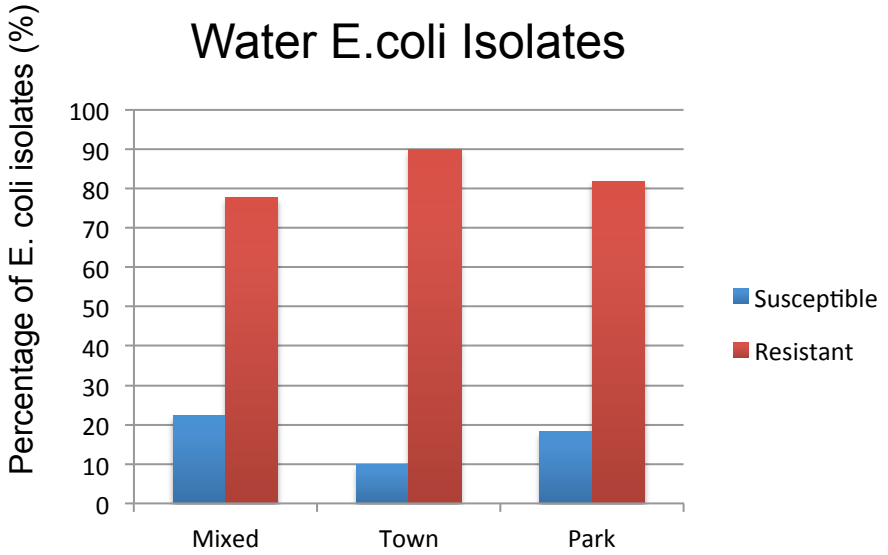


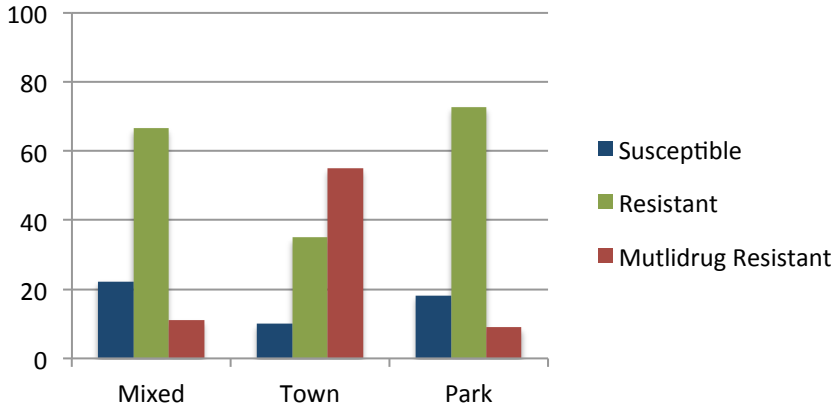
# E. coli, seasonal fecal biomass & anthropogenic land use type

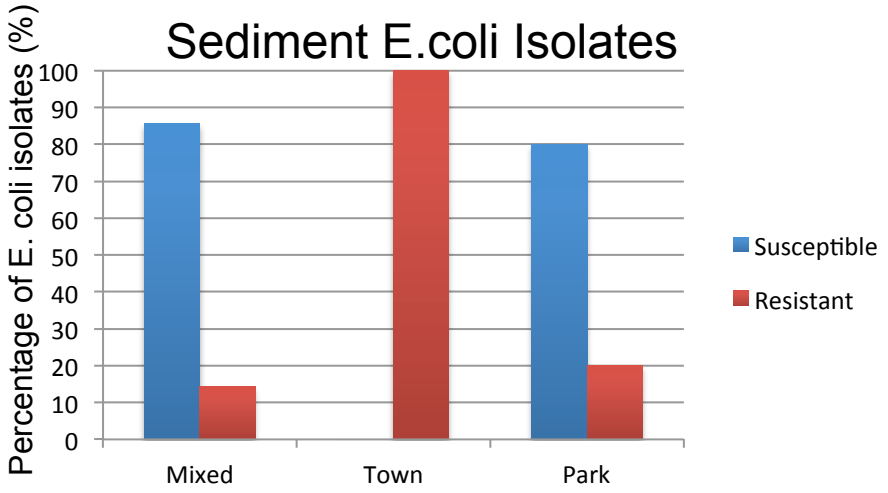
**T. Fox and K.A. Alexander, unpublished data**

