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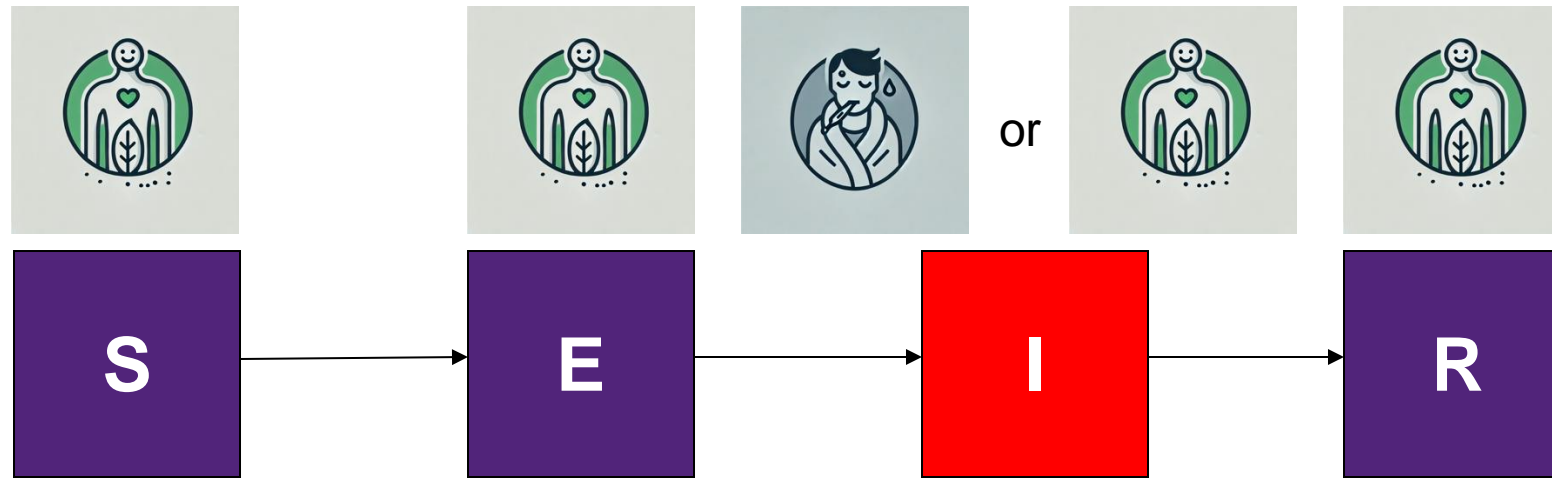
# Principios y aplicaciones del análisis de redes en la vigilancia y epidemiología de enfermedades infecciosas: ejemplos con influenza A en el Sudeste Asiático y China

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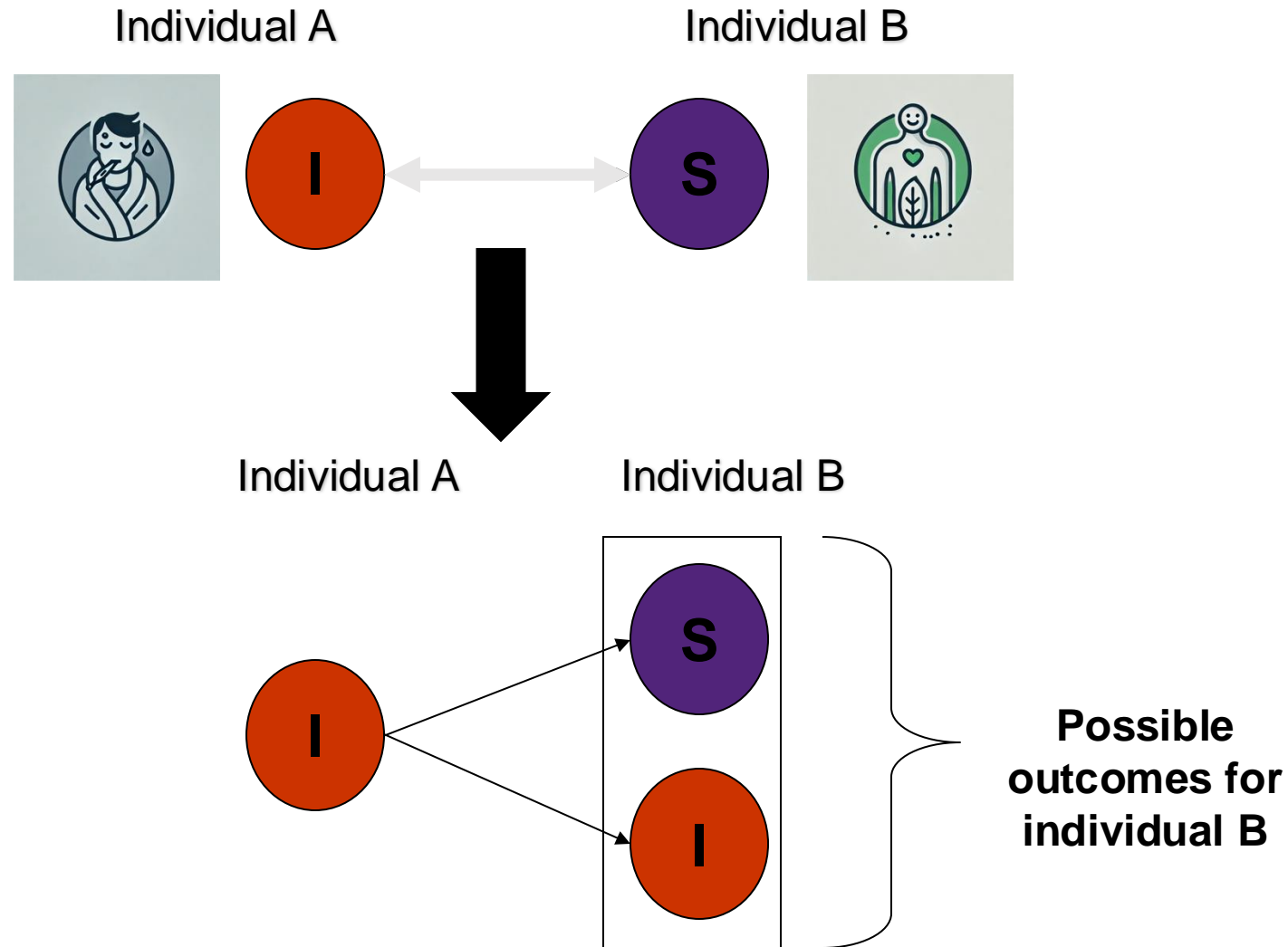


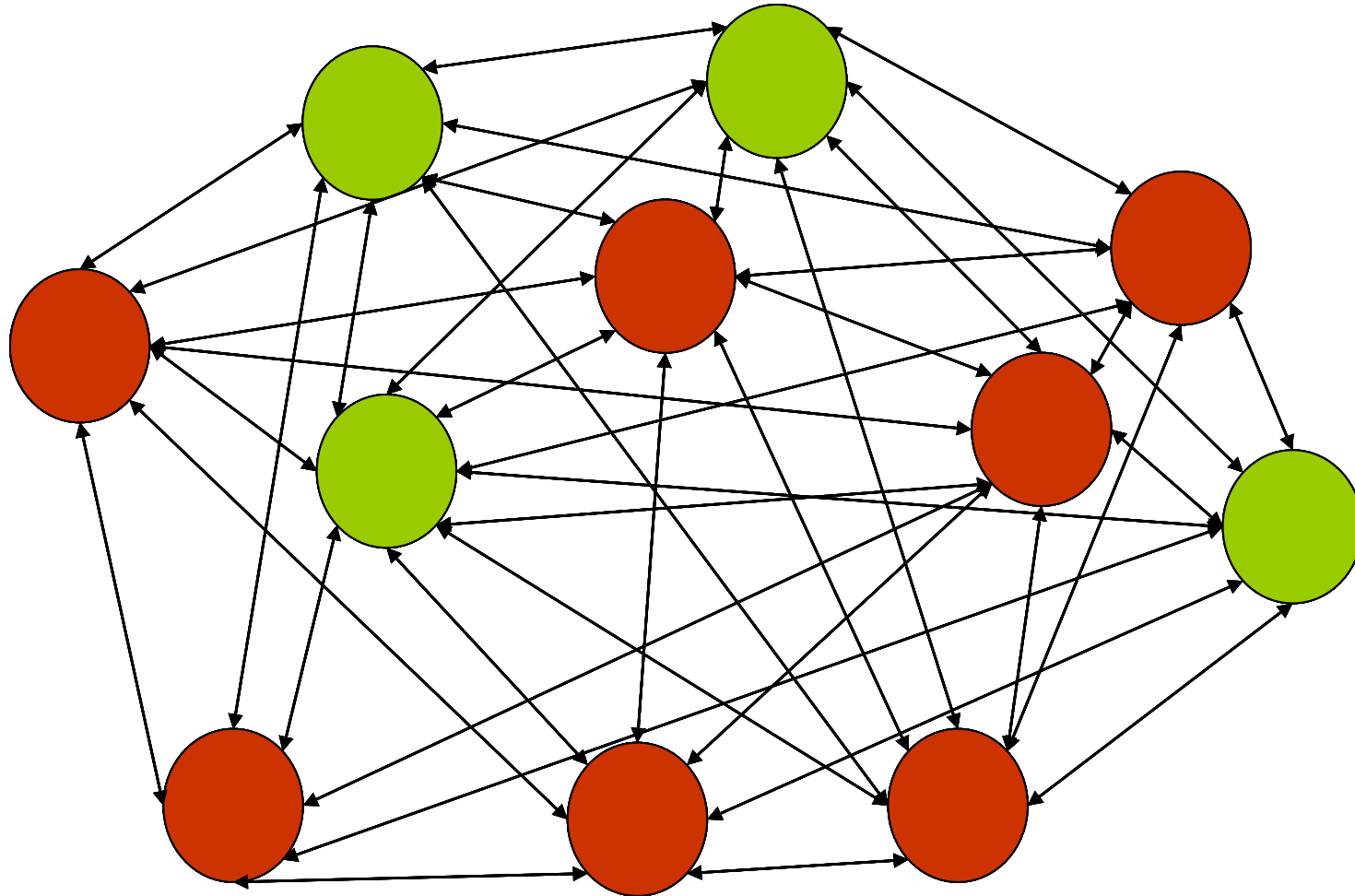
S – Susceptible

E – Exposed (infected)

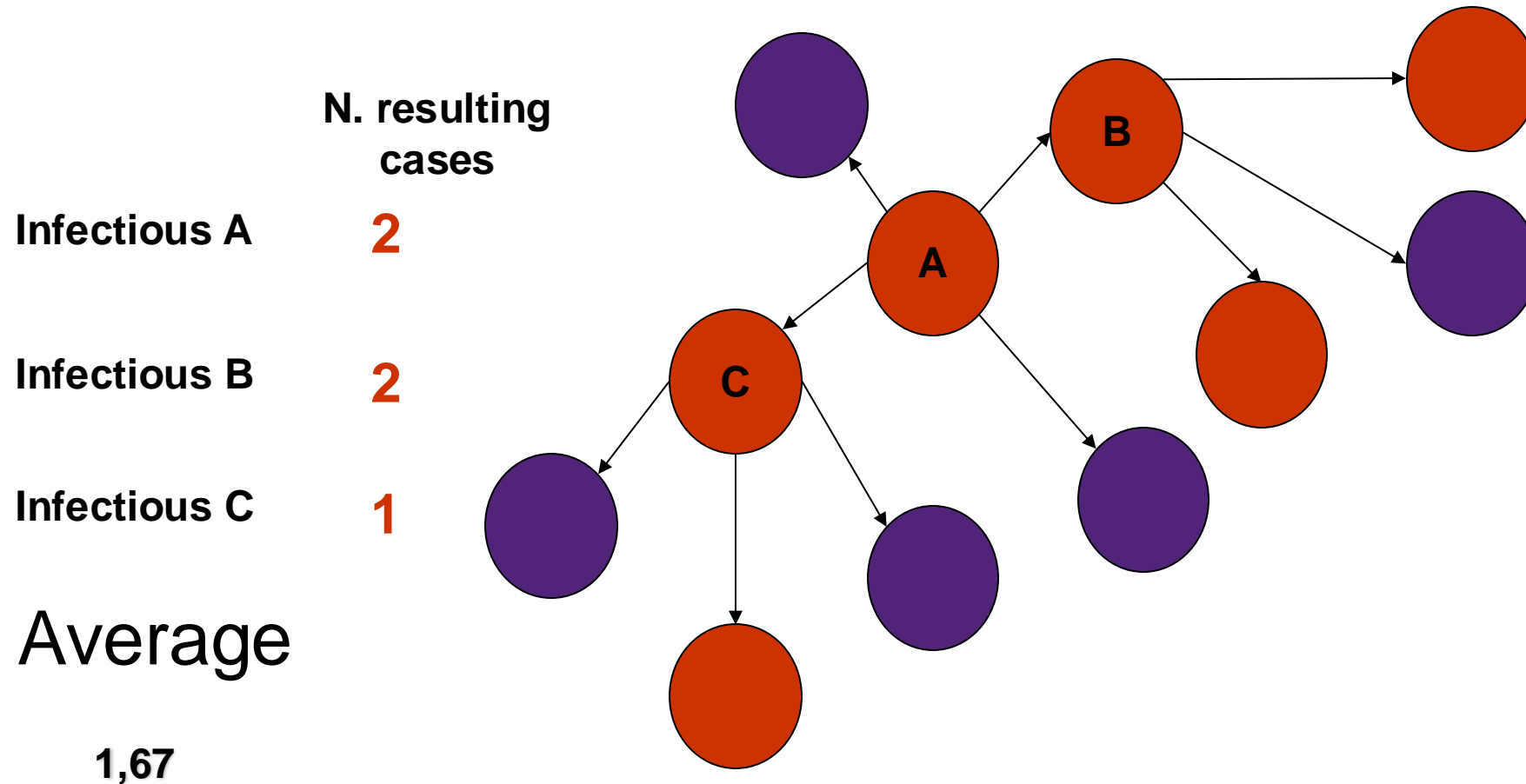
I – Infectious

R – Recovered (Immune)





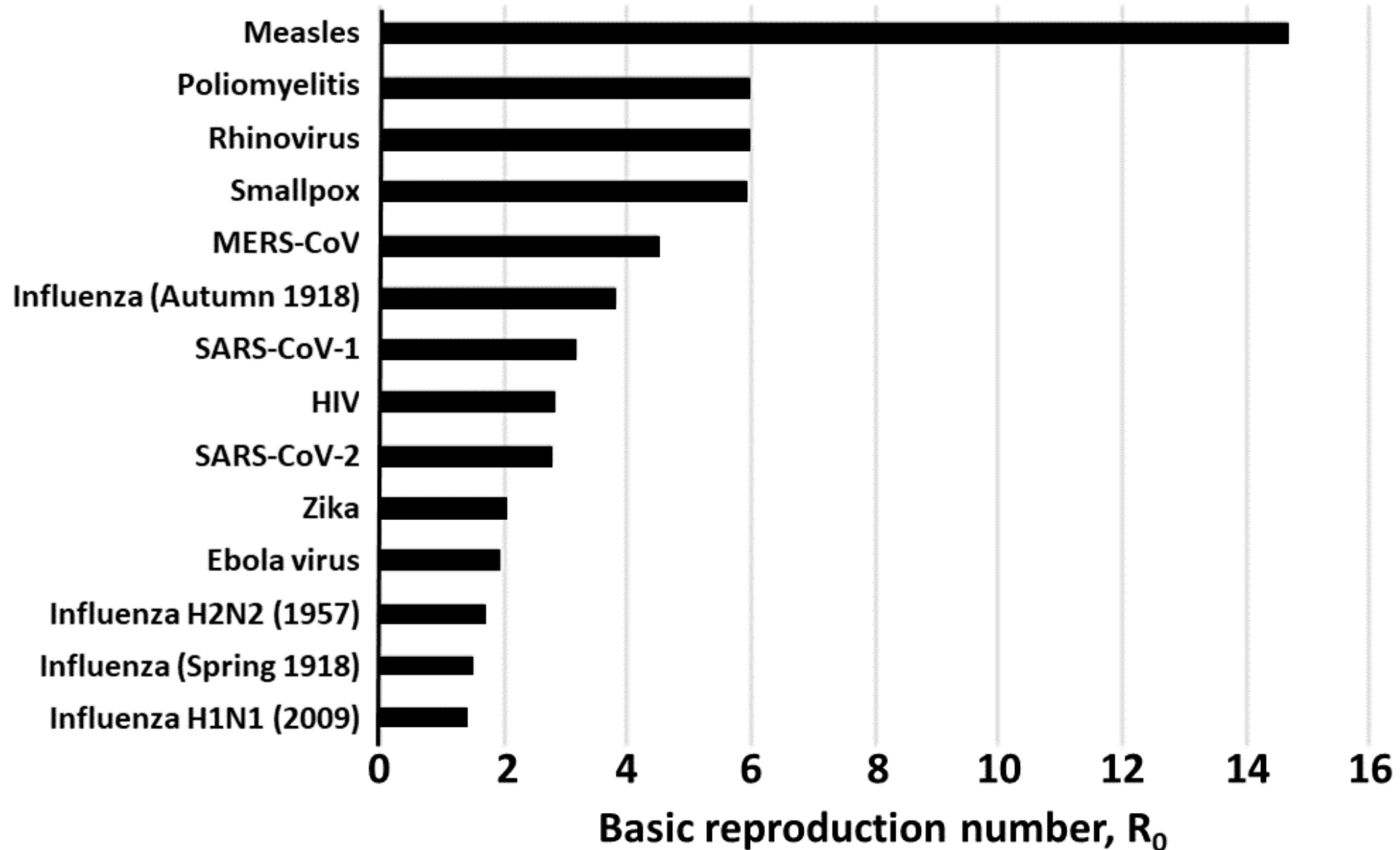
# ¿Cuál es el potencial de infección? – Tasa de reproducción ( $R_0$ )



## The threshold conditions for disease spread:

- Deterministic approach
  - $R=1$  (endemic situation)
  - $R<1$  – disease will not spread
  - $R>1$  – disease will spread
- Stochastic approach
  - $R<1$  – minor outbreaks may occur
  - $R>1$  – minor or major outbreak may occur
- Proportion of the population needed to be immunised to control transmission:
  - Herd immunity threshold =  $1 - (1/R_0)$

# R0 para enfermedades infecciosas seleccionadas



**Basic Reproductive ratio (R0)** - Average number of secondary infections produced by the introduction of an infectious case in a homogeneously mixing, totally susceptible population during its entire infectious period.

$$R_0 = \boxed{ecr} \times \left( \frac{1}{r} \right)$$

R0 is related to the number of individuals effectively contacted by per unit time (effective contact rate) and the duration of the infectious period.



- **The force of infection  $\lambda$**  is the probability for a susceptible host to acquire the infection.
- In a simple model with homogeneous “mixing”, it has 3 “factors”:

$$\lambda = m \times (I / N) \times t$$

- **$m$**  : “mixing” rate (contact pattern using contact networks)
- **$I / N$**  : proportion of contacts with infectious hosts

**Effective contact rate (ECR)**

- **$t$**  : probability of transmission of the infection once a contact is made between an infectious host and a susceptible host

→ **Number of new infections** =  $\lambda \times S$  (“catalytic model”)

## 01

A network consists of “units of interest” that may be “linked” in some way (or not!)

## 02

Units of interest are NODES

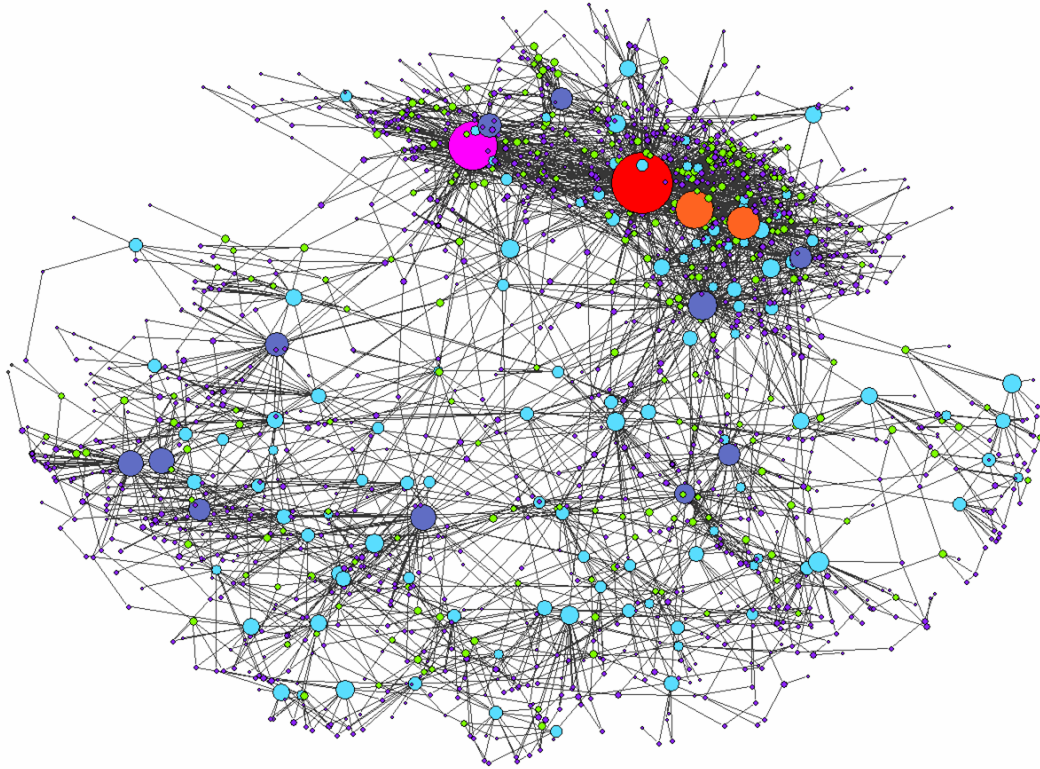
## 03

Links are EDGES and represent some form of “relationship”

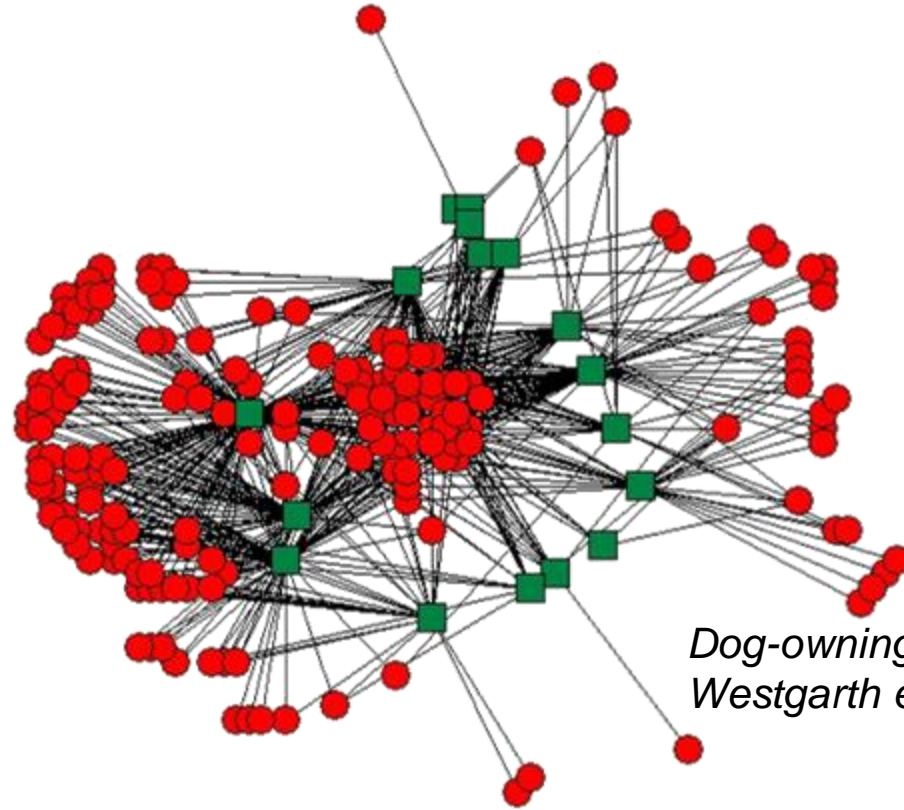
## 04

Each type of link defines a distinct network

- It may (or may not) be reasonable to amalgamate networks

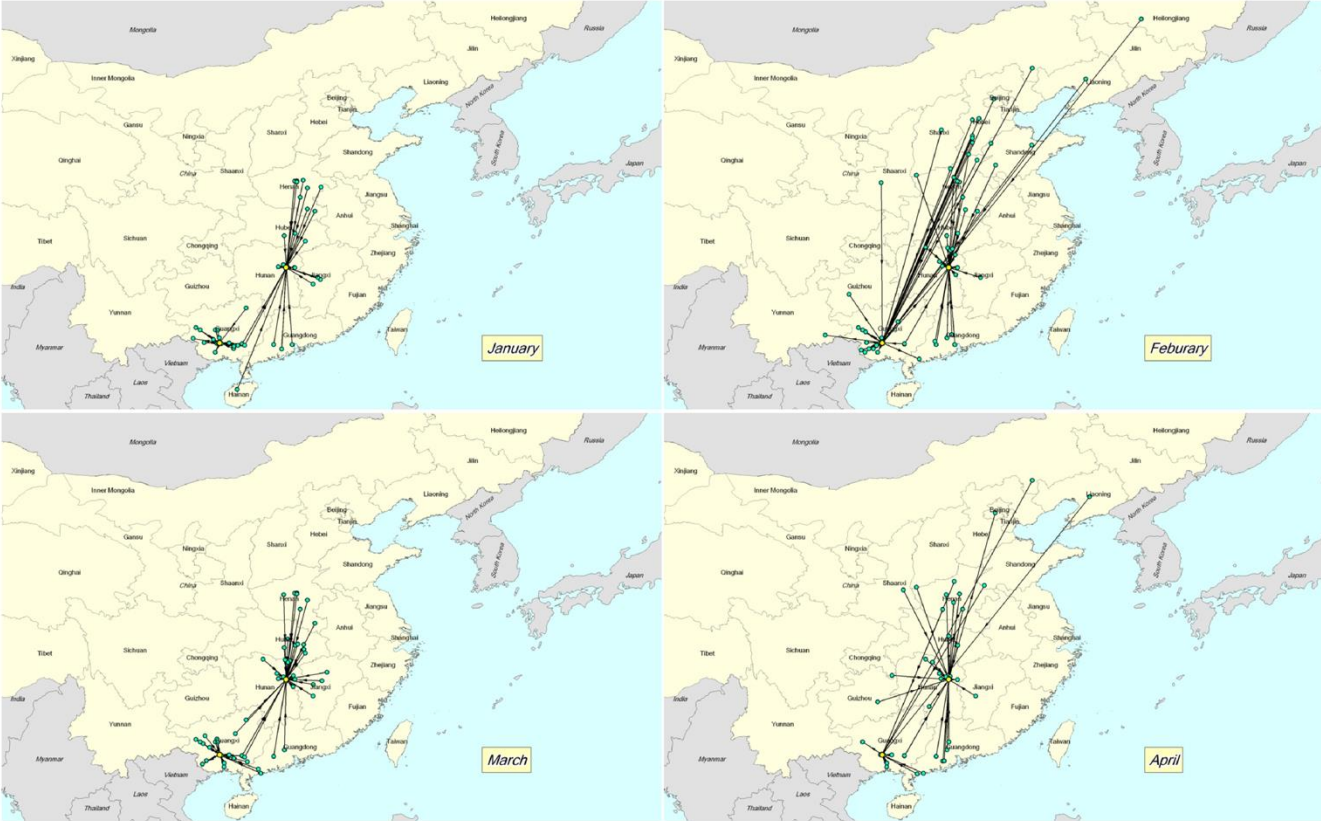
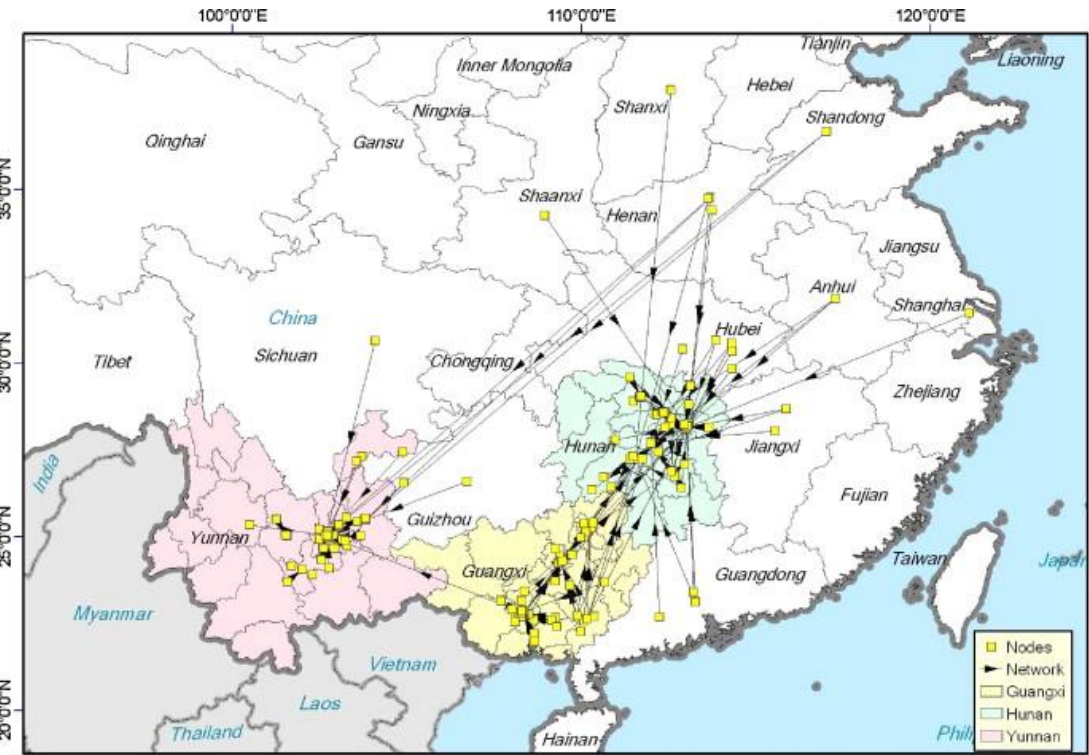


*Cattle movement, UK, Feb 2002*  
*Christley et al, SVEPM 2005*



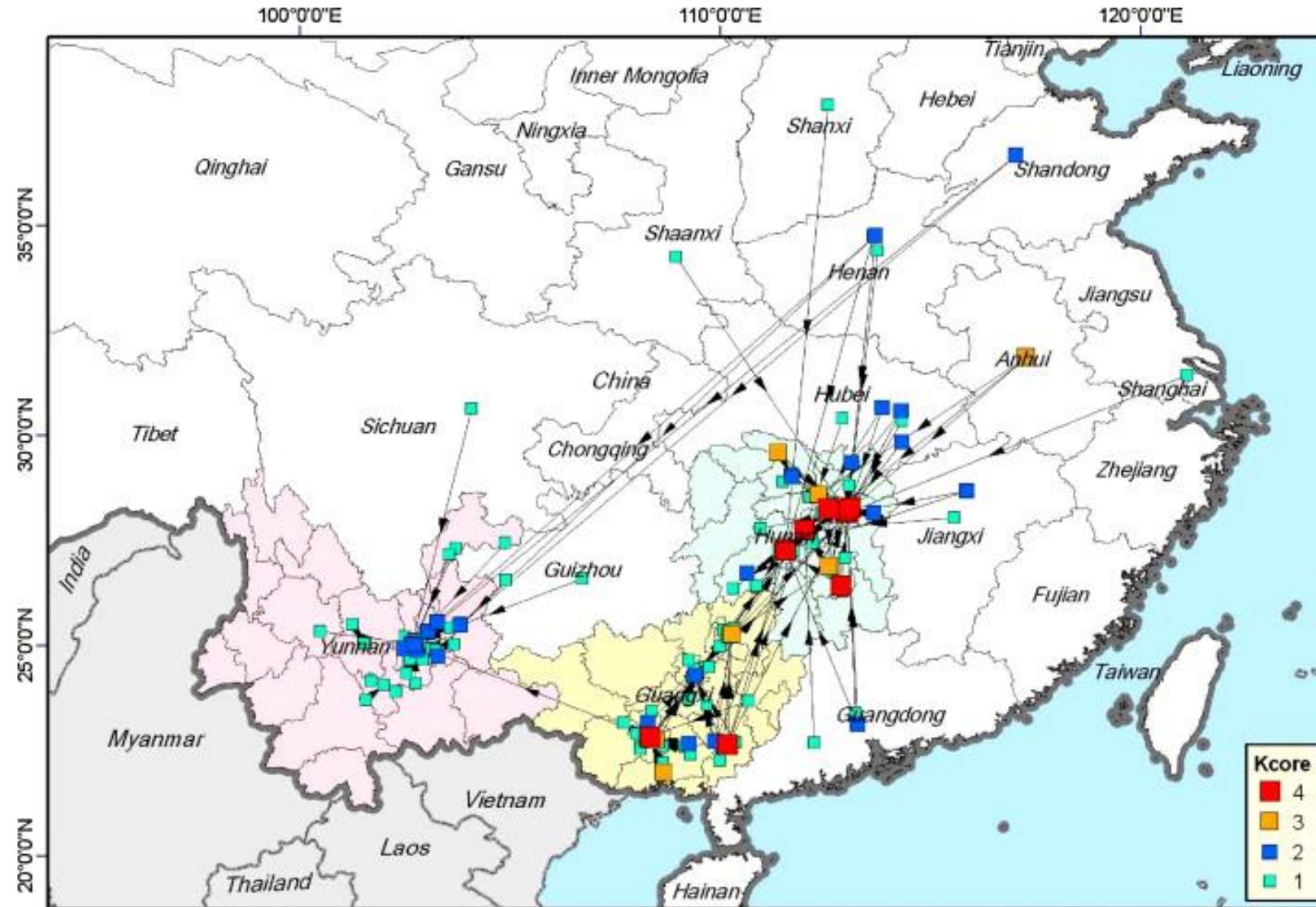
*Dog-owning households*  
*Westgarth et al, 2006*

# Redes de mercado de aves vivas en el sudeste de China

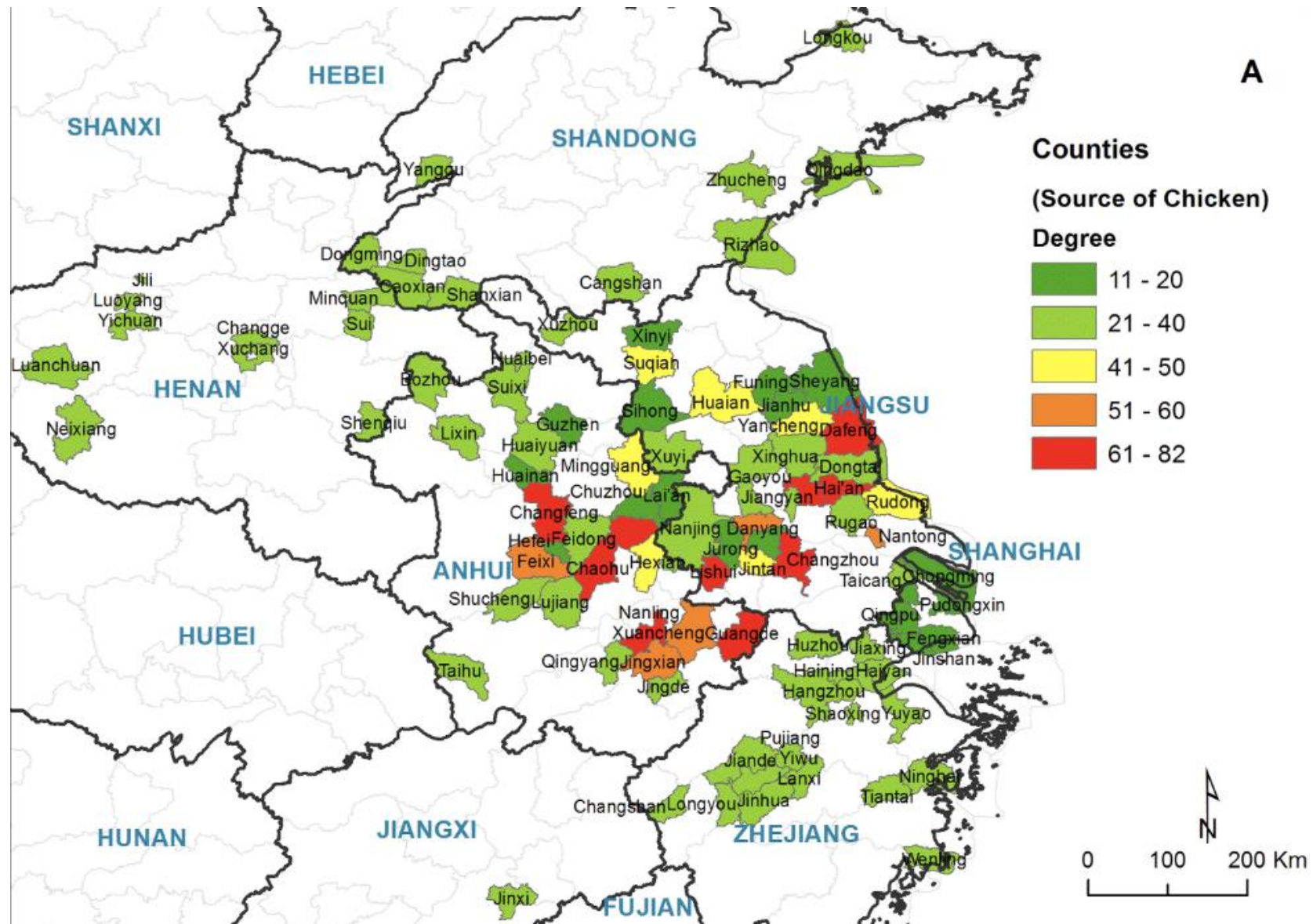




# Red de movimiento de aves de corral de 2-mode “nodo de mercado-fuente” en el sur de China según el valor k-core



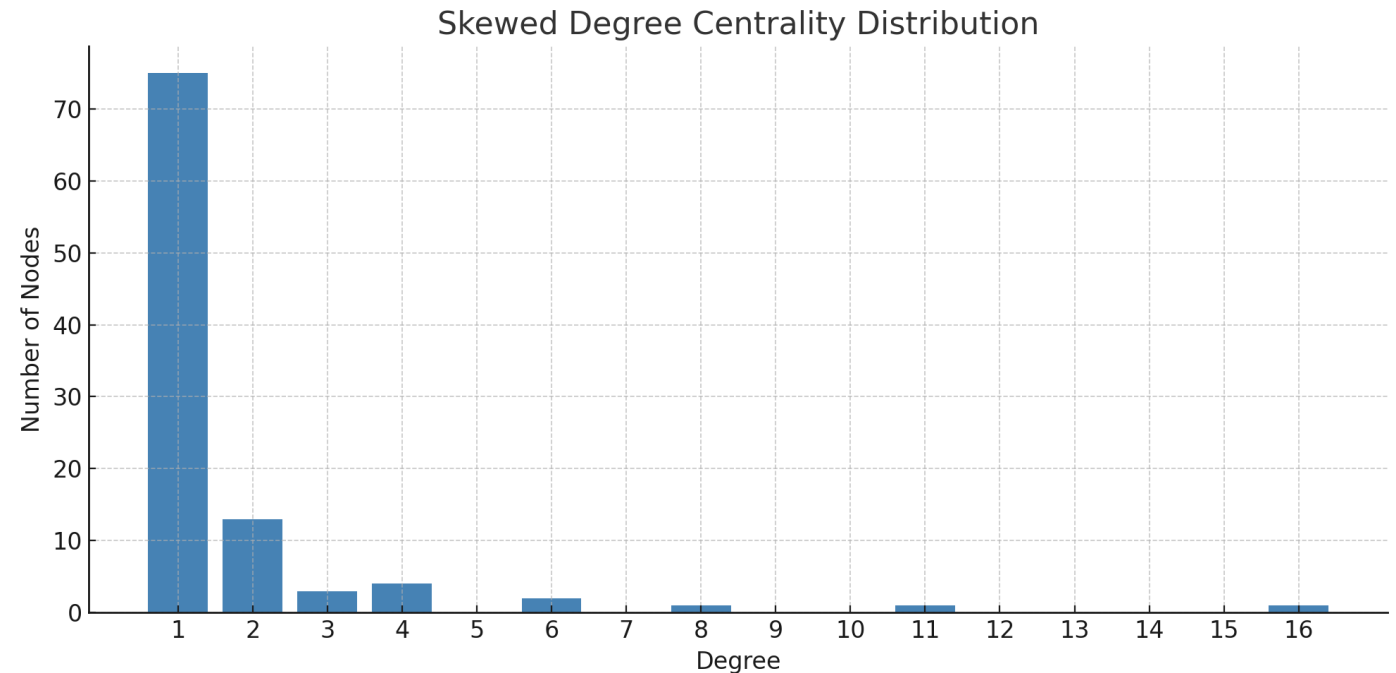
# 1 mode “source–source node” network of poultry movement in eastern China according to the degree value



## Network structure has important implications for infectious disease control

Networks with skewed degree distributions said to be:

- Resistant to random control programmes
- Susceptible to targeted control programmes



## Implications for disease control and biosecurity:

- Random (elective) control/prevention/biosecurity may have little effect globally unless undertaken on a large proportion of nodes
- Targeting “high risk” nodes
  - More useful in disassortative networks (?biological)
  - May need to target more nodes in assortative networks (?social)
  - Requires identification of high-risk individuals
    - Difficult
    - Varies with time



## Individual level factors

- Disease status
- Social status/age

## Management factors

- Biosecurity indicators
- Housed v's pastured
- Stocking density

## Geographic and Environmental factors

- Spatial location
- Climate/season
- Terrain

*A diseased individual may have:  
**Increased contact rate**  
Early stages of on outbreaks*

- **Decreased contact rate**  
*Disease control interventions  
in place- e.g. movement  
restriction*



# Gracias - preguntas?

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