Persistence of Rift Valley fever virus in East Africa

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Rift Valley fever (RVF) – the disease

RVF – description & occurrence

Hosts – Sheep, goats, cattle,

Vectors – mosquitoes *Aedes*, *Culex*, *Anopheles* spp, etc

Impacts: zoonosis, livelihoods, trade

The problem

- RVF epi-system components -> hosts, vectors, environment, socio-economic aspects
- RVF epi-system components highly heterogeneous --> interactions -> complexity
- Interactions - profound effects on transmission
- E.A. – 2 (interconnected?) transmission cycles

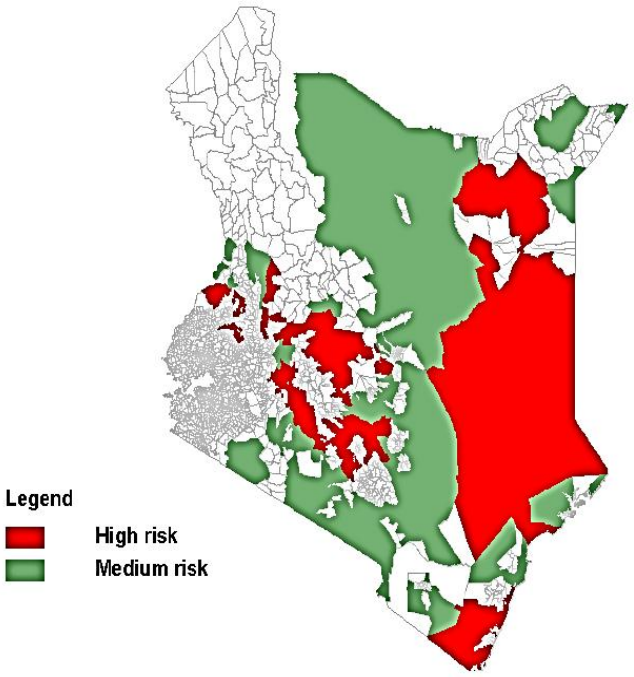
The bigger problem

Where is the virus between the outbreaks?

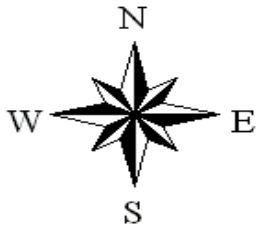
Aedes mechanism

Sylvatic/endemic – epidemic link

Understanding the persistence question



Source: Centers for Disease Control



- Part of a broader aim – to dissect the mechanistic complexity of RVF epi-system
- Model - a spatially-explicit stochastic simulation model
- Predict risk & impacts of RVF occurrence in NE Kenya
- Interventions

RVF model structure – on-going

- A hybrid 2-host individual-based & 2-vector difference equation-based (discrete) model

- Model is based upon:
  - *Grid cell framework supporting host movements, vector static subpopulations, vector breeding sites, precipitation*
  - *Host and vector population dynamics*
  - *RVF virus transmission*

- Outcome – disease incidence in hosts & vectors

Model variables and initialization

- Grid dimension
- Vector breeding sites
- Vectors:
  - *Aedes* eggs
  - *Culex* eggs
- Rain
- Herds (cattle)
- Flocks (sheep)
- Host movements
- Time step
- Time Horizon