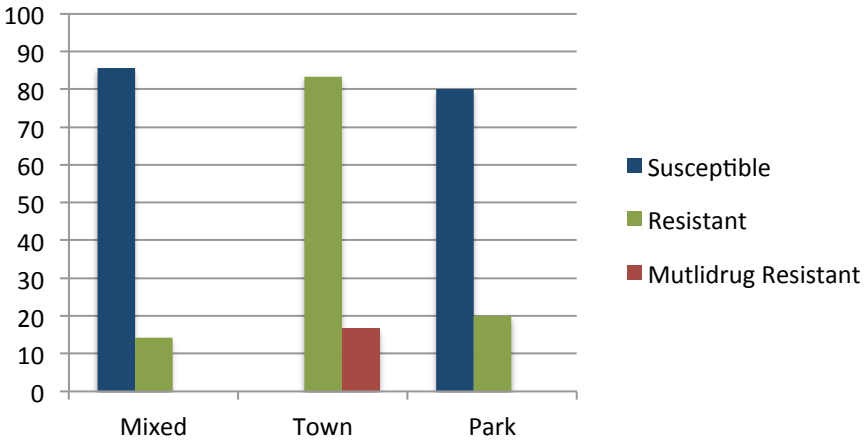


# Antibiotic resistance signature of human fecal source but also emerging health threat



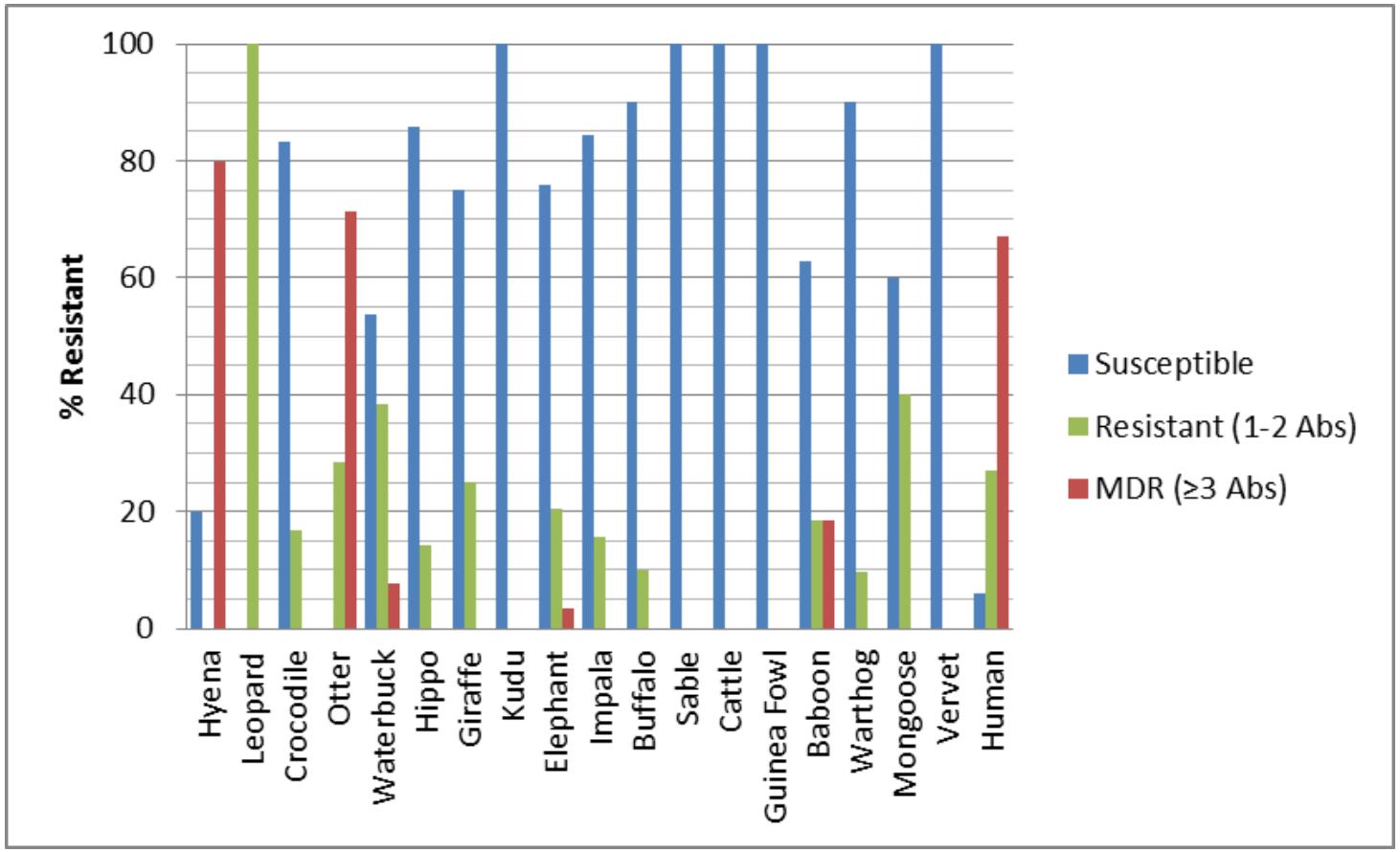



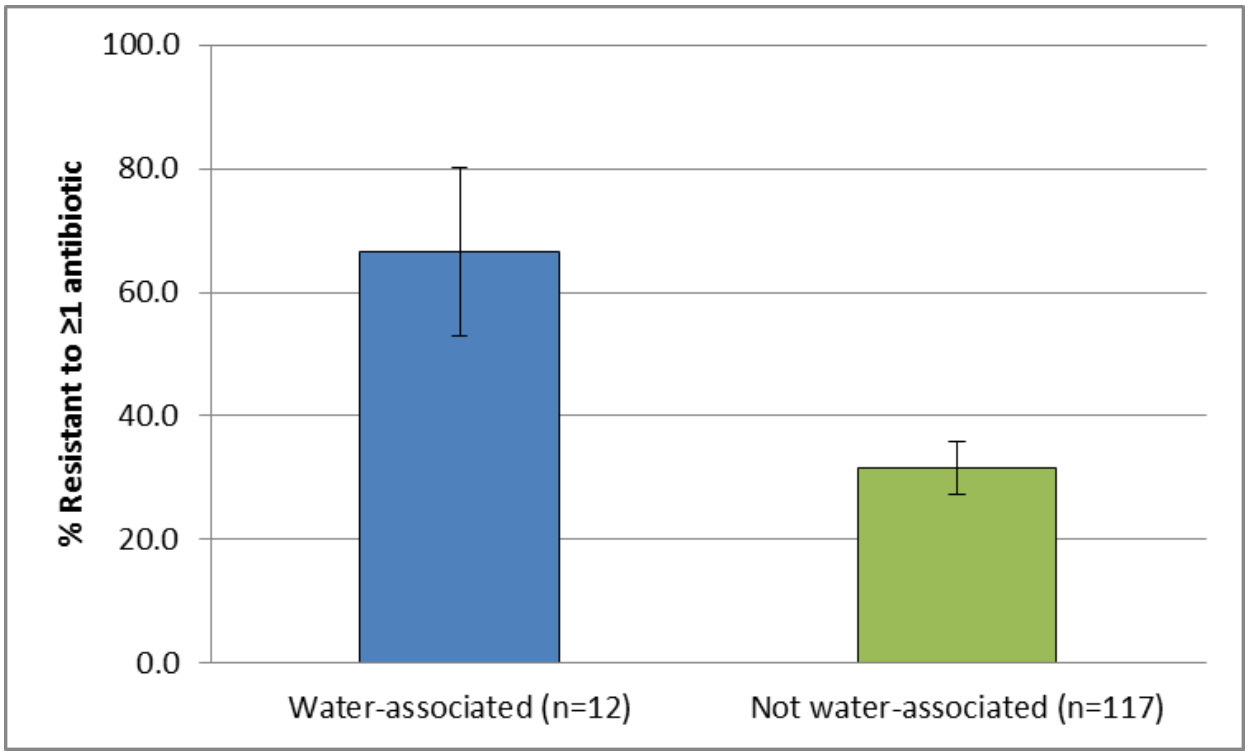

**C.E. Sanderson, and K.A. Alexander, unpublished data**

# Wildlife and humans?




***E. coli* antimicrobial resistance patterns –** Percentage of susceptible, resistant (1-2 antibiotics) and multidrug (≥3 antibiotics) resistant *E. coli* isolates collected from wildlife in and around Chobe National Park, as well as human clinical samples submitted to Kasane Primary Hospital.

**S.E. Jobbins and K.A. Alexander, unpublished data**

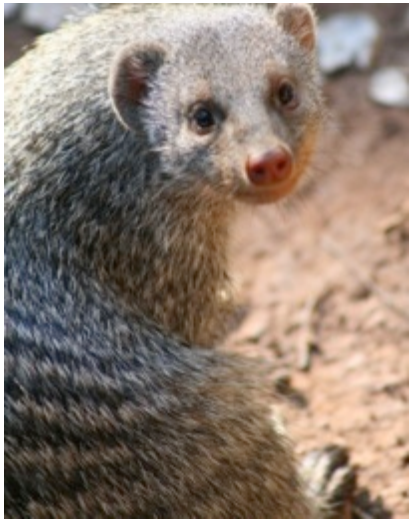



**Influence of association with water on accumulation of antibiotic-resistant *E. coli***
**-** Prevalence of antibiotic resistance in feces collected from water-associated vs. predominantly terrestrial wildlife in and around Chobe National Park, northern Botswana. Height of column represents the percentage of feces containing *E. coli* isolates which were resistant to at least one of the ten tested antibiotics.

