



# Modeling Animal Movement to Help Control PPR

## Update and Information Needs

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- **Problem**
- **How model results can help design controls**
- **Model outline - Processes**
- **Alternative control processes**
- **Example results from the model as it is**
- **Information needs**
  - **How some key processes work**
  - **Times and quantities**
  - **Control option specifics**
  - **Characteristics of diseases with similar symptoms**

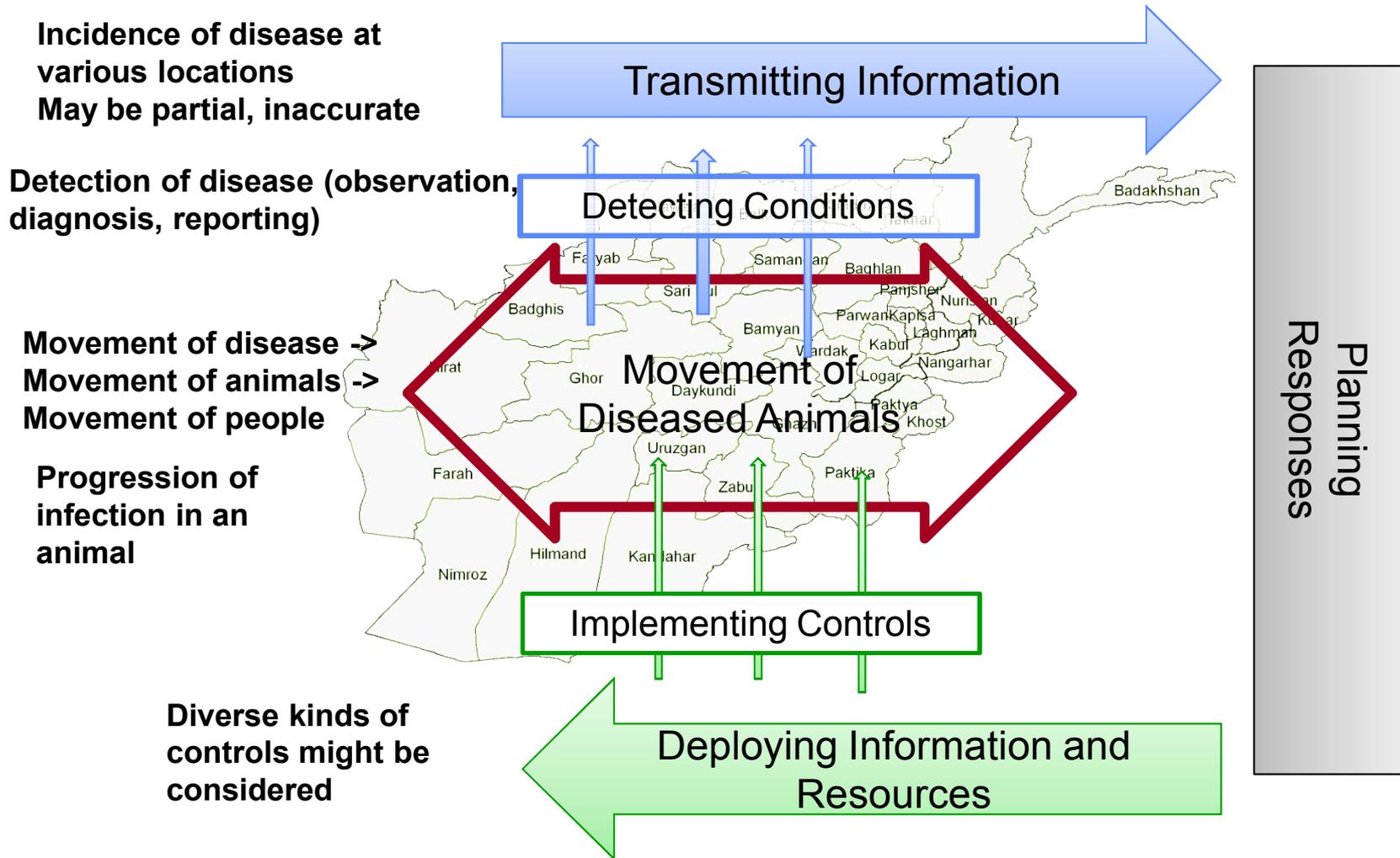
# Characteristics of the system

- **Information about incidence of infection is hard to obtain and communicate to central institutions**
- **Diagnostic criteria might be hard to satisfy – how useful could partial or uncertain information be?**
- **Resources for intervening are scarce, badly distributed, and hard to deploy and apply**

# Possible Controls

- **Will need to be modeled themselves (rather than taken for granted) because of the special logistical difficulties in Afghanistan**
- **Possible kinds of controls:**
  - **Vaccination**
  - **Quarantine?**
  - **Culling? (as a control dynamic for the model, at least)?**
- **Constraints on administering controls that may constrain selection of a response**
  - **Communication of decisions**
  - **Compliance**
  - **Movement of required resources (vaccines, personnel, etc.)**

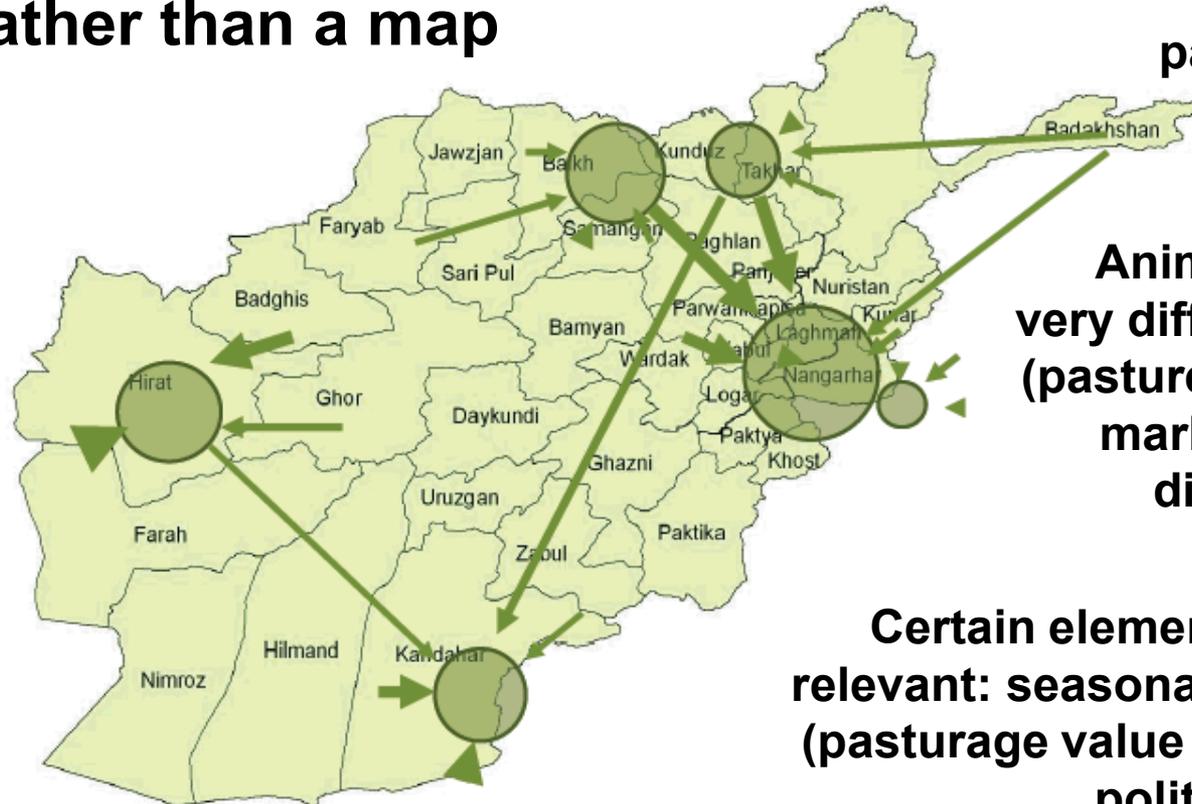
# Modeled Processes



# Model Structure - I

Space is described by a *network* rather than a map

Cultural practices and economics interact with geography to shape patterns of movement.



Animals are moved between very different kinds of locations (pasture, village markets, major markets). These create very different opportunities for disease transmission.