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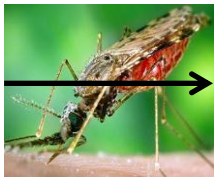
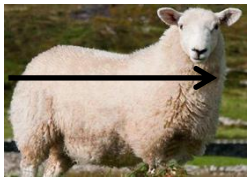
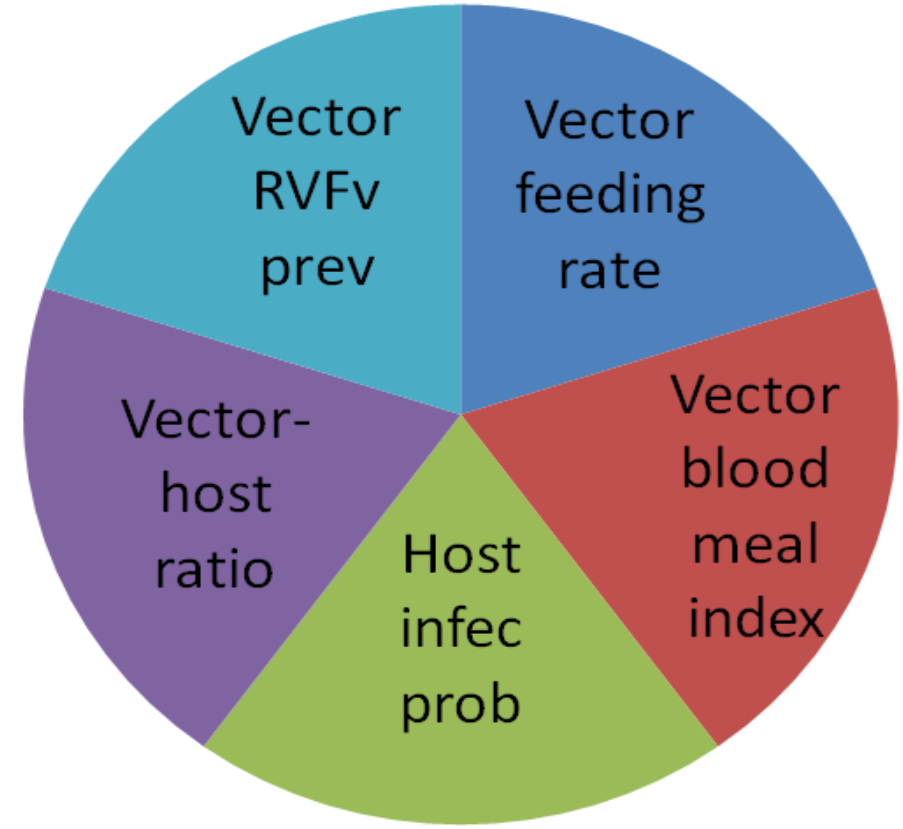
RVFv transmission in the model

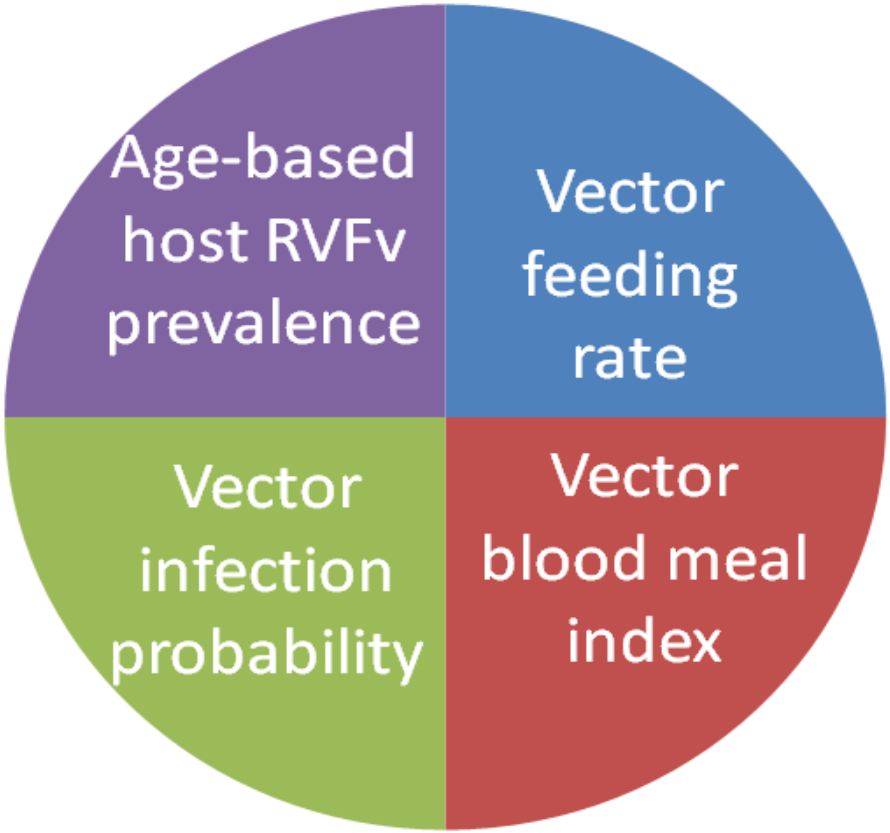
Daily vector to host transmission potential