**S. E. Jobbins, and KA Alexander, unpublished data**

EcoHealth
DOI: 10.1007/s10393-013-0838-2

ECOHEALTH

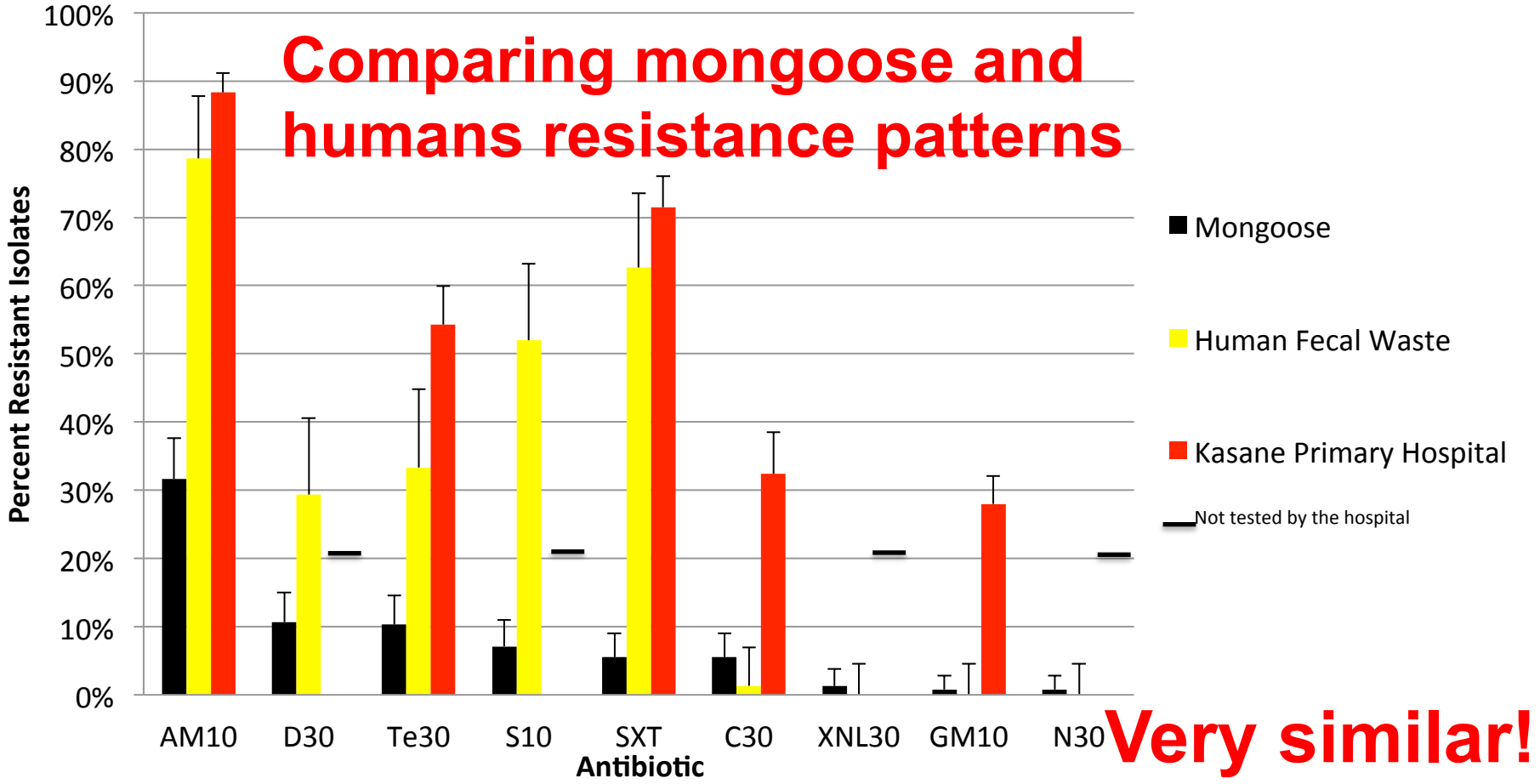


# Tracking Pathogen Transmission at the Human-Wildlife Interface: Banded Mongoose and *Escherichia coli*

R. Pesapane,[1] M. Ponder,[2] and K. A. Alexander[1,3]

*2013*

**Comparing mongoose and humans resistance patterns**




**Very similar!**

# Increased contact - Human and Mongoose exchange microorganisms- increased disease transmission potential

Molecular Genetic Techniques REP–PCR, MLST

*E. coli* isolated from human (red) and mongoose (blue) in townships and associated national park (AMOVA Fst-.00247)

