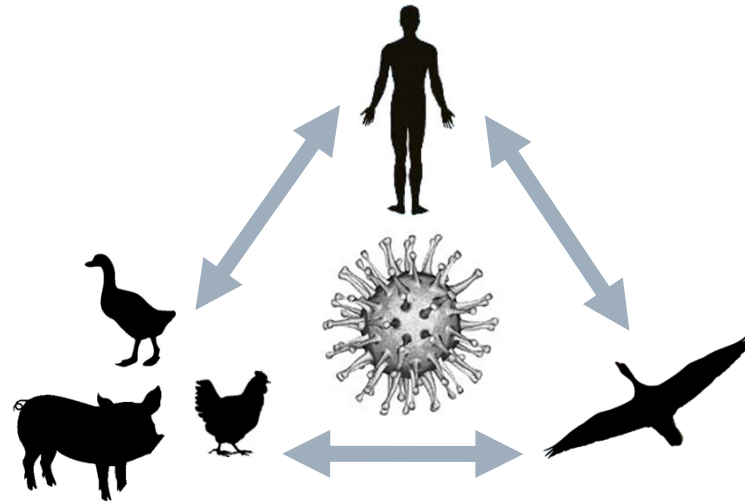




Agriculture intensification and the emergence of avian influenza in Asia



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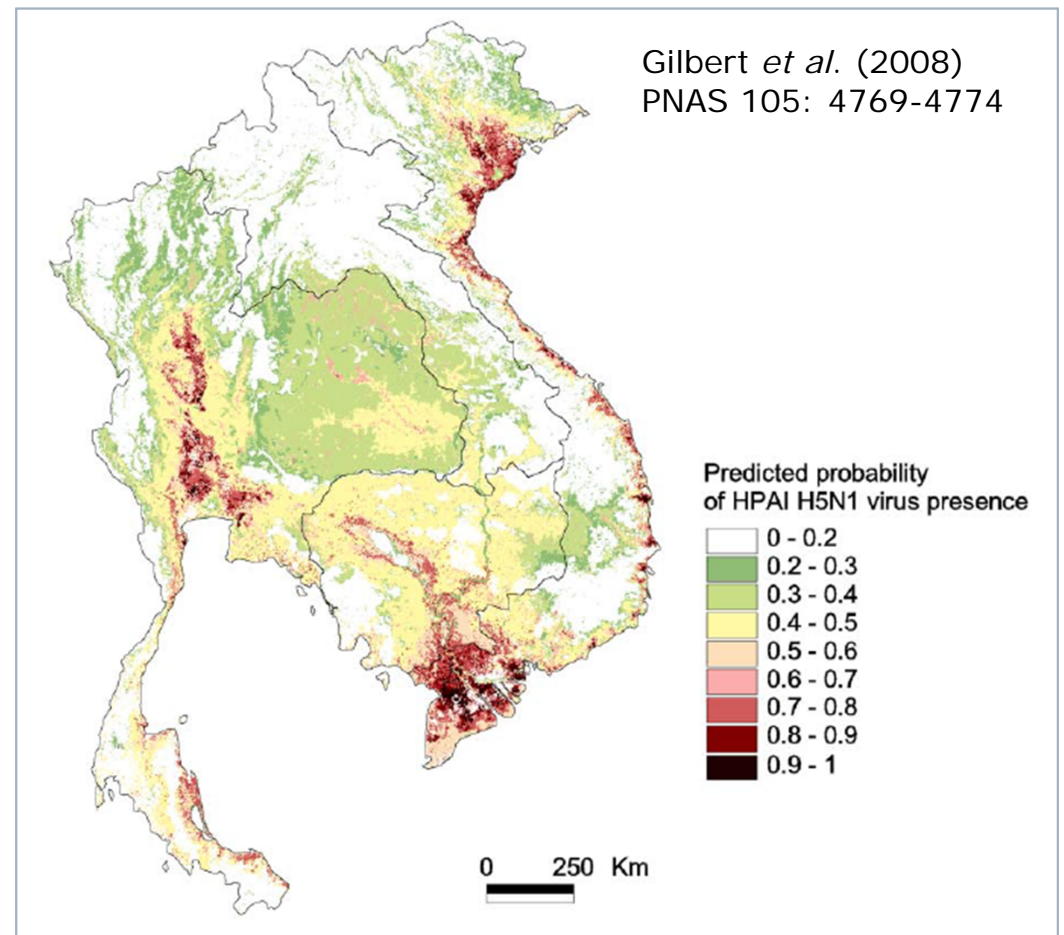


T. Robinson & J. Slingenbergh (FAO), X. Xiao (U. Oklahoma)

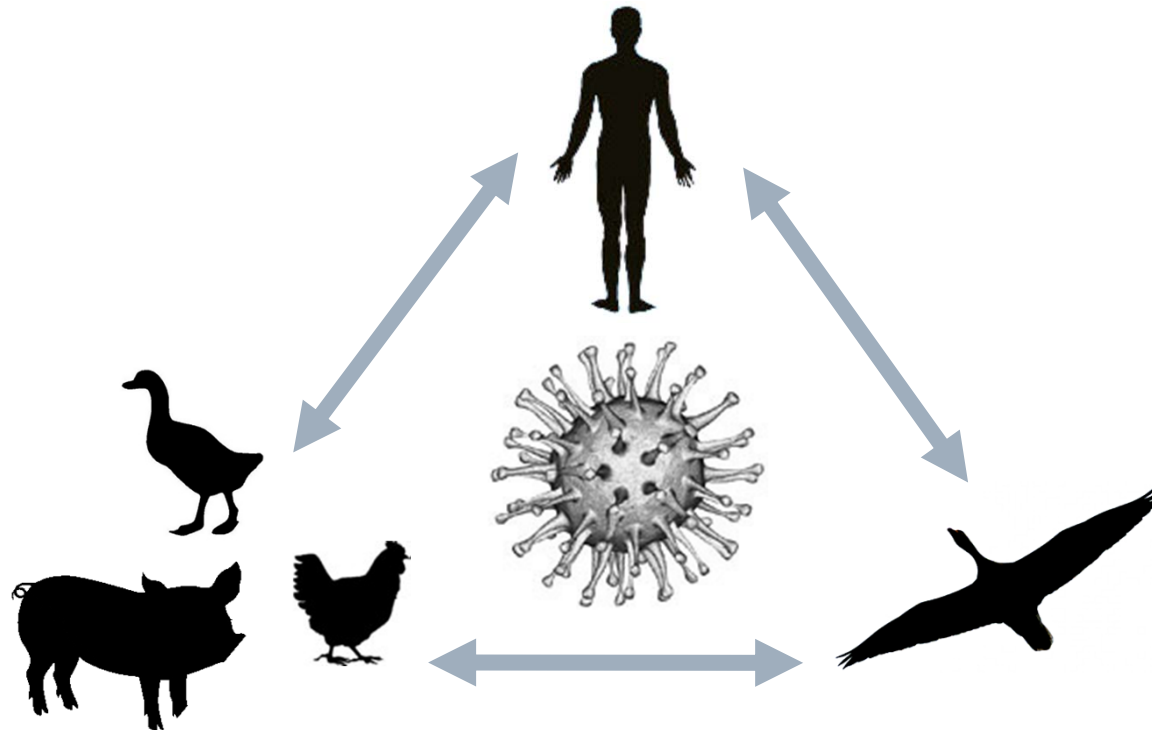
- Spatial epidemiology of livestock diseases
 - Highly pathogenic avian influenza Asia
 - Bluetongue in Europe
 - Bovine tuberculosis in Great-Britain

- Quantify risk
- Identify risk factors
- Mapping the risk

- RS
 - Env. variables
 - Space-time

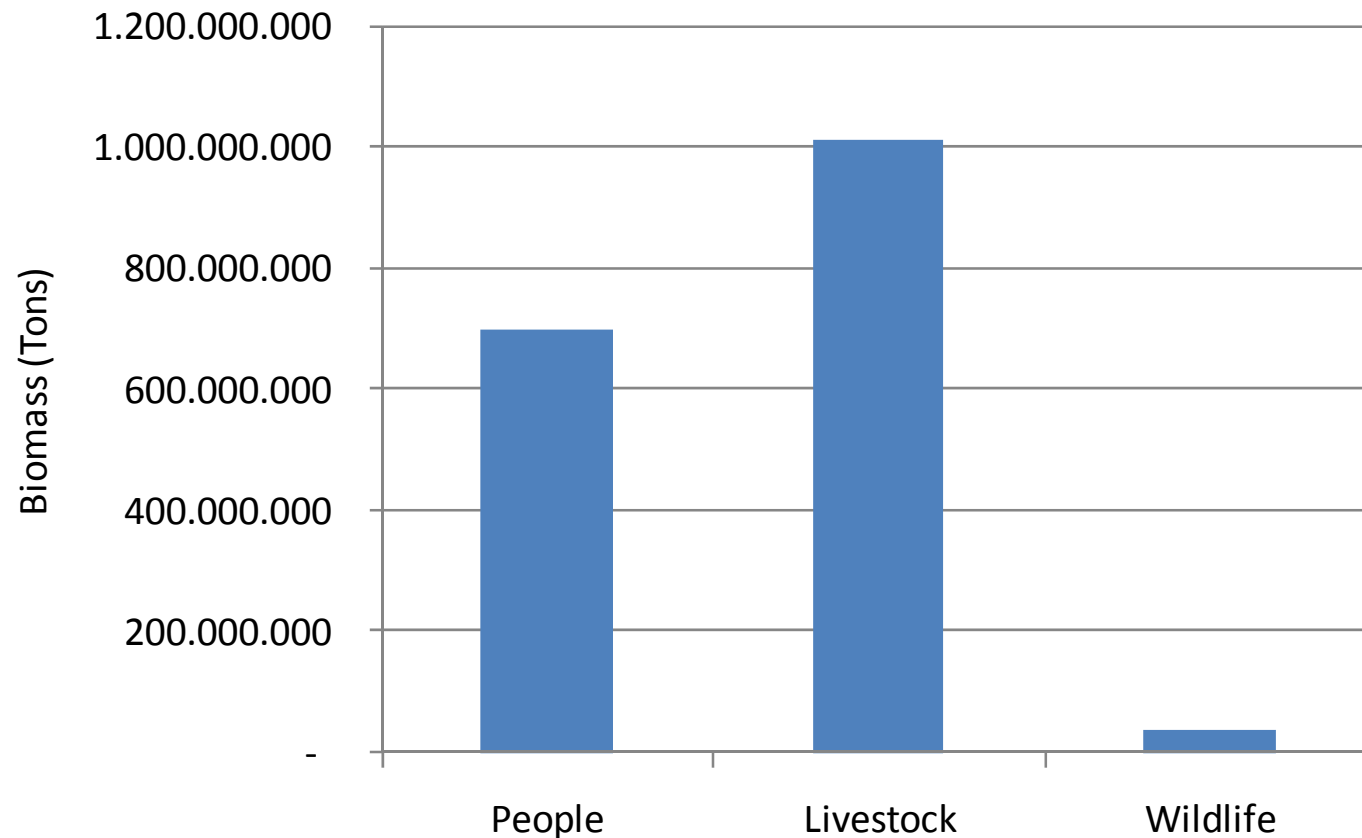


Agriculture intensification and the emergence of avian influenza in Asia



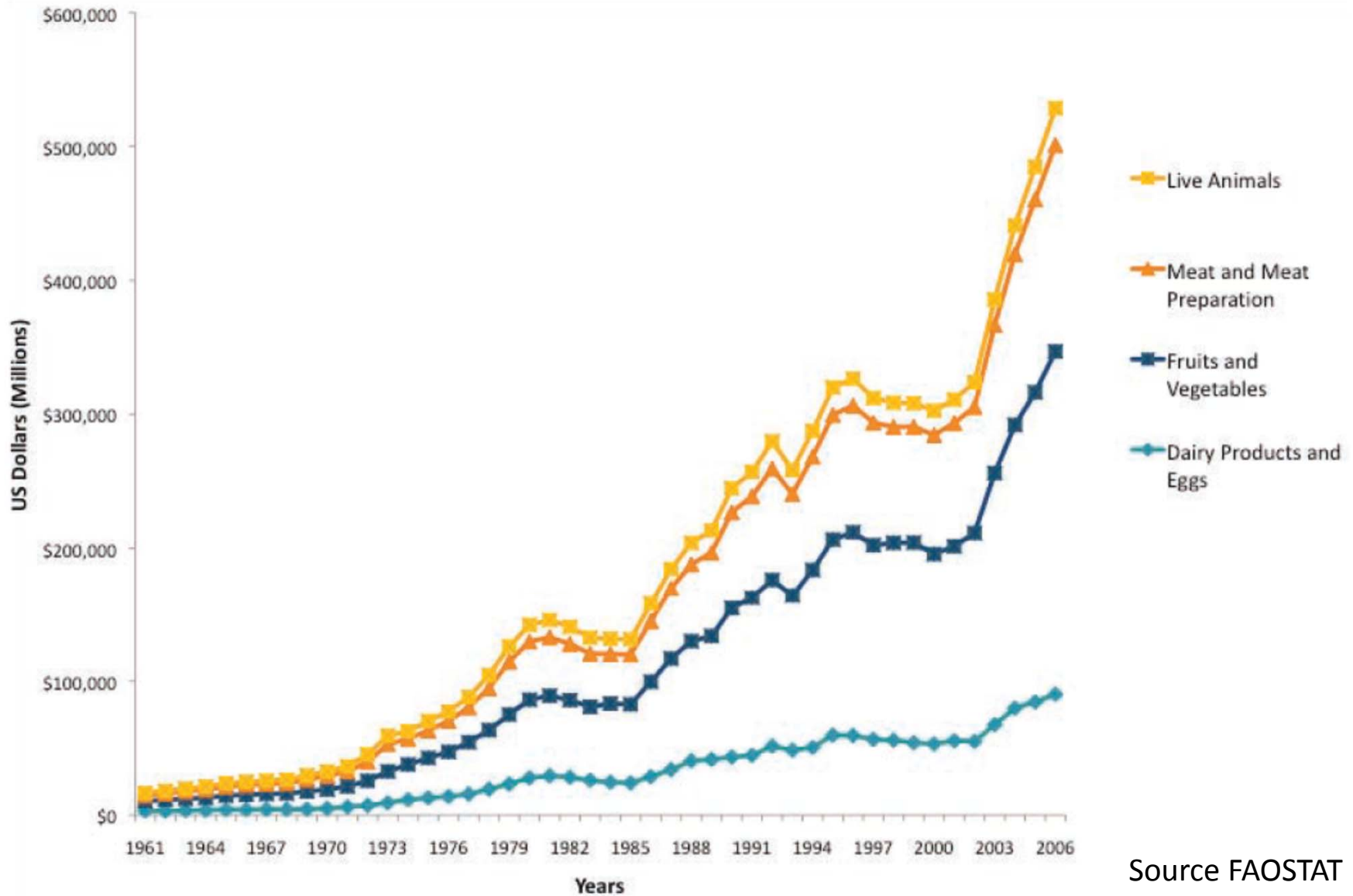
Can we better understand the conditions of emergence and spread ?

- We are the main agent of change for pathogen;
- We have evolved together with our livestock and have shared pathogens (Diamond 2002)



Updated & adapted from Smil 2002

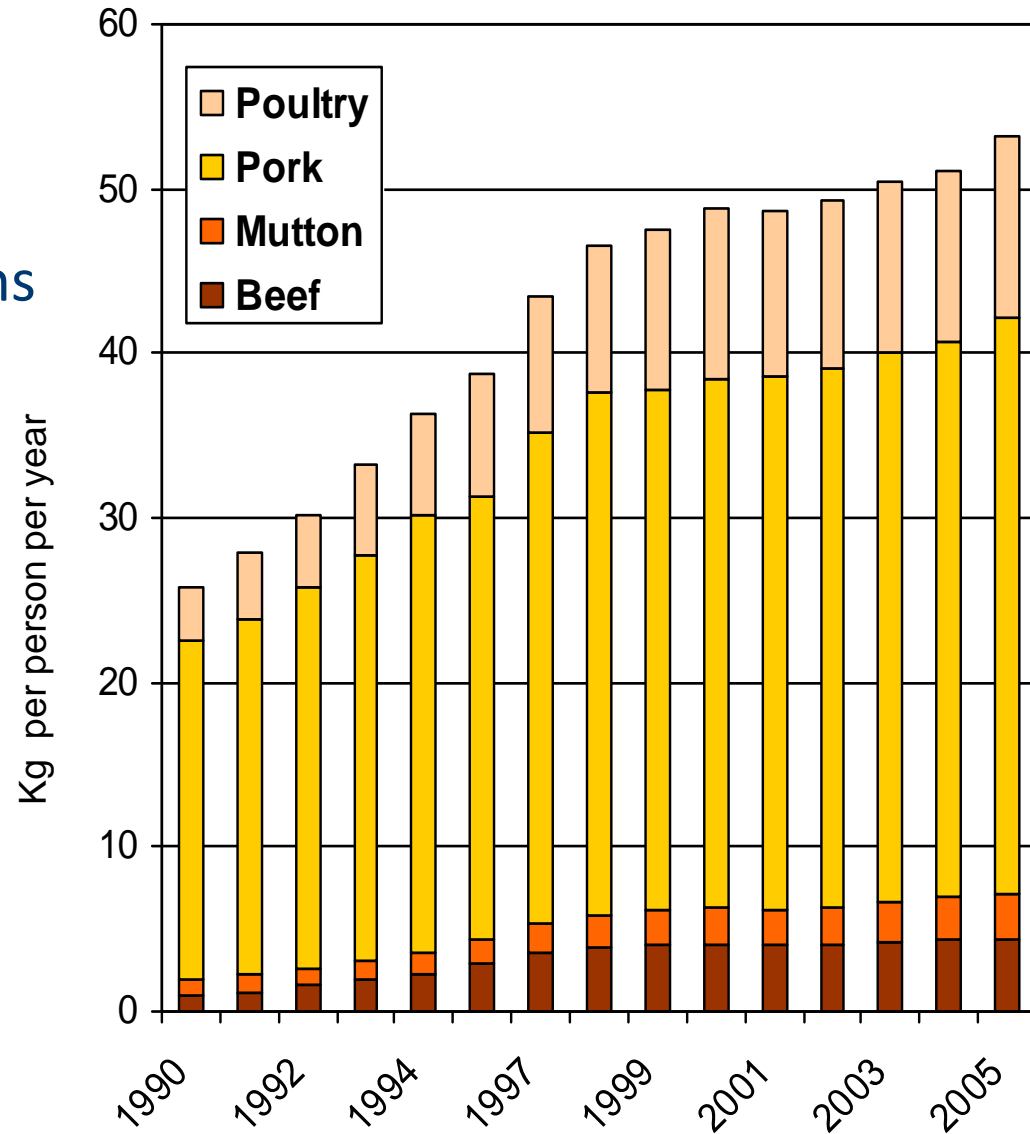
- Temporal pattern of international trade by commodity type



Source FAOSTAT

- Changes in demography
- Changes in consumption patterns

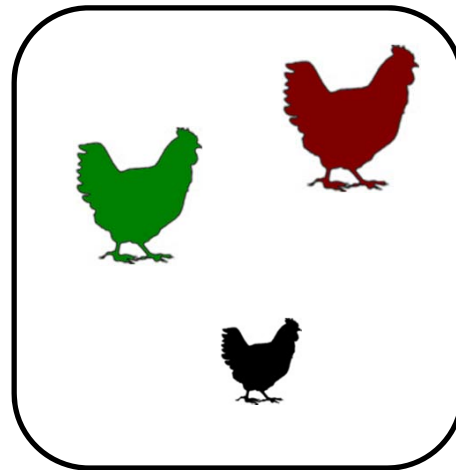
Meat consumption



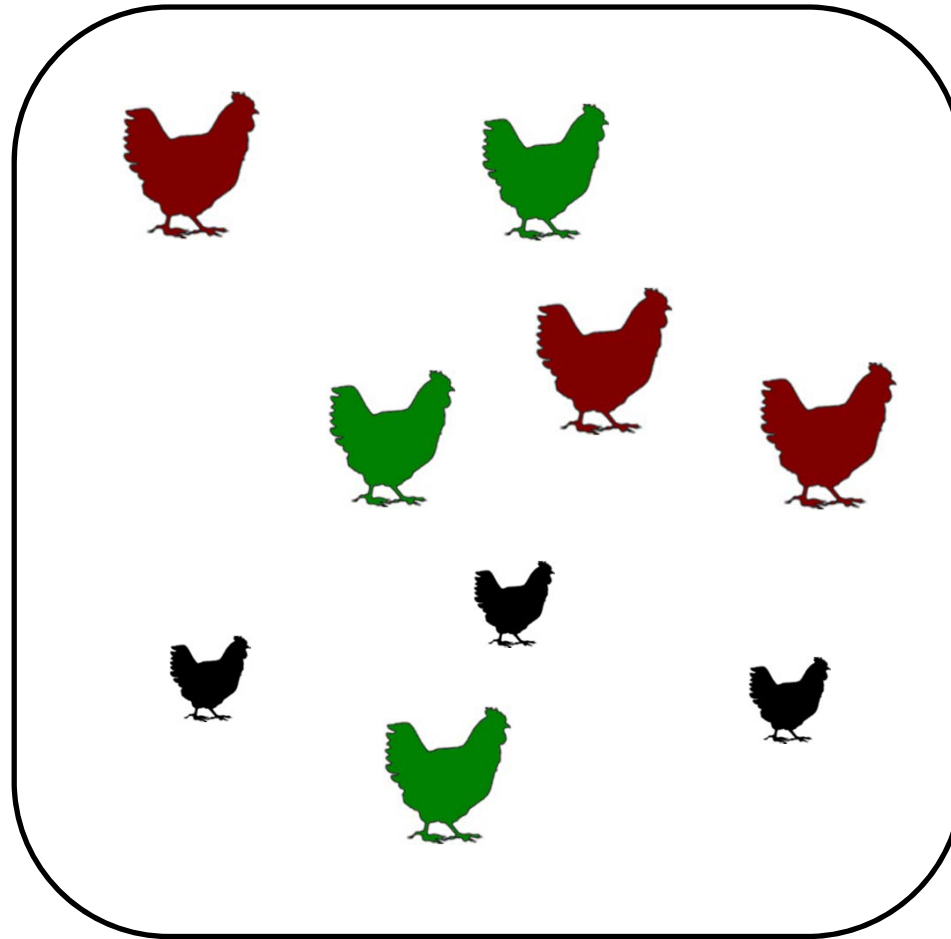
- Intensification: starting situation: backyard chickens



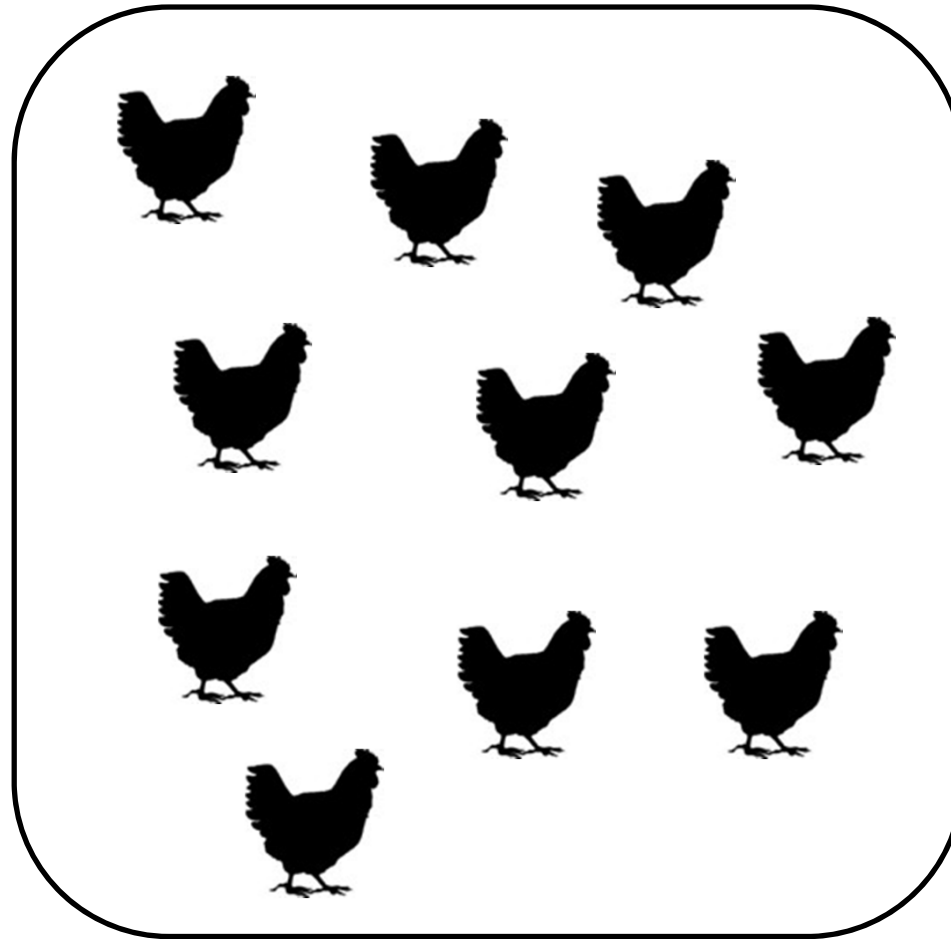
- Intensification: build fences



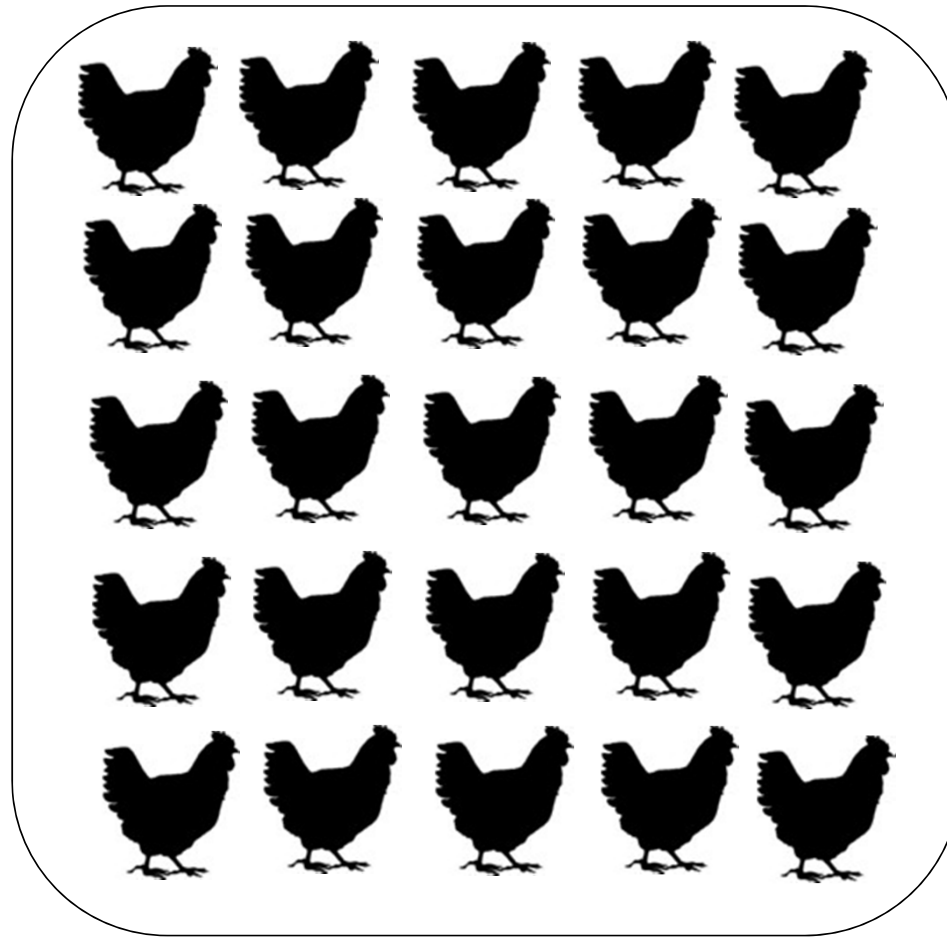
- Intensification: increase number & farm



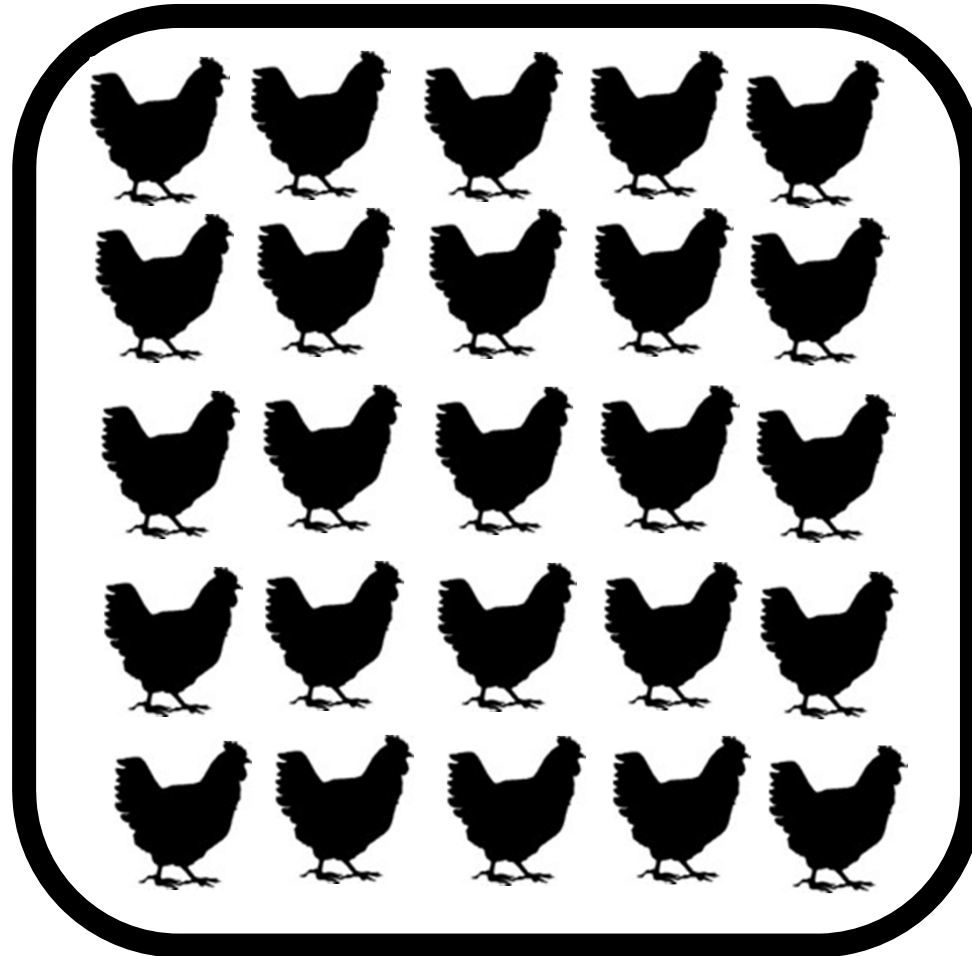
- Intensification: used of specialized breeds: invest in trade



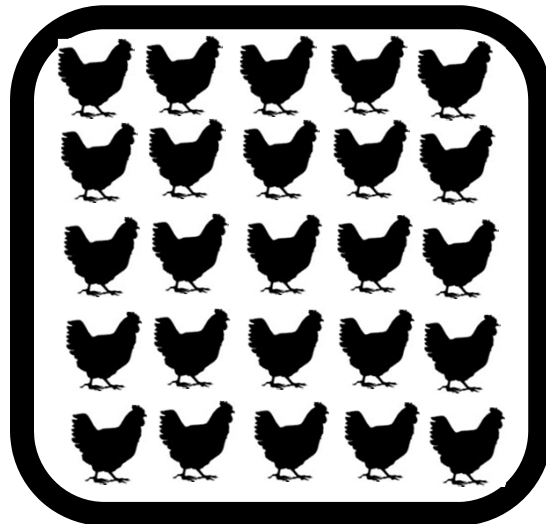
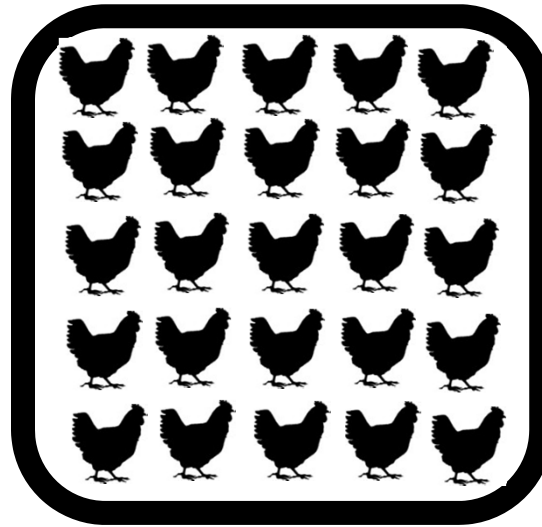
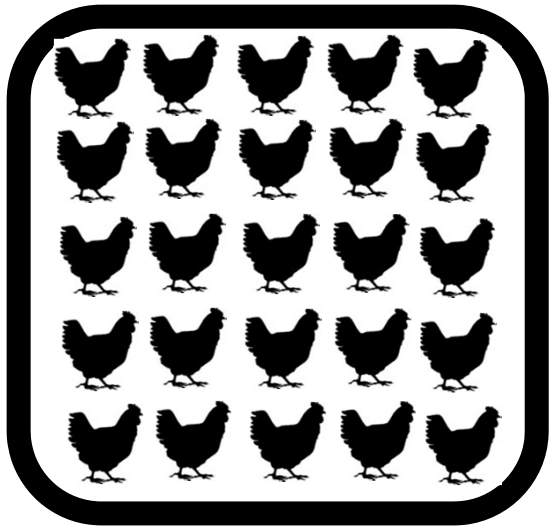
- Intensification: increase density – higher outputs



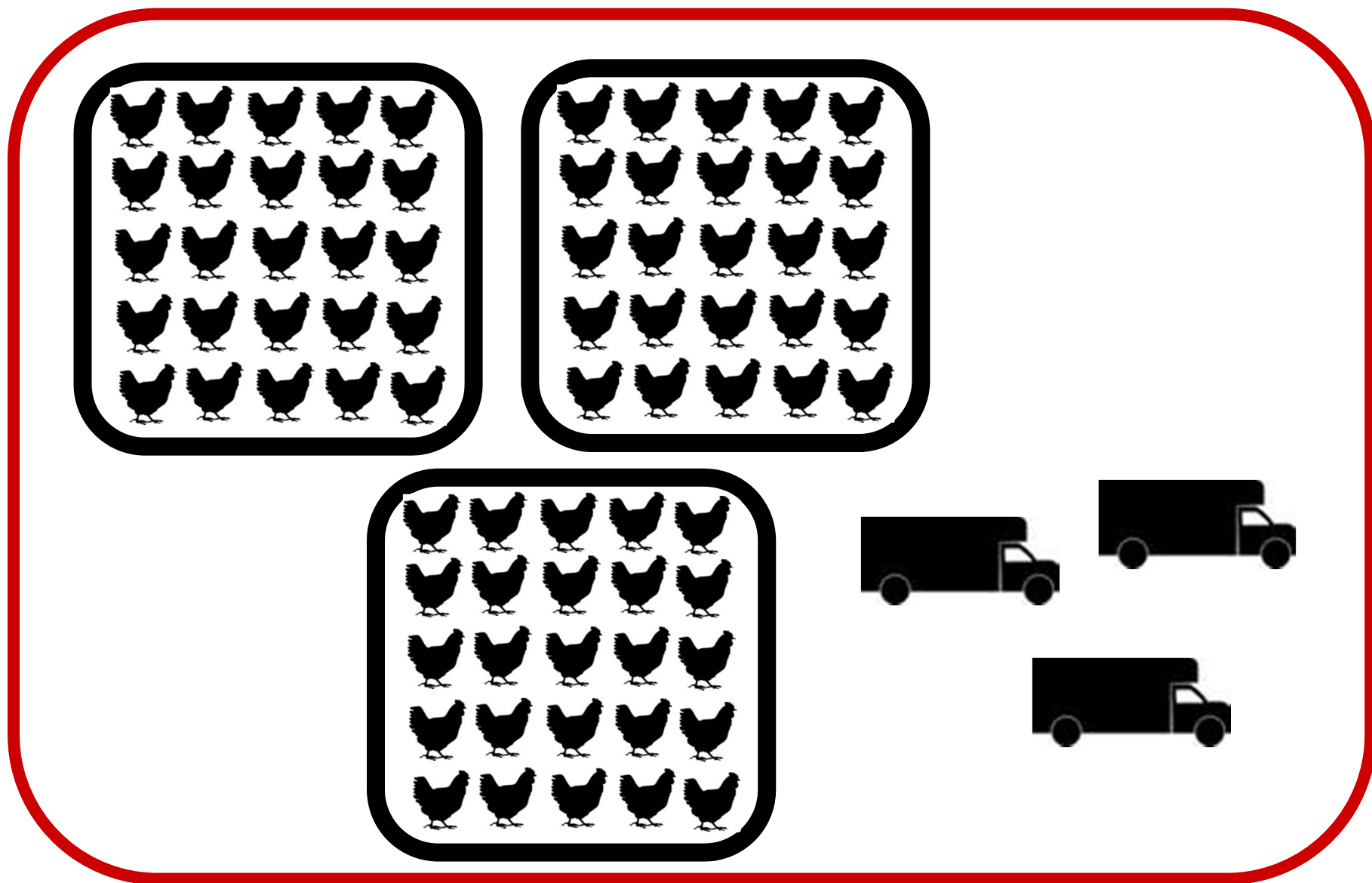
- Intensification: increase biosecurity to prevent disease

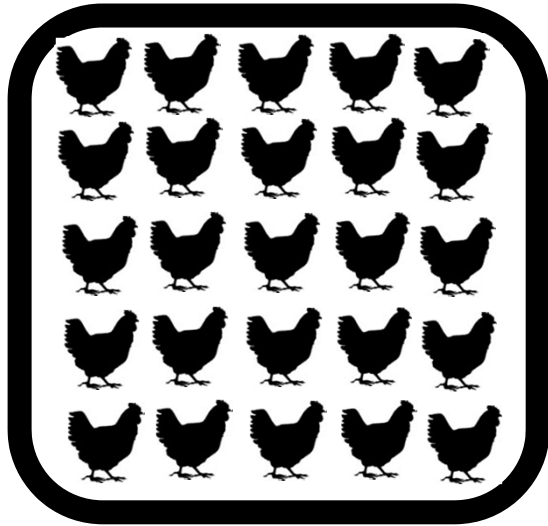


- Intensification: have more facilities



- Intensification: vertical integration & biosecurity





High density

Increases transmission

Reduces immunity

Low genetic diversity

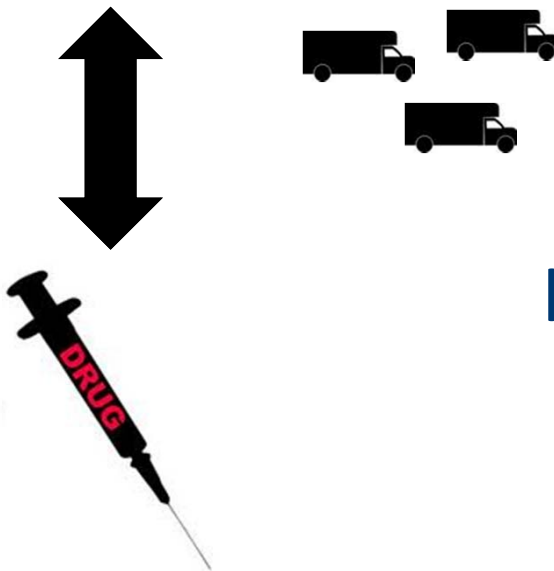
Selects specialized pathogens

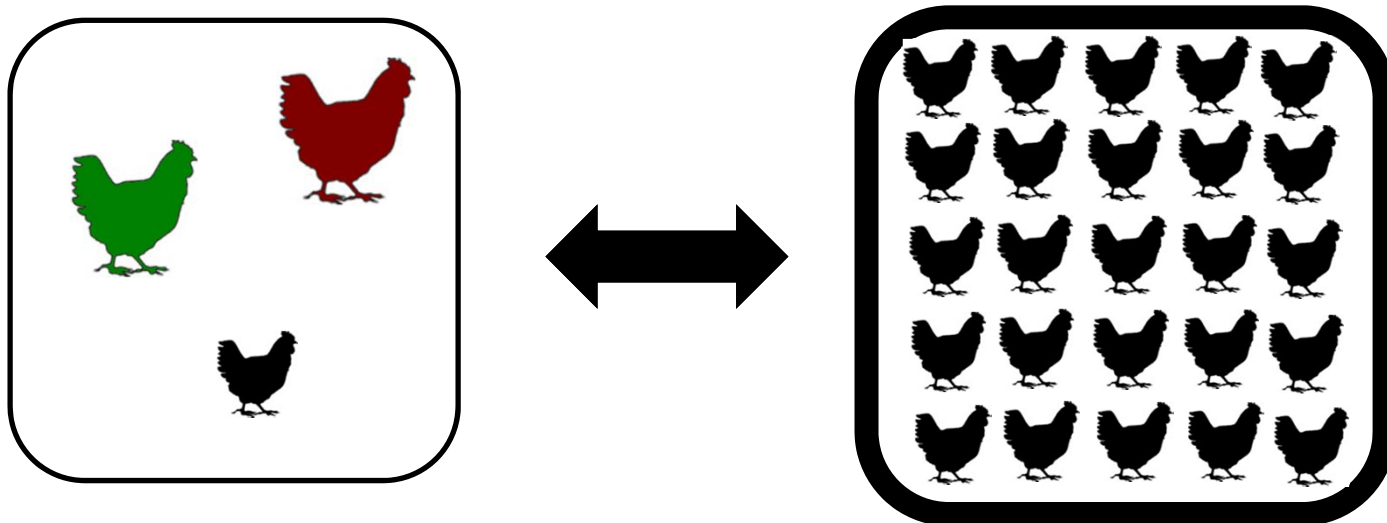
High turnover

No possibility to transmit resistance

High trade of live animals and products

Favour long-distance transmission





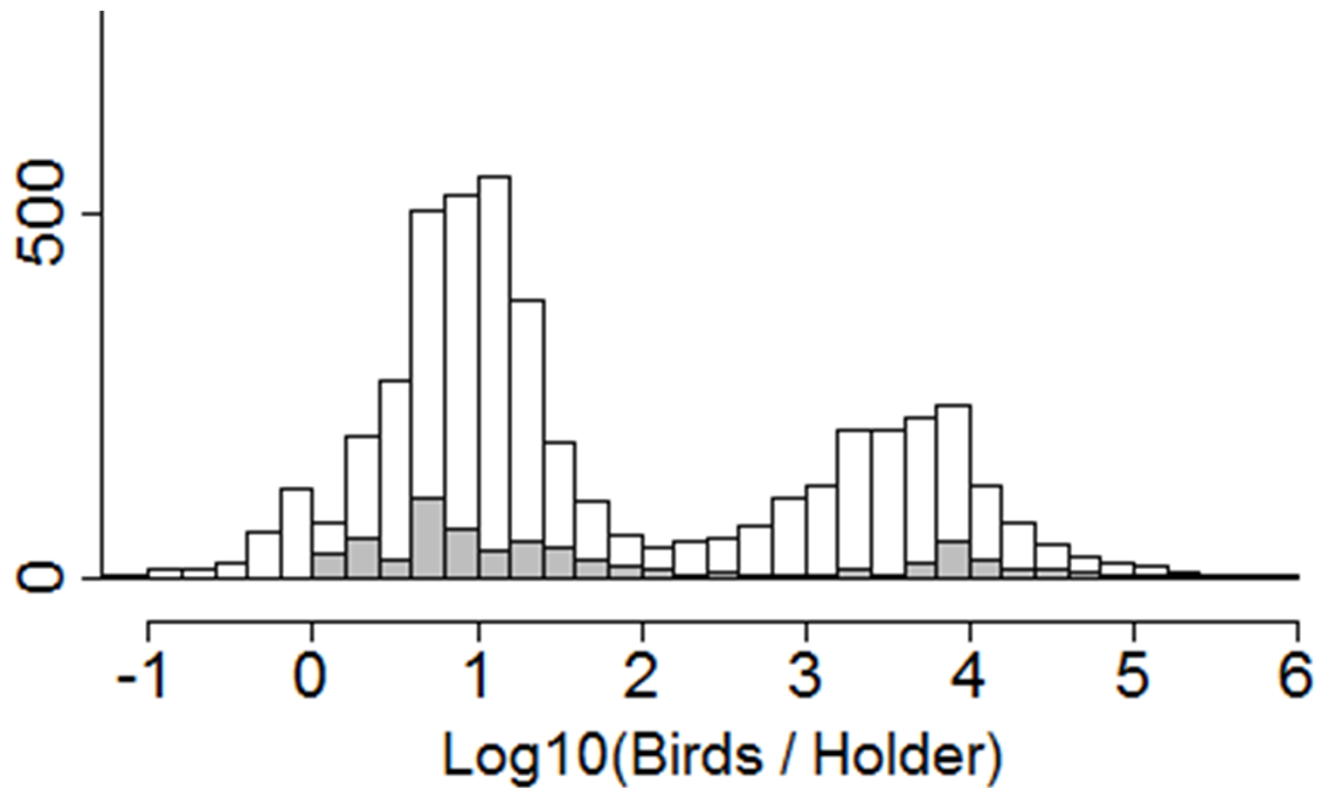
Two main equilibrium

Low input – low outputs (< 2 kg / head / year)