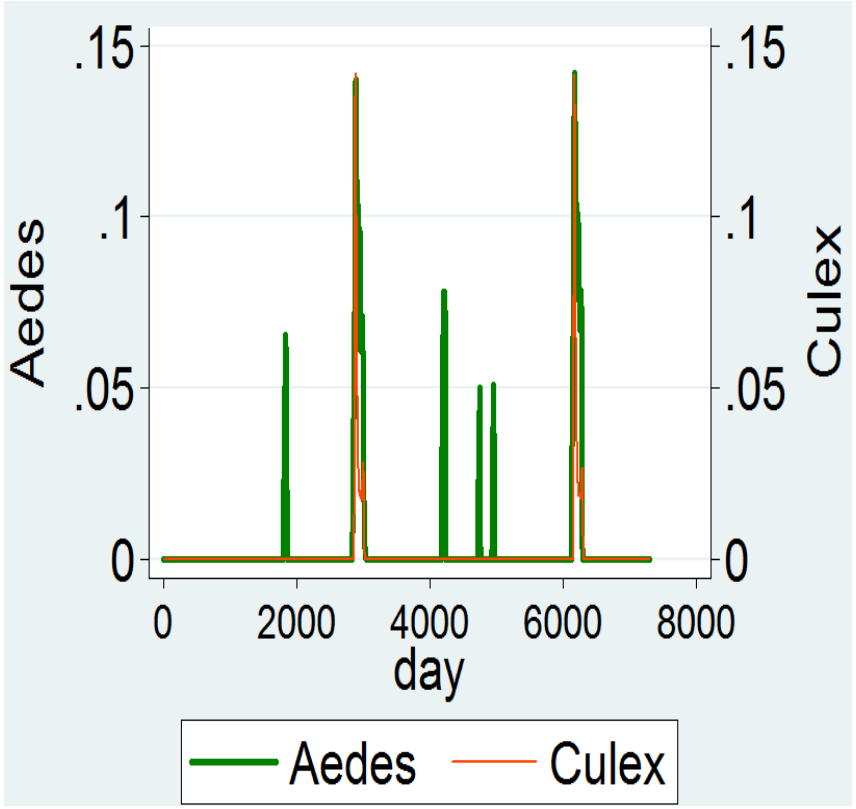
Daily host to vector transmission potential