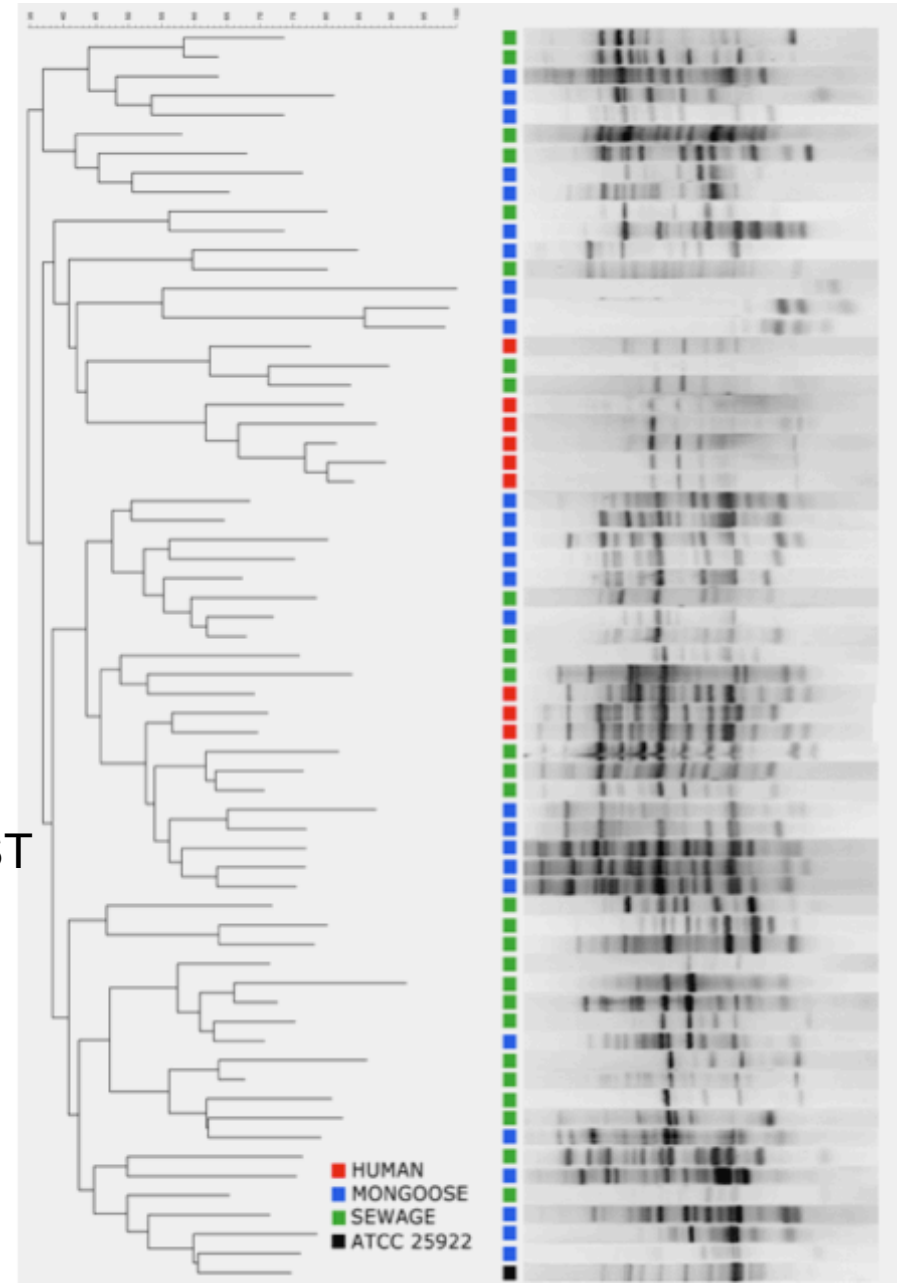



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Figure -Neighbor-joining method (Pearson's product-moment correlation) generated from a distance matrix based on electrophoretic data derived from Rep-PCR genomic fingerprinting.

Study Identifies:

1. Multidrug Resistance in mongoose greatest in the National Park.
2. Evidence of increased microorganism exchange between humans and wildlife.

**Human impacts to biodiversity can be large even in protected areas at low population density**

**Increases in exposure to antibiotic resistance and disease transmission potential - increased public health threat!**

# Model Simulation of Hydrological Dynamics

## Hydrological Simulation Program – FORTRAN (HSPF)

**Allow us to understand how water moves through the system connecting humans and animals their microorganisms- Acceptable Limits of Change (TDL)**

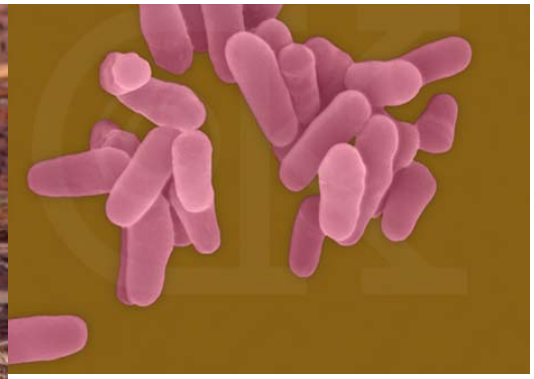
EMERGING INFECTIOUS DISEASES®

Emerg Infect Dis. 2010 August; 16(8): 1296–1299.
doi: 10.3201/eid1608.100314

PMCID: PMC3298296

# Novel *Mycobacterium tuberculosis* Complex Pathogen, *M. mungi*

Kathleen A. Alexander,[✉] Pete N. Laver, Anita L. Michel, Mark Williams, Paul D. van Helden, Robin M. Warren, and Nicolaas C. Gey van Pittius



**Closely related to Human TB**

It has been nearly two decades since an organism been identified in the Mtb Complex, the majority having been discovered in the early and mid-20th century.