Certain elements of geography are relevant: seasonality, security, terrain, (pasturage value and transportability) political/tribal affiliations

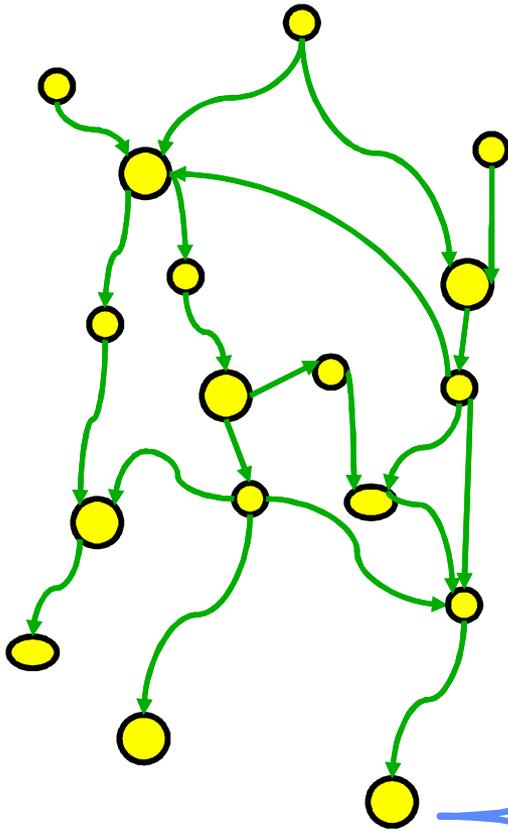
From Afghanistan PEACE Project's *Afghanistan Livestock Market Assessment Report on Afghanistan Livestock Market Dynamics October 2008 – October 2009*  
Dr. Catherine A. Schloeder and Dr Michael J. Jacobs

# Model Structure - II

## Network elements

- Nodes are locations where animals stay for significant periods (e.g. pasture, villages) or change condition (e.g. markets, butchers)
- Links are pathways between nodes. Animals' conditions might change as they move along links

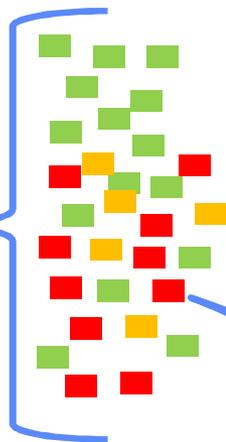
**People and animals move on the network**



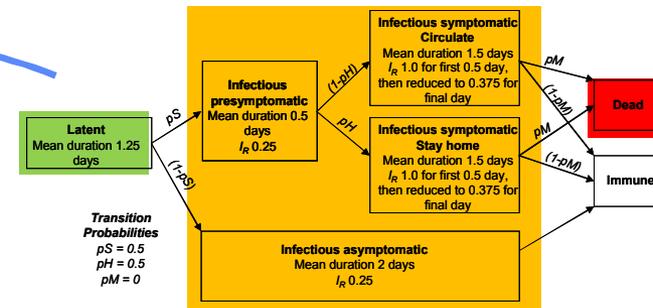
## System state

- Number of animals in different disease states at each location
- Individual (representative) animals are modeled in different stages of disease.

**Disease moves through populations at locations**



Transmission events depend on disease stage, animal density, location, access to treatment

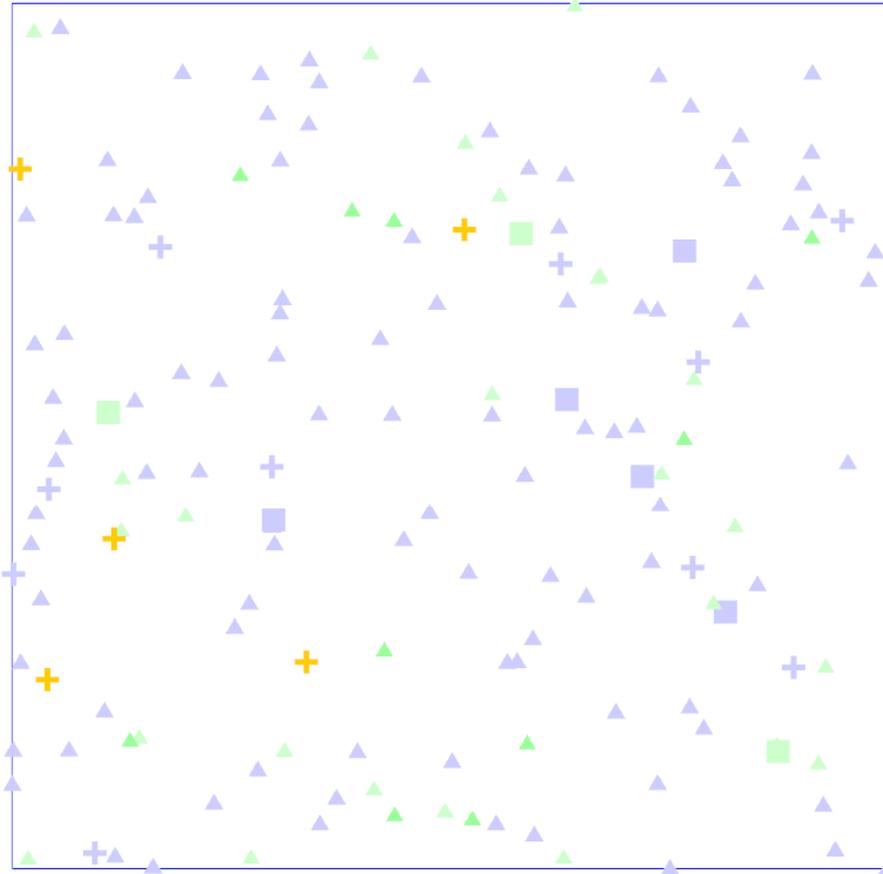


**Disease progresses within animals**

- Information about incidence is partial and may be inaccurate. Modeling imperfections and delays in monitoring the system allows to design control measures that will work in the real environment.
- Many features of the modeled system are uncertain (disease characteristics, nomadic patterns, cross-border interactions). Including these uncertainties in policy evaluation, and using them to guide information collection, is a central part of the approach.

- We can use the model to compare alternative controls
- Basis of comparison
  - Number of dead animals
  - Amount of vaccine used
- Alternative controls
  - Mass vaccination
  - Syndromic vaccination
- Uncertainties
  - Effectiveness of vaccine
  - Presence of other diseases
  - Likelihood of exhibiting symptoms
  - Compliance
  - ??

# Example Outputs – Agent movement and behavior



Villager's herds, Kuchi herds, Veterinarians, and couriers move among pastures, camps, villages, and large markets

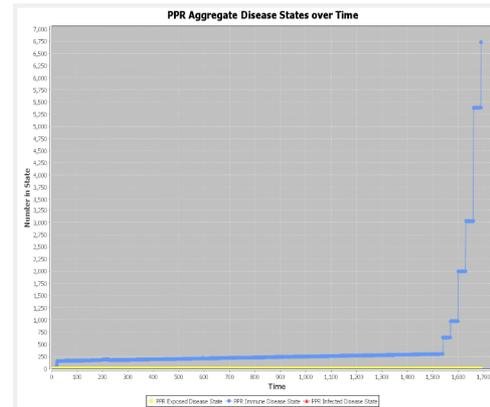
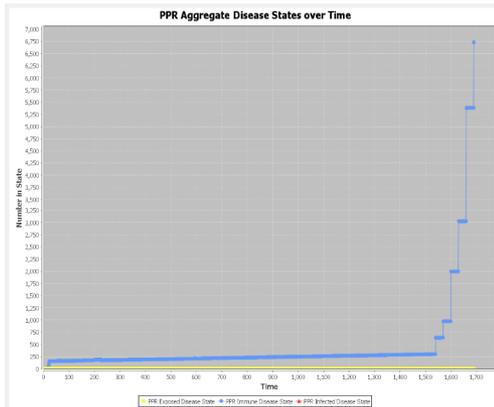
Veterinarians make rounds, administering vaccine according to the simulated strategy

# Example Outputs – Strategy performance

## Mass Vaccination

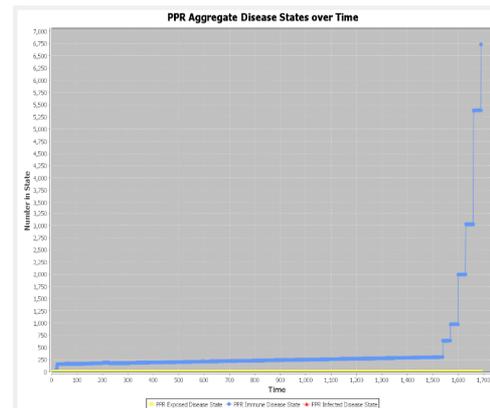
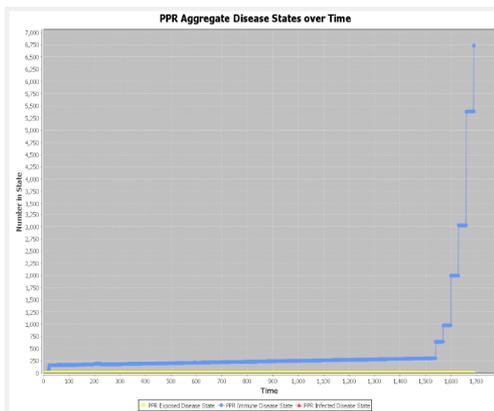
## Syndromic Vaccination

Fractional  
Loss to PPR

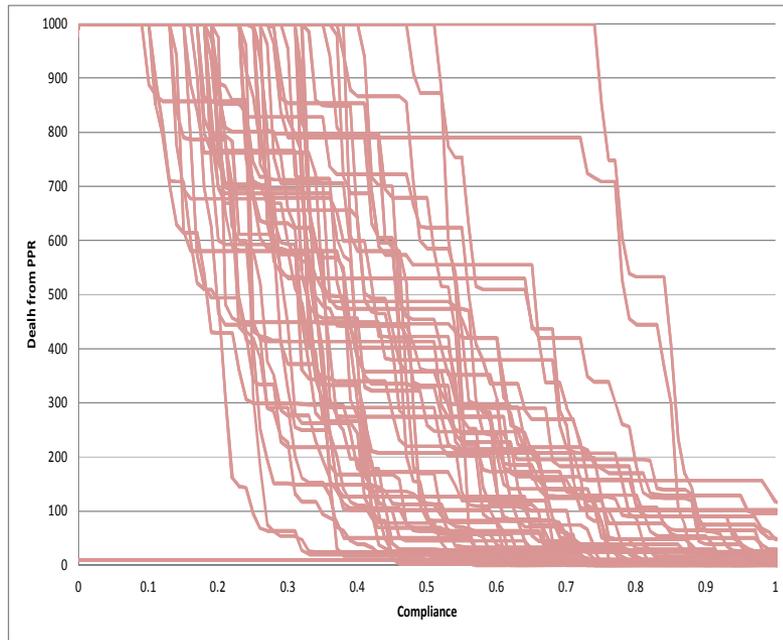


Uncertainty in  
parameters  
leads to many  
possible  
outcomes for  
each strategy

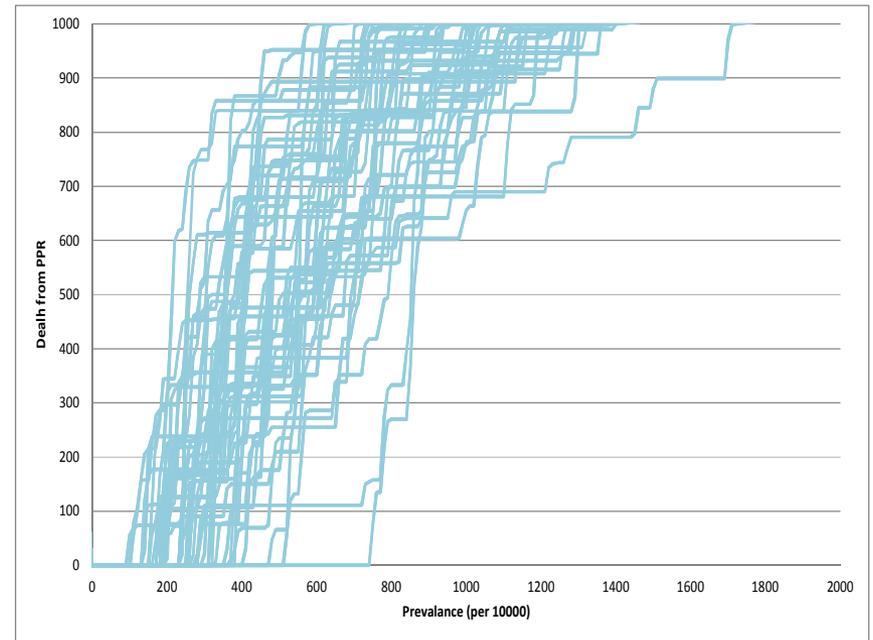
Doses  
Administered



# Example Outputs – Critical Values



Sensitivity to Compliance



Sensitivity to Prevalence of  
Confounding Disease

- **About Real-world conditions:**

- How often do veterinarians make their rounds?
- How many locations do they visit?
- How long does it take to distribute vaccine to the field?

- **About Controls**

- What fraction of migrating herds would avoid border inspections?
- Where might inspections be practically implemented?

- **About Diseases with Similar Symptoms**

- What are the characteristics of a representative respiratory infection with PPR-like symptoms?