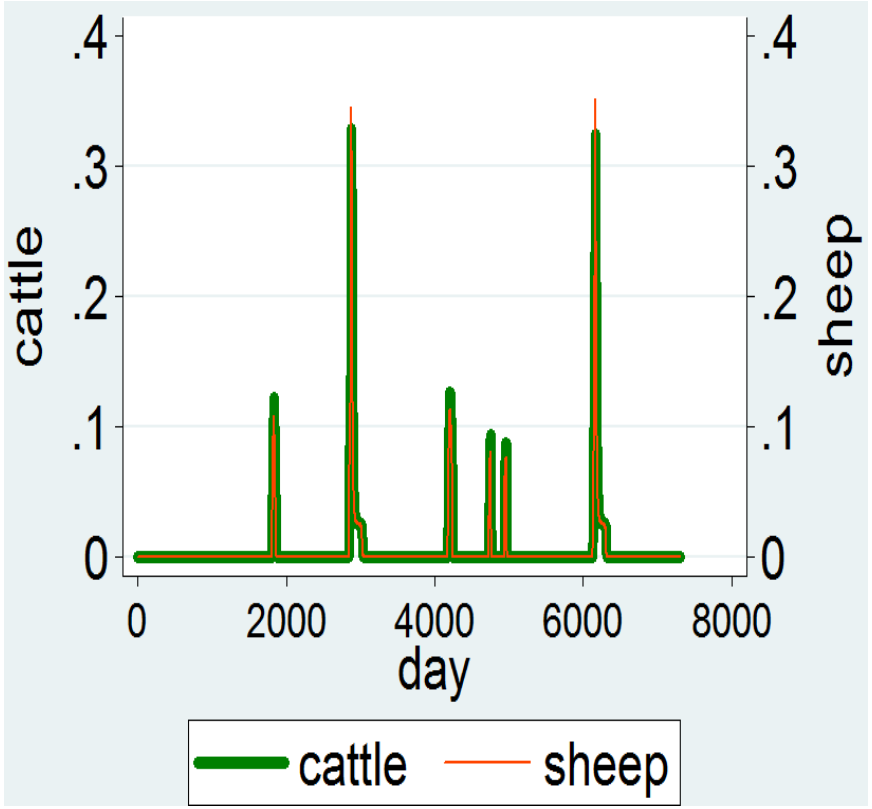
Model analysis

Mean RVFv incidence averaged over 250 simulations

Vectors



Hosts



Unravelling the persistence question

Where is the virus between outbreaks?

Aedes mechanism

Sylvatic-epidemic cycle

Seed the system: Aedes & Culex eggs

Shut down all rain

Vary daily natural mortality risk in eggs

1 – 30 years

Shut down Aedes mechanism

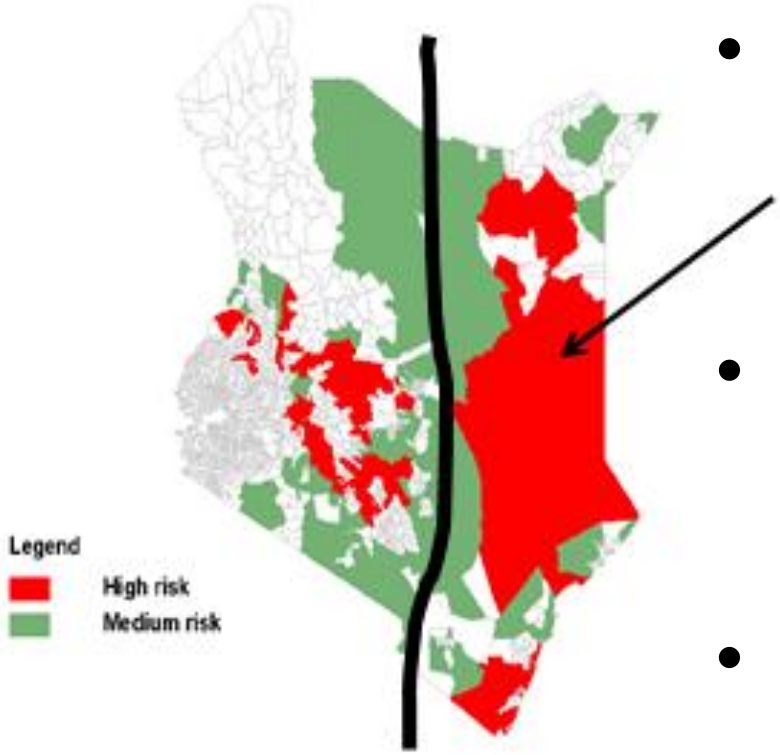
Randomly introduce viraemic hosts in different herd sizes at different timings before flooding

Scenario 1: *Aedes* mechanism

Aedes eggs surviving drought

Daily natural mortality risk	Outbreak after 5 years?
30 years	Yes
25 years	Yes
20 years	Yes
15 years	Yes
10 years	Yes
5 years	Yes
4 years	No
3 years	No
2 years	No
1 year	No