# Ecosystem health and biodiversity – human waste impacts, feedbacks, and risk

**Human waste and degradation of environment can increase density, aggression, and injury among wildlife – Mongoose and increased transmission of the novel TB pathogen (*M. mungi*) in association with human waste.**

## Potentially increasing human and animal exposure risk

Fairbanks, B., Hawley, D., and KA Alexander, 2013. Do not feed the wildlife: behavior and disease consequences of foraging in garbage for banded mongoose.

*Jobbins, Sanderson, and Alexander, Zoonoses and Public Health, 2013. Accepted*

# Leptospirosis

- Globally important zoonotic pathogen, often in areas of poverty and poor sanitation.
- Animals (domestic and wild) act as reservoir hosts, humans can also contribute.
- Can be transmitted through urine contamination of the environment, bush meat, flooding and other climatic drivers


***42% of mongoose were positive (n=41)***
***NO CASES IN HUMANS (1974-203)***

Banded mongoose act as an important sentinel for assessing human and environmental health.

Human mediated changes to the environment and biodiversity increase contact between wildlife and humans and disease transmission potential.

OPEN ACCESS Freely available online

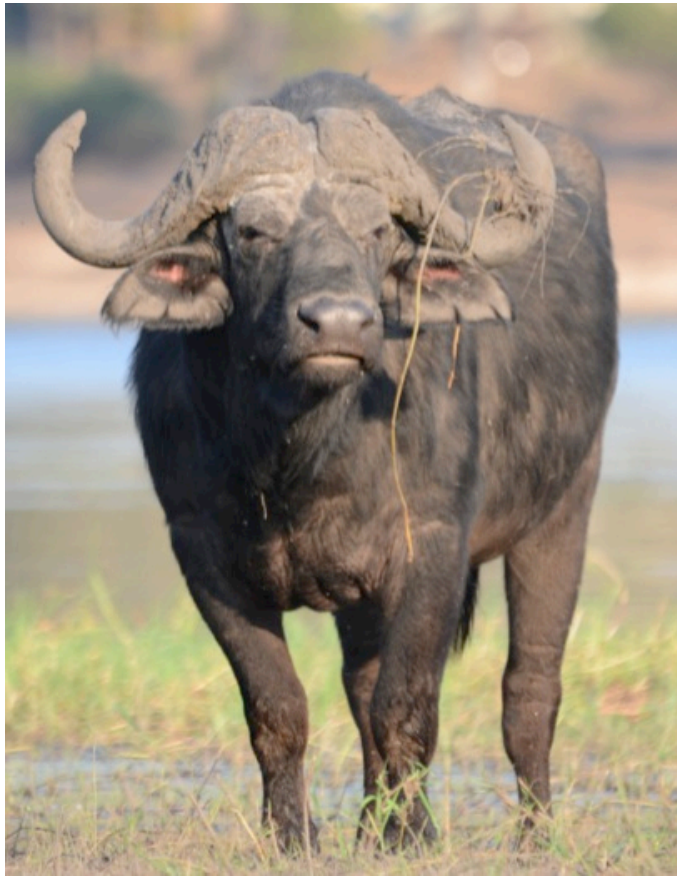
PLoS one

# Buffalo, Bush Meat, and the Zoonotic Threat of Brucellosis in Botswana

Kathleen Anne Alexander[1,2]*, Jason Kenna Blackburn[3,4], Mark Eric Vandewalle[2], Risa Pesapane[1], Eddie Kekgonne Baipoledi[5], Phil H. Elzer[6]

Samples screened with the Rose Bengal Test (RBT) and fluorescence polarization assay (FPA):

*buffalo (247), bushbuck (1), eland (5), elephant (25), gemsbok (1), giraffe (9), hartebeest (12), impala (171), kudu (27), red lechwe (10), reedbuck (1), rhino (2), springbok (5), steenbok (2), warthog (24), waterbuck (1), wildebeest (33), honey badger (1), lion (43), and zebra (21).*

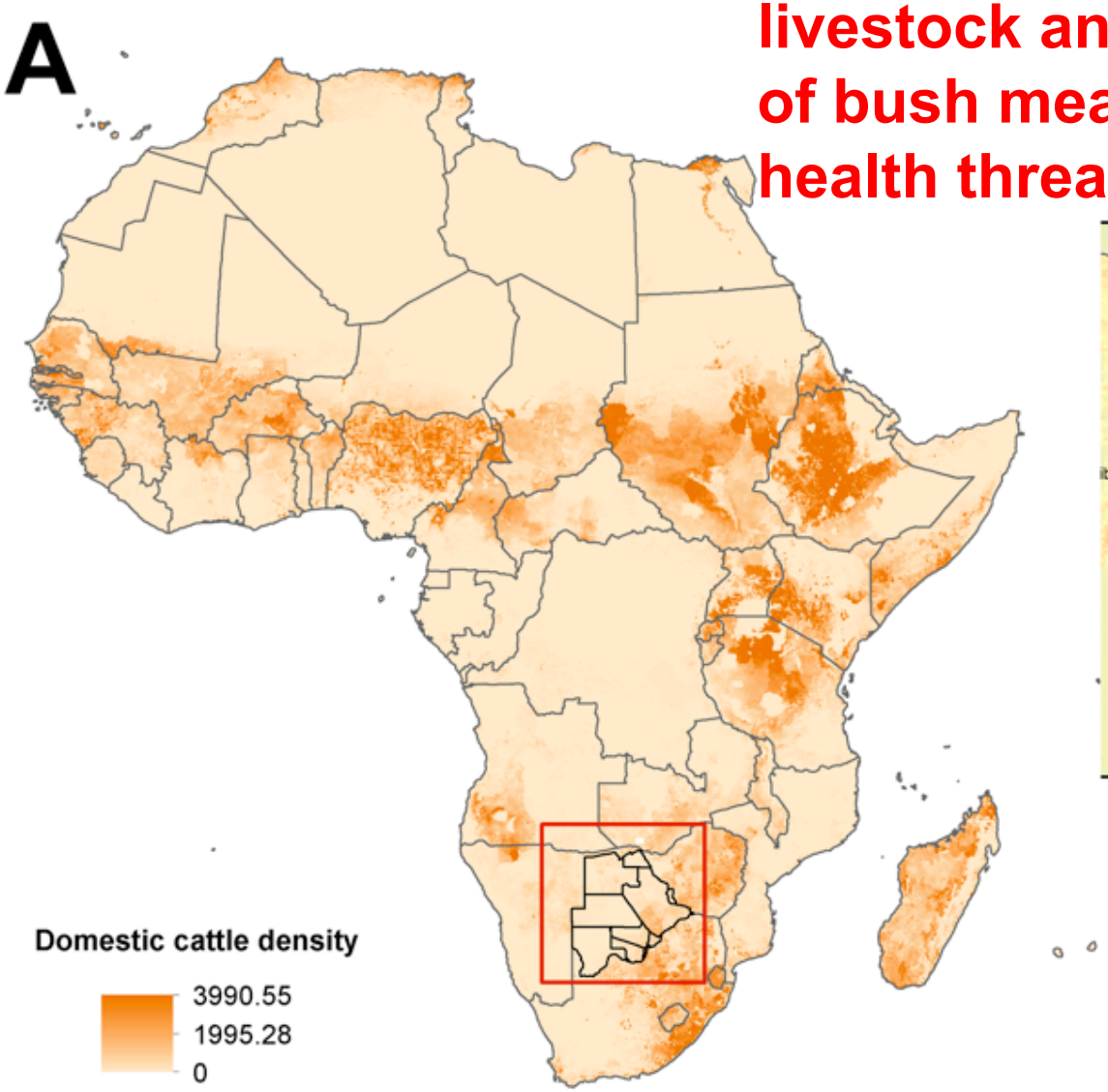


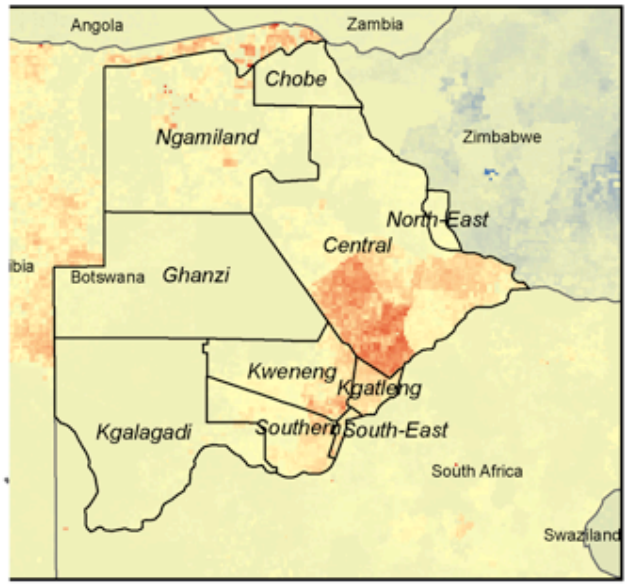
- 6% of buffalo (n=247) and 11% of giraffe (n=9) were positive

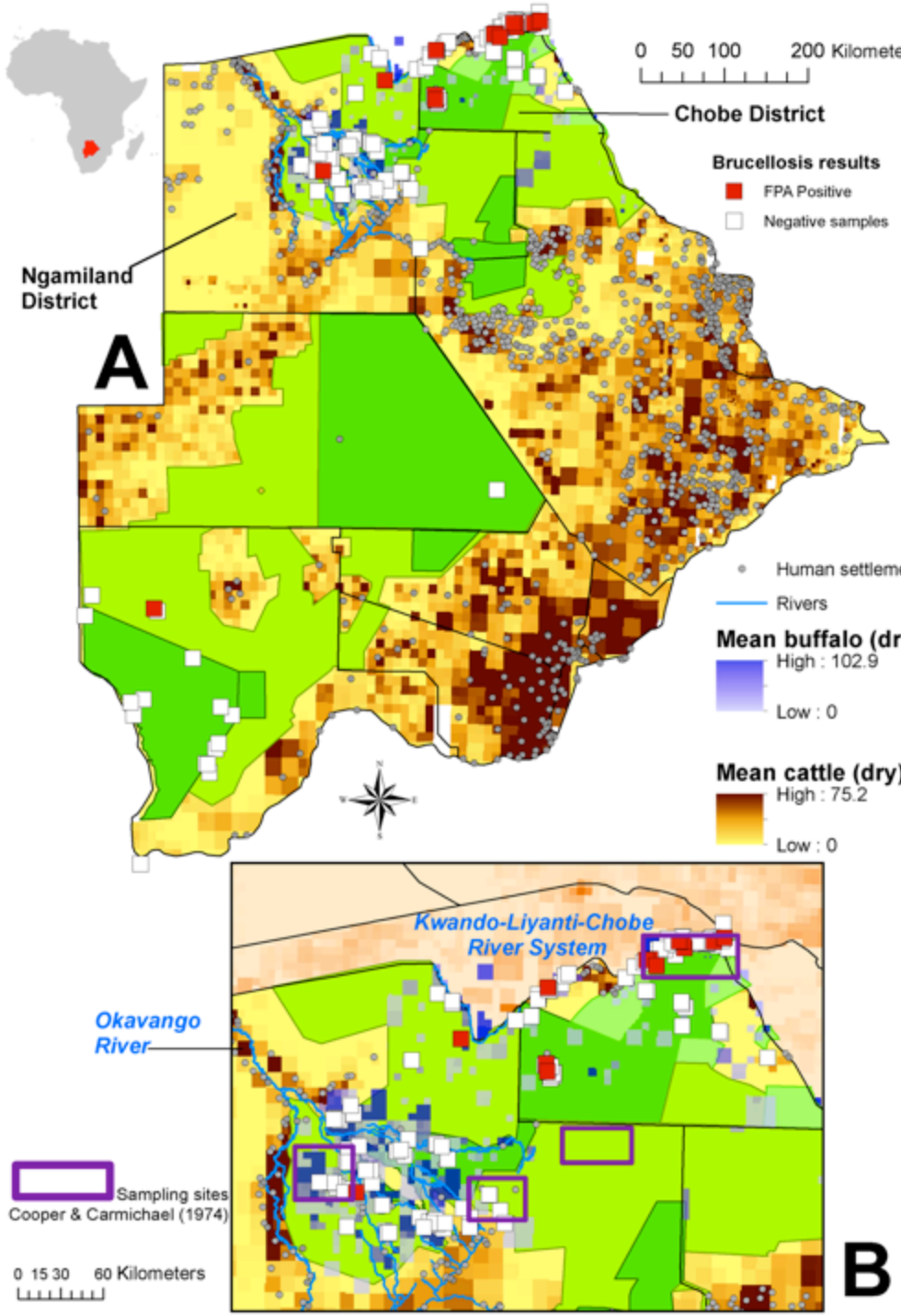
- Human cases (n=37) reported from 1974-2006, likely underestimated- difficult to diagnose.

**Growing cattle populations (exception Zimbabwe),landscape changes, increased contact between cattle and wildlife and transmission**
**- few true reservoirs of brucellosis, outside of cattle, identified.**

**Increased contact between livestock and wildlife & human use of bush meat can increase public health threats**





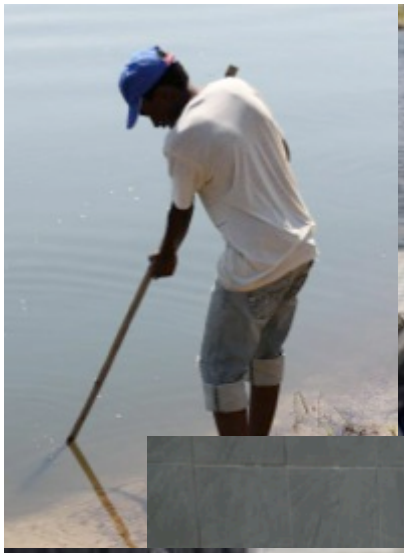

- Transforming ecosystems, increasing livestock-wildlife interface;
- Buffalo are a preferred species for bush meat;
- Cultural practices of bush meat processing might change patterns of exposure and infection risk;
- Diagnosis difficult, Malaria?

# Biodiversity and ecosystem services influence human health!

Bill Gates Foundation

**Sustainably managing our biodiversity resources can save money, lives, and reduce public health threats.**

# Special thanks to the team!




# Financial Support




For more information contact:
K.A. Alexander – kathyalx@vt.edu

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