

Principios y uso del análisis espacial en la vigilancia de enfermedades zoonoticas

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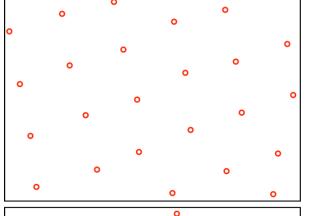


PRINCIPIO 1:

LA DISTRIBUCION DE ENFERMEDADES INFECCIOSAS NO ES ALEATORIA

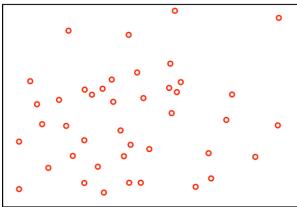
Tipos de distribucion geografica





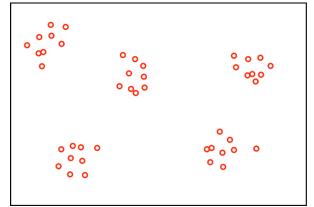


Uniform: Not as common. Territory or scarcity of resources



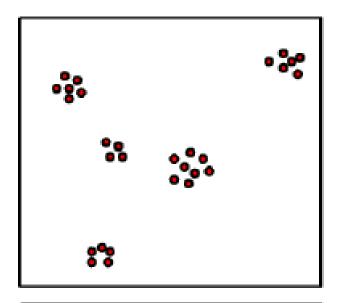


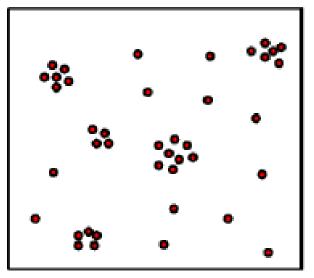
Random: Quite rare. Can be hard to determine between truly random or largely clumped





Clumped: Most common. Ecology, social interaction, resources are clumped, disease transmission (spatial clusters)

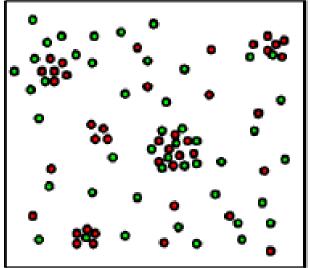


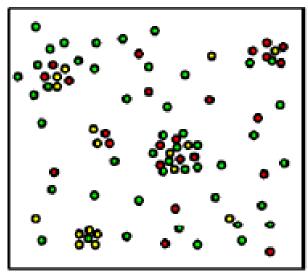


Clusters with noise

Clusters with noise and background population

Clusters

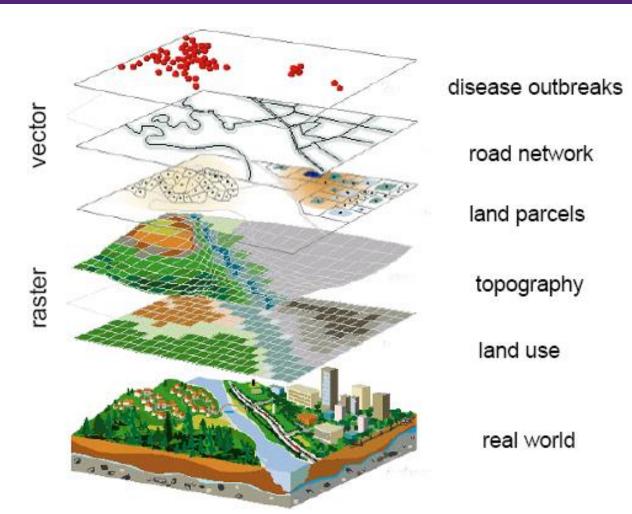




Clusters with noise and background population and covariates

Landscape epidemiology (Pavlovsky, 1966; Burnet & White, 1972) of Queensland

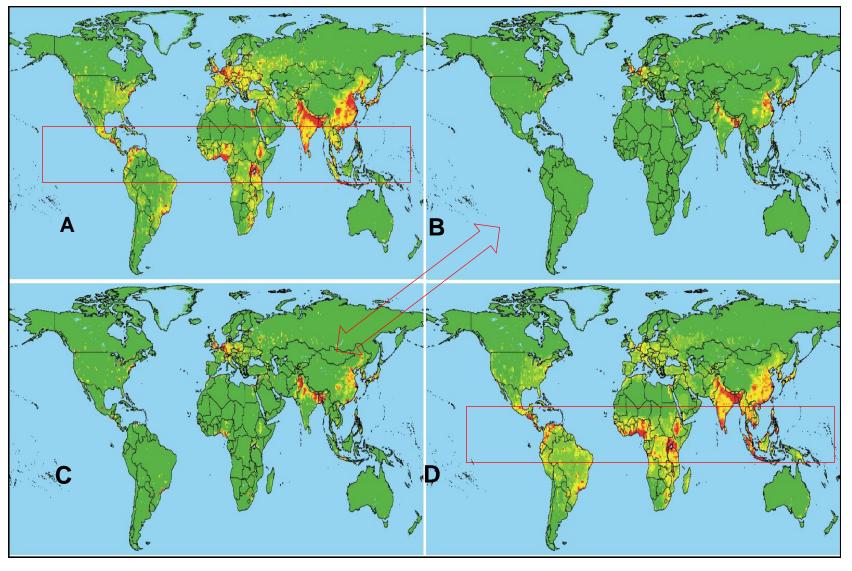
- **Natural foci** of infectious diseases in defined geographical areas during defined time periods.
- Key environmental elements (elevation, temperature, rainfall, humidity) influence:
 - presence, development, activity + longevity
 - pathogens, vectors, animal reservoirs of infection & their interactions with humans.
- Higher the number of factors favourable for transmission, the higher the probability of an infectious disease becoming established in a natural foci.



Al conocer las condiciones ambientales necesarias para la transmisión de patógenos en la naturaleza, se puede utilizar el paisaje para identificar y predecir la distribución espacial (y/o temporal) del riesgo de enfermedades.

Padrones geograficos globales de enfermedades infecciosas emergentes

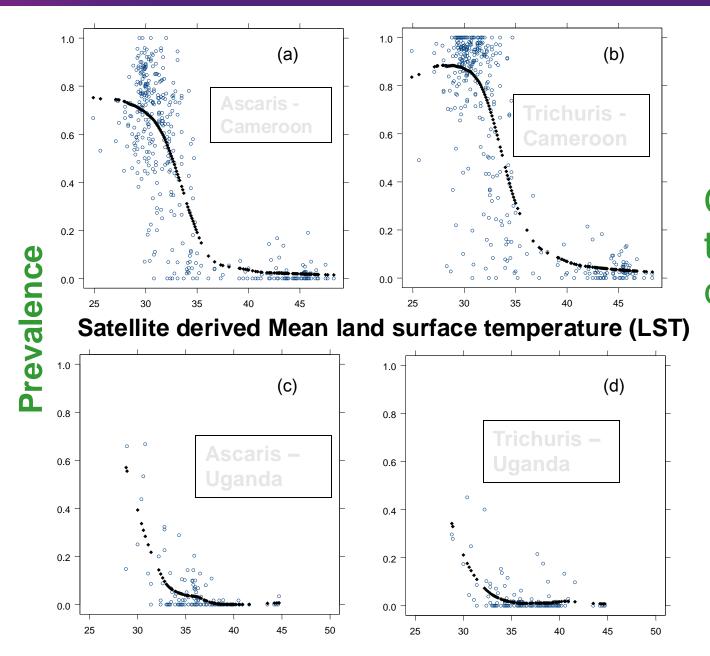




A: zoonotic pathogens from wildlife C: drug-resistant pathogens

B: zoonotic pathogens from non-wildlife D: vector-borne pathogens





Correlation between temp. and prevalence of helminth infections

Agregados espaciotemporales de antrax cutaneo en China (2005-2012) THE UNIVERSITY OF QUEENSLAND

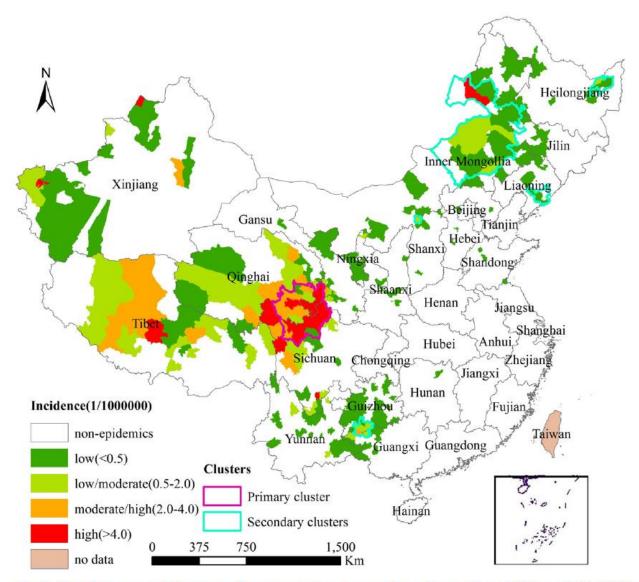
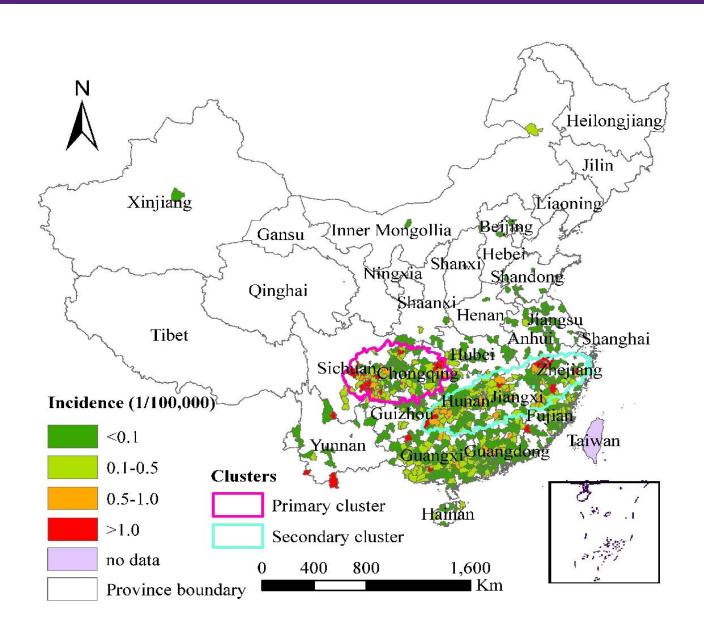


Fig 3. Spatiotemporal clusters of human cutaneous anthrax in mainland China, 2005–2012.

Agregados espaciotemporales de leptospirosis en China (2005-2012) THE UNIVERSITY OF QUEENSLAND





El problema de la dependencia/agrupamiento espacial



- Spatial dependence = spatial (auto)correlation = spatial heterogeneity = clustering
- Are disease rates more similar in locations that are closer together in space?
 - Tobbler's law of geography
- May occur because transmission is facilitated by close proximity
 - risk factors are heterogeneous
- Causes problems in traditional statistics



PRINCIPIO 2:

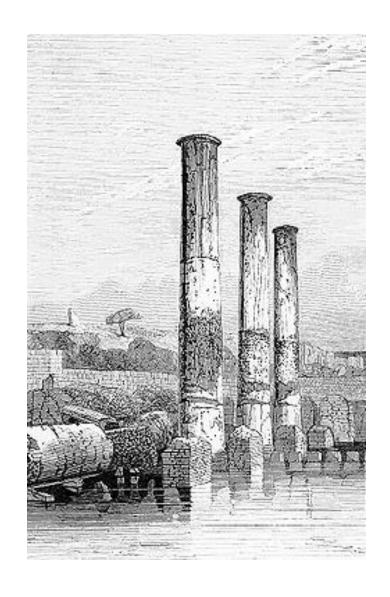
LOS FACTORES DE RIESGO PARA INFECCION VARIAN CON LA LOCALISACION

Límites de la epidemiología



Epidemiologic analysis of evidence:

- provides a profile of the type of individual who is likely to contract a disease after being exposed to an agent.
 - Time, place, demographics
- quantifies the amount of disease that is associated with an agent (measures of disease frequency)
- identifies risk factors that are associated with an increased risk of disease in groups of individuals (measure of disease association)



Enfermedades infecciosas

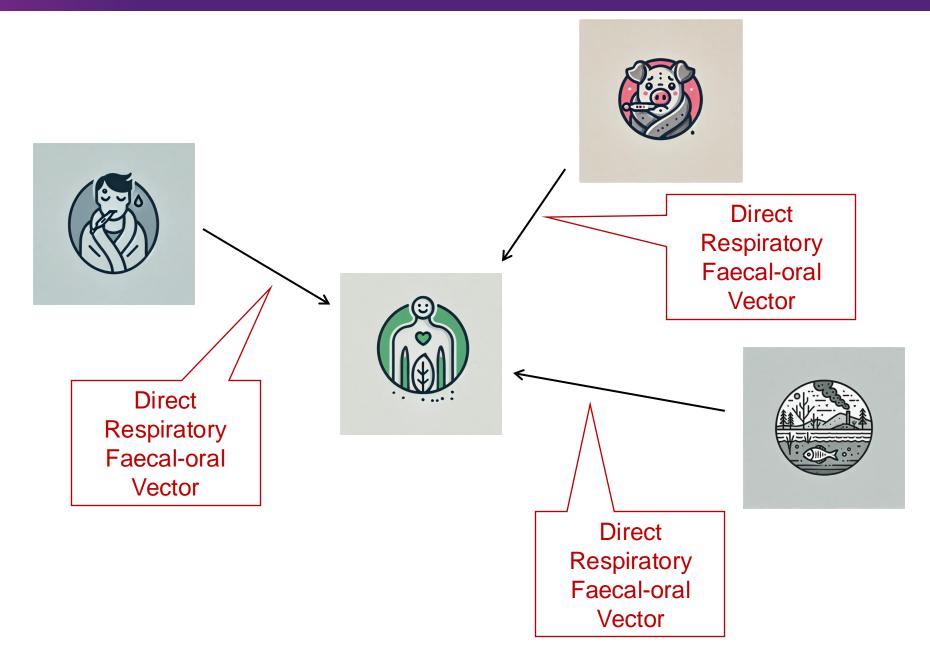


"An illness due to a specific infectious agent or its toxic products that arises through transmission of that agent or its products from an infected person, animal or reservoir to a susceptible host, either directly or indirectly through an intermediate plant or animal host, vector, or the inanimate environment. "

Last, 1995

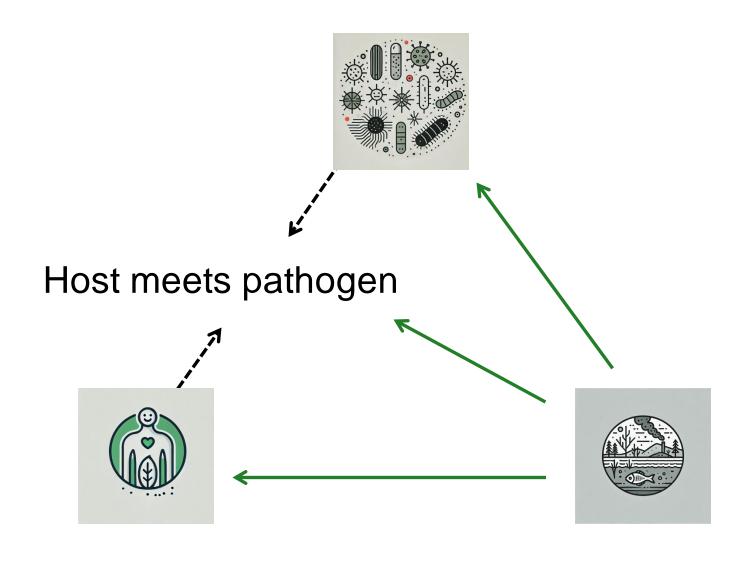
Rutas de infeccion





Dinamica basica de la triada epidemiologica





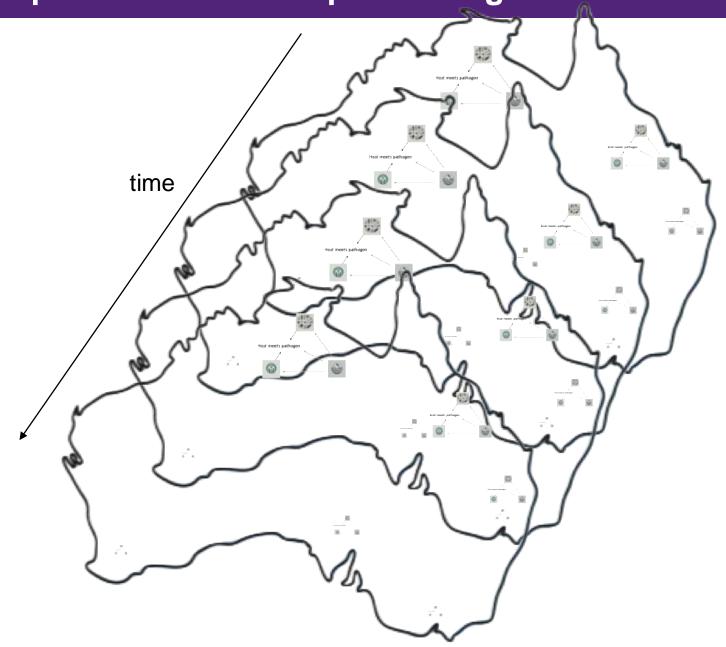
Dinamica espacial de la triada epidemiologica





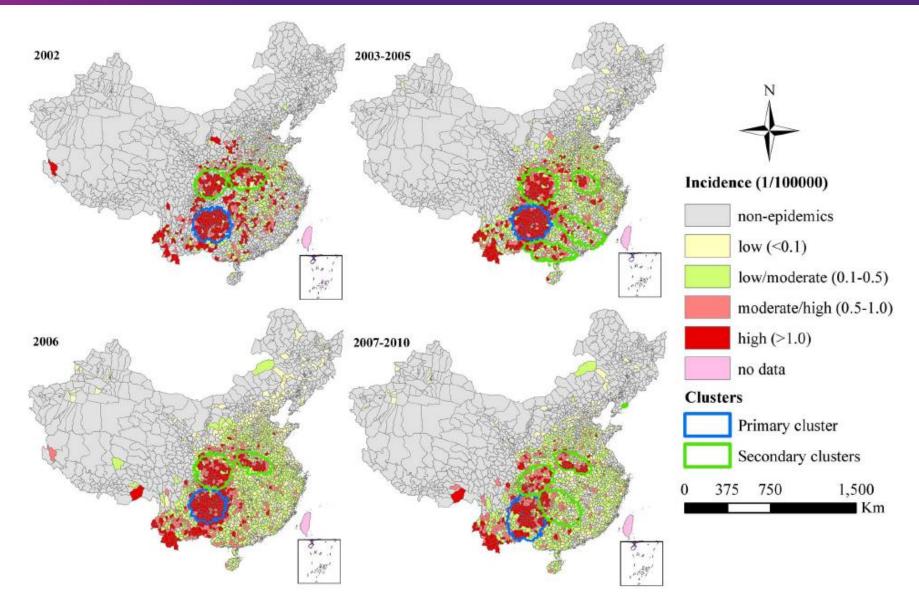
Dinamica espaciotemporal de la triada epidemiologica





Padron espacial de la Encefalite Japonesa en China (2002–2010) of Queensland





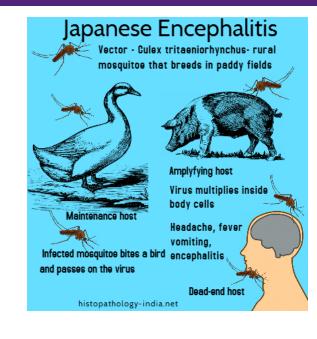


Figure 4. Space-time clusters and annual average incidence of JE cases in mainland China. doi:10.1371/journal.pntd.0002285.g004

Determinantes de la agrupación de enfermedades



Population distribution

- -Human population
- -Animal density distribution
- -Farm locations

Distribution of disease control

- -Vaccination coverage
- -Distribution of water and sanitation

Distribution of socioeconomic factors

- Behavior
- Health access
- Husbandry systems

Distribution of landscape variation

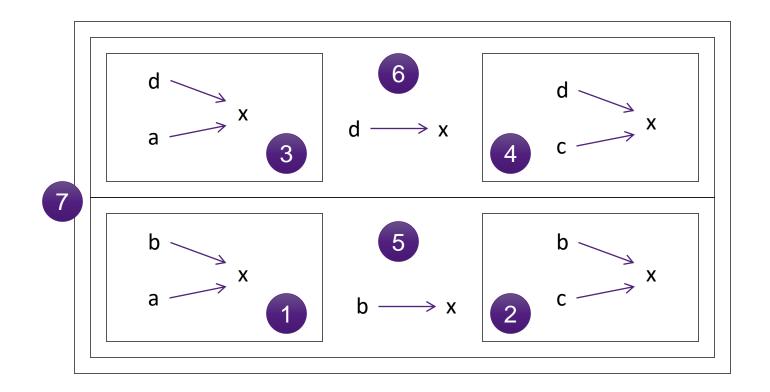
- Physical environment
- Climate indicators

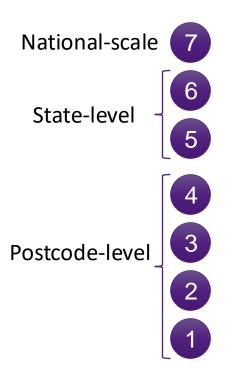
Visualización y análisis de datos de área: la cuestión de la escala



Ecological falacy:

- When statistics are compared across different spatial scales.
- Patterns of risk factor association are different at different scales of analysis e.g. we cannot use a state-level risk factor to predict what will happen to specific individuals within the Postcodes of the state.





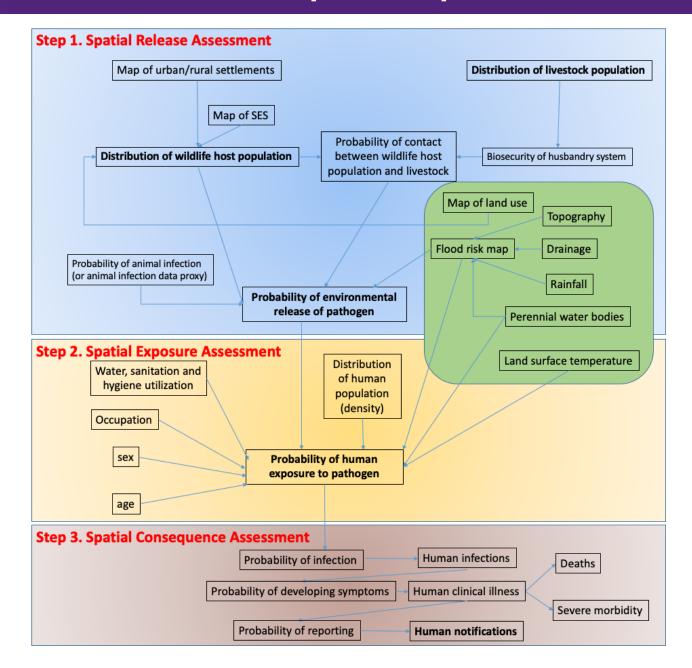


PRINCIPIO 3:

LA VÍA CAUSAL DE UNA ZOONOSIS ES UNA CASCADA DE TRANSMISIÓN

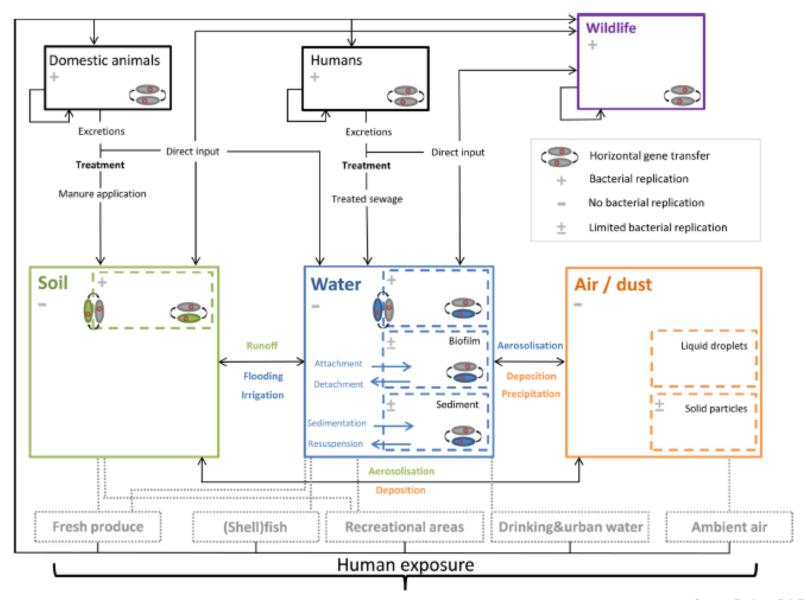
Vía causal general de una zoonosis impulsada por el medio ambiente of Queensland





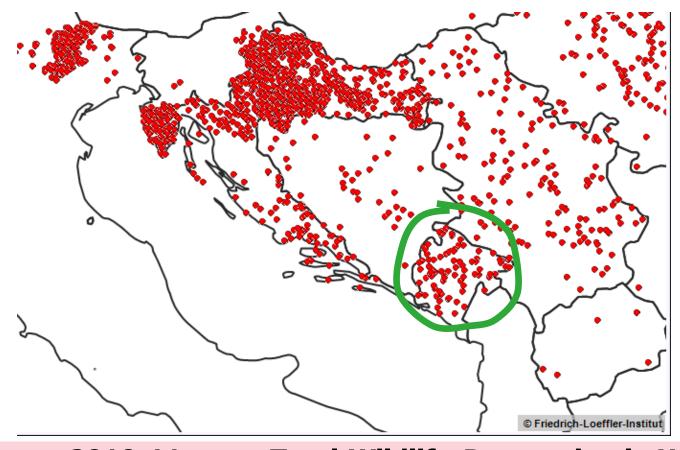
El papel del medio ambiente en la transmisión de la resistencia a los antimicrobianos a los humanos





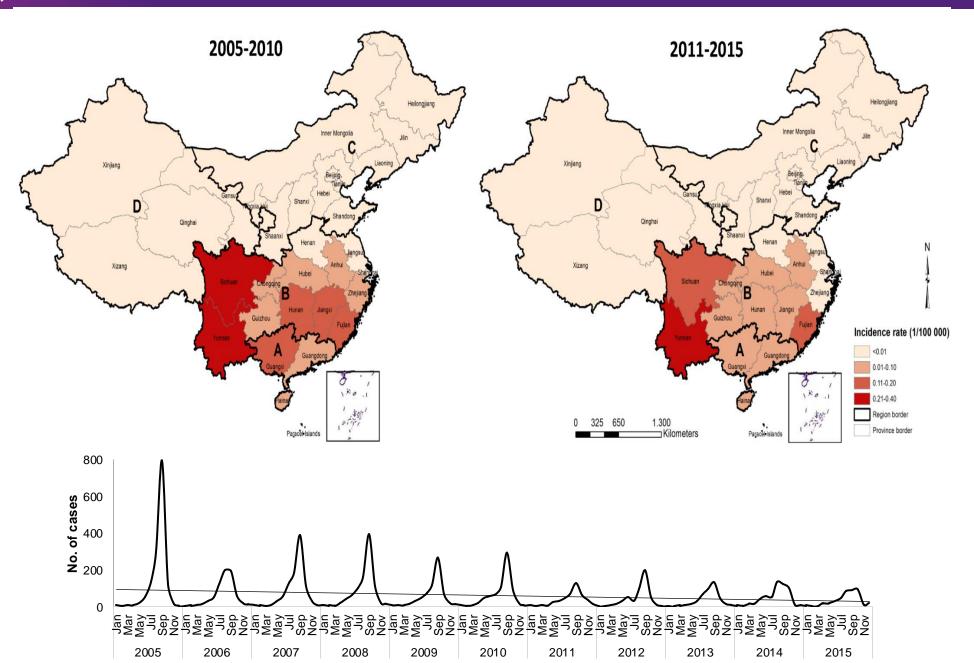
Rabia en la region del Oeste de los Balkanes





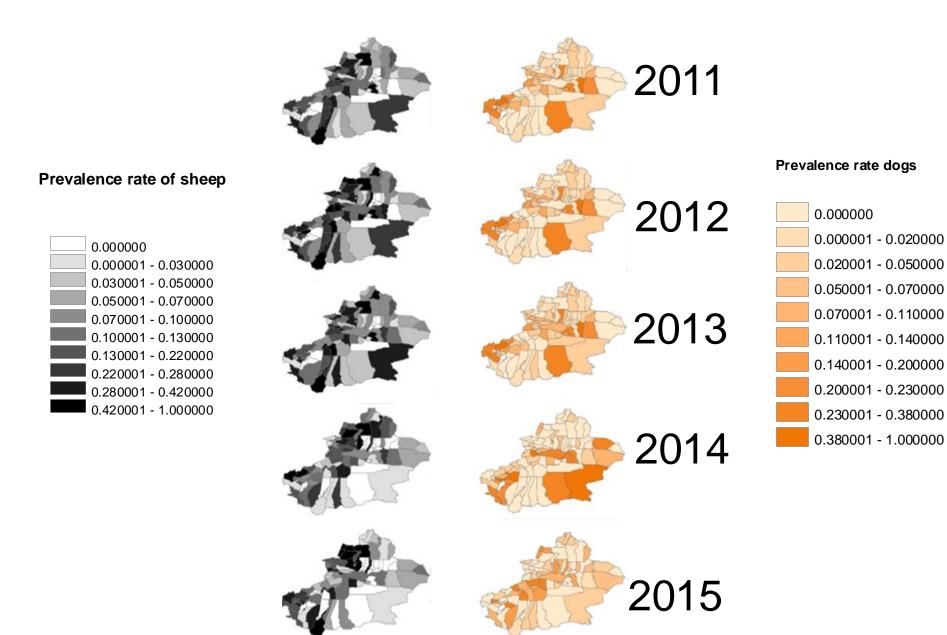
Rabies cases 2010-11	<u>Total</u>	Wildlife	Dom. animals	Humans
Europe	13,364	7,482	5,863	20
Montenegro + neighbours	1,303	1,1480	156	0
Montenegro	93	79	14	0





Geographical distribution of Echinococcosis in animal reservoirs in Xinjiang THE UNIVERSITY OF QUEENSLAND China.





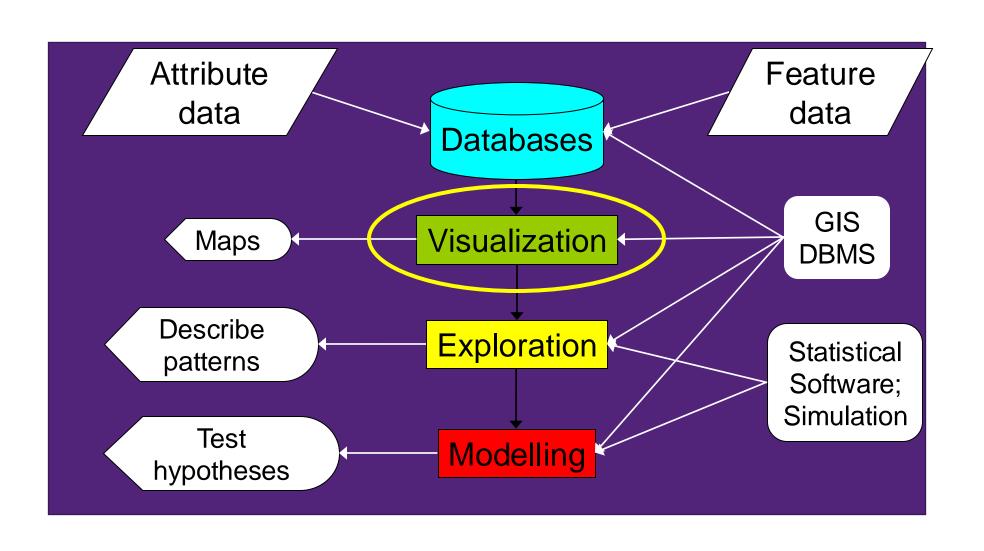


PRINCIPIO 4:

ANALISIS ESPACIAL DE ENFERMEDADES ZOONOTICAS SIGUE UN PROTOCOLO SEQUENCIAL QUE CONSIDERA LOS TRES PRIMEROS PRINCIPIOS

Marco para la investigación epidemiológica espacial of The University Of QUEENSLAND



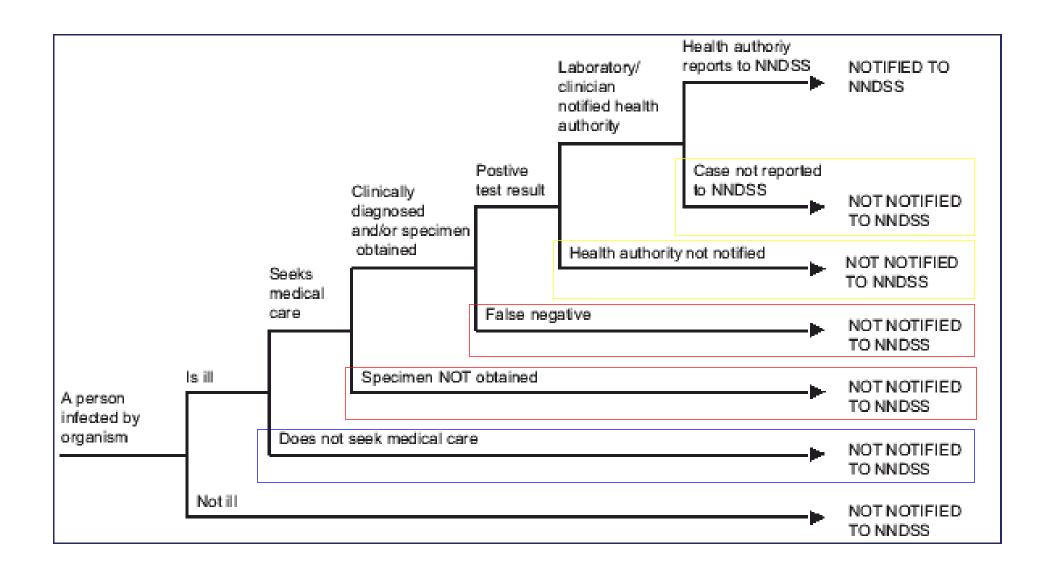


Visualización



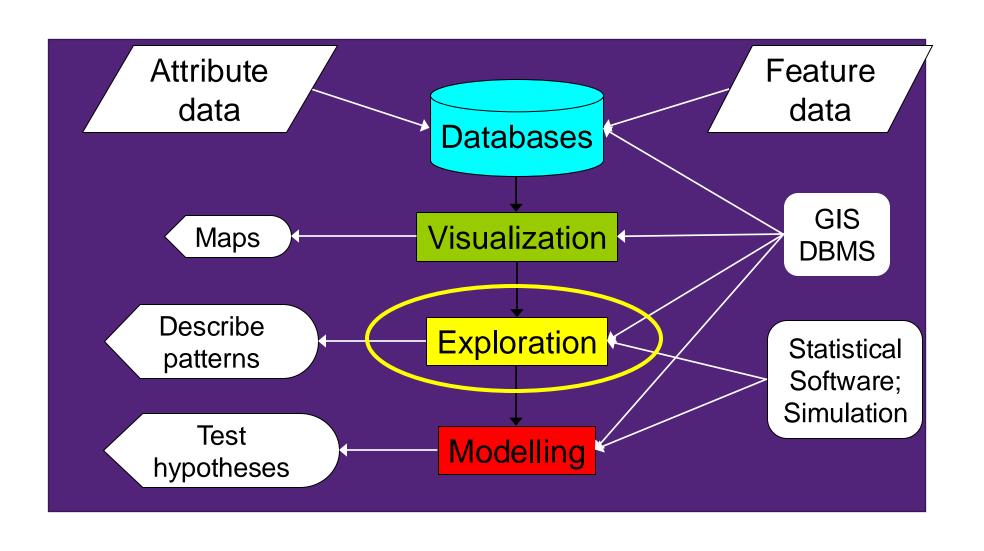
- Hypothesis generating: is there a pattern?
- Visual analysis for spatial/spatiotemporal patterns
- Conducted using a geographical information system (GIS)
- Show actual values 2D, 3D, more dimensional
 - Points
 - Coloured points
 - Map series (adds time)
- Generate continuous representations
 - Interpolation
 - Smoothing

Factores que afectan la calidad de los datos de vigilancia de una enfermeda of QUEENSLAND



Marco para la investigación epidemiológica espacial of The University Of QUEENSLAND





Evaluacion de agregados espaciales



Null hypothesis: spatial randomness

•i.e. constant relative risk through space (and time)

Alternative hypothesis

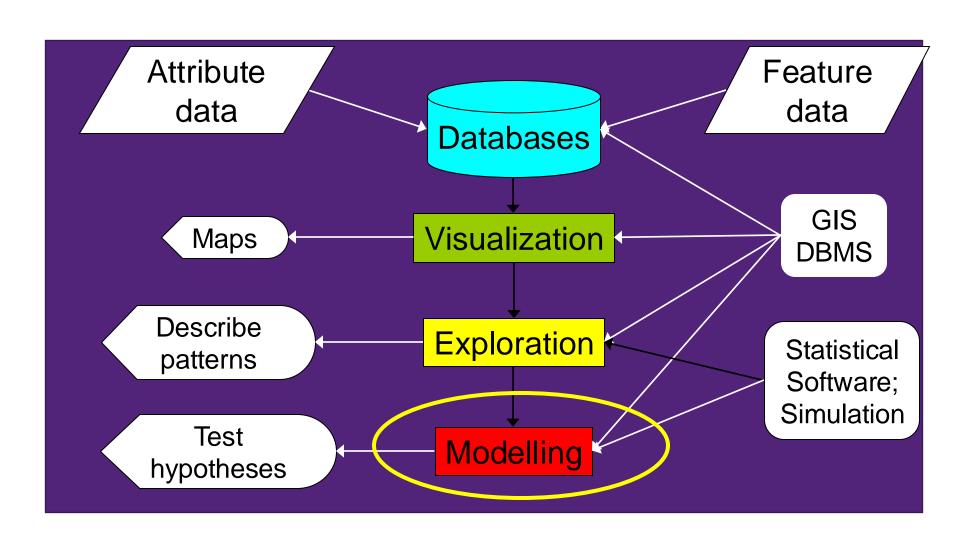
- Higher than expected rate of disease
 - Putative: Around a point (or line) source
 - Global: In some location(s) on the map (not defined)
 - Local: In some specific location(s) (clusters)

Test statistics

- 1. Global v. local v. putative source
- 2. Point v. area data
- 3. Just case v. case-control v. case-population (incidence vs prevalence)
- 4. Spatial v. spatiotemporal

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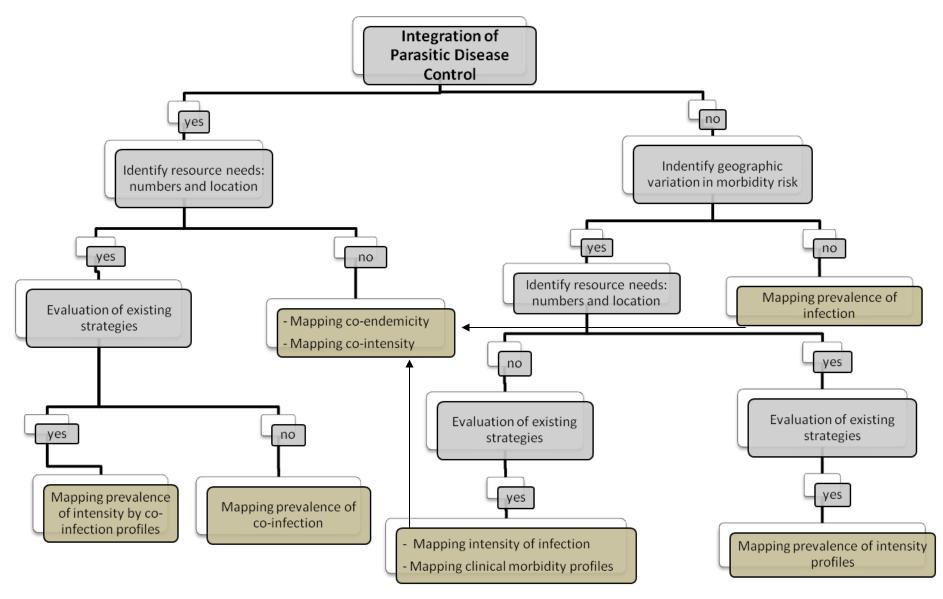
Modelado: alcance



- Hypothesis testing: specific hypotheses about the cause of spatial/spatiotemporal patterns
 - Might aim to determine important risk factors for disease
 - Might aim to predict values in locations that were not sampled
 - Might incorporate spatial correlation
- Operational objectives
 - Population at-risk estimation/identification
 - Surveillance design
 - Identify resources needed (ie. Locations and cost)
 - Evaluate existing strategy performance (ie. Sens/Spec)

Decision-tree for the application of mapping tools to assist the planning and evaluation tropical disease control





Source: Soares Magalhaes et al 2011, Adv in Parasitology

Pasos tomados durante el modelado espacial



e.g.

- > LST
- Rainfall
- ➤ NDVI
 Spatial unit of analysis:
- > Barangay

Contextual Data

Statistical modelling

- e.g. Total number individuals included in analysis:
- > 35,573
- > Age: 2-86
- > Sex

- STEP 1: Build non-spatial statistical model
- STEP 2: Investigate spatial structure of residual variance
- STEP 3: Build spatial model
- STEP 4: Conduct model validation
- STEP 5: Full model learning
- STEP 6: Full model prediction





Gracias - preguntas?

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