Aedes RVFv reservoir mechanism



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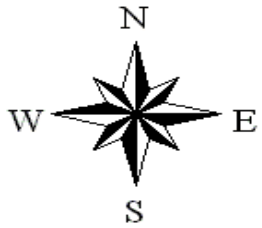
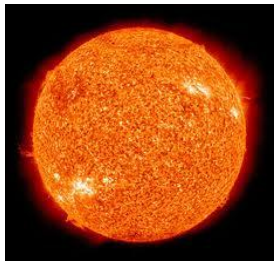


- Eastern part *always* experience outbreaks
- Is it the *Aedes* mechanism at play??
- Real outbreak intervals could be longer than 4-5 years
- Seasonal rains may seed "*fresh*" eggs

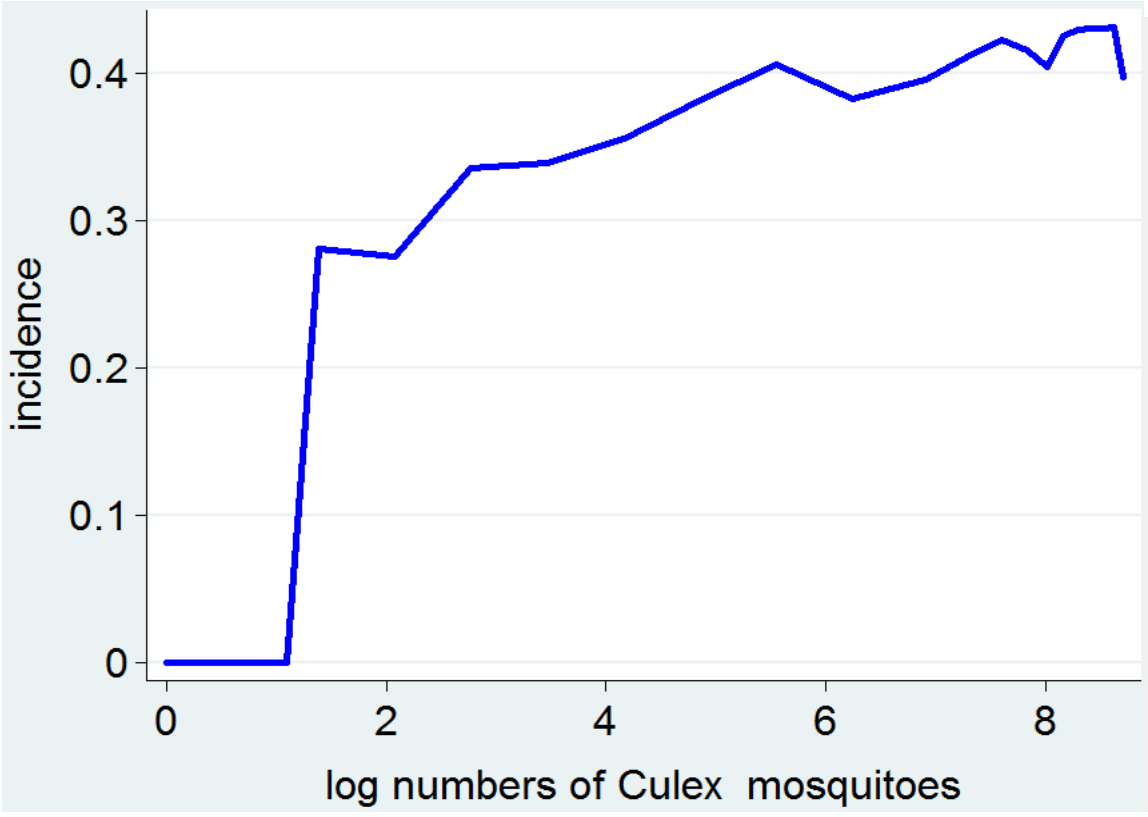
Scenario 2: Sylvatic-epidemic cycle



Mainland

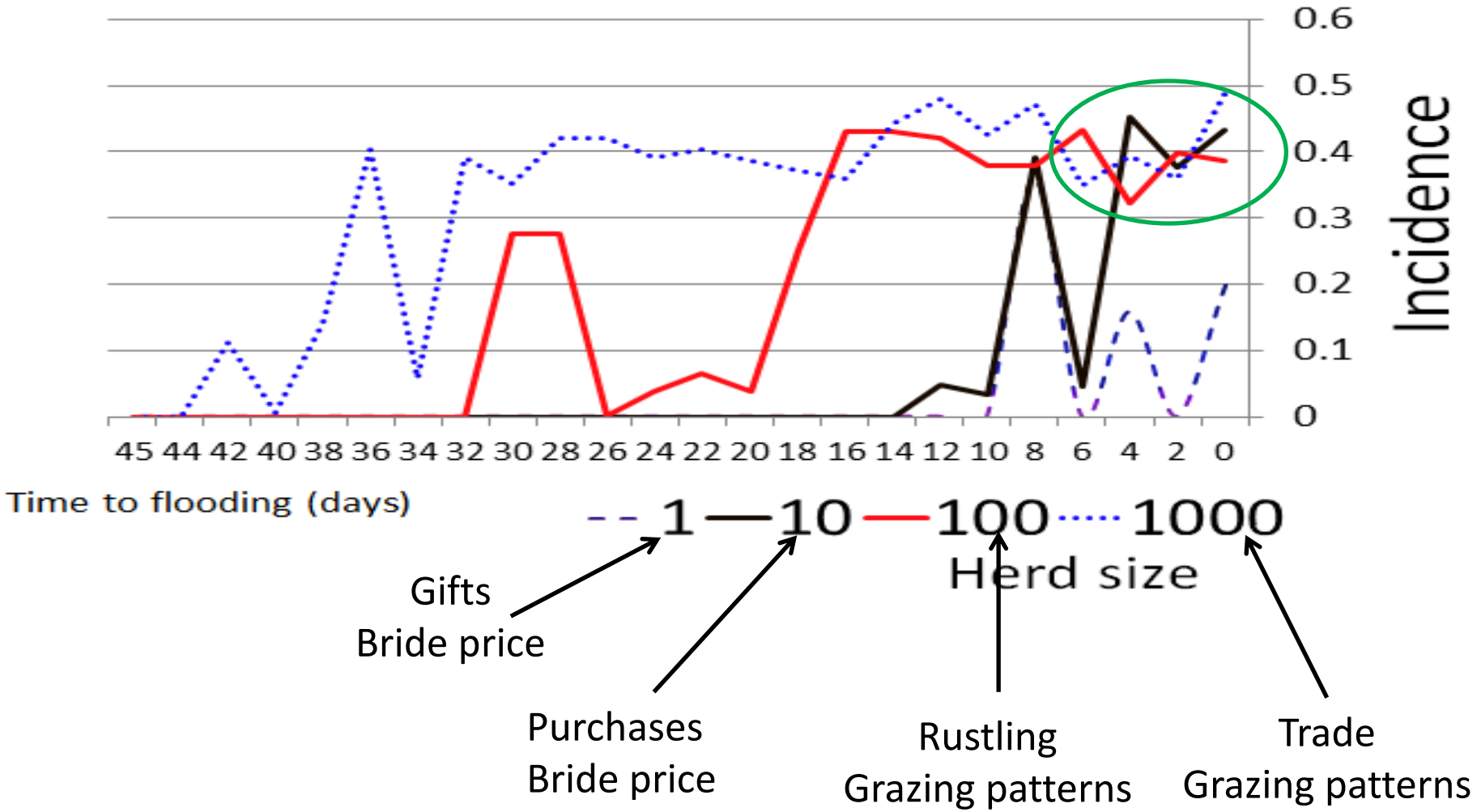
Epidemic

Wet season grazing



Suppose a viraemic sylvatic herd decides to pay a visit at the mainland…

but at different timings before flooding…



Conclusions

- Model outcomes reflects what could be going on in different parts of the region

Applications

- Integrate more mechanisms in the model
- Guide field data collection
- Assess control interventions
- Building capacity amongst communities in EWs
- Ways of integrating with climate models
- Further refining the model

Acknowledgements

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Thank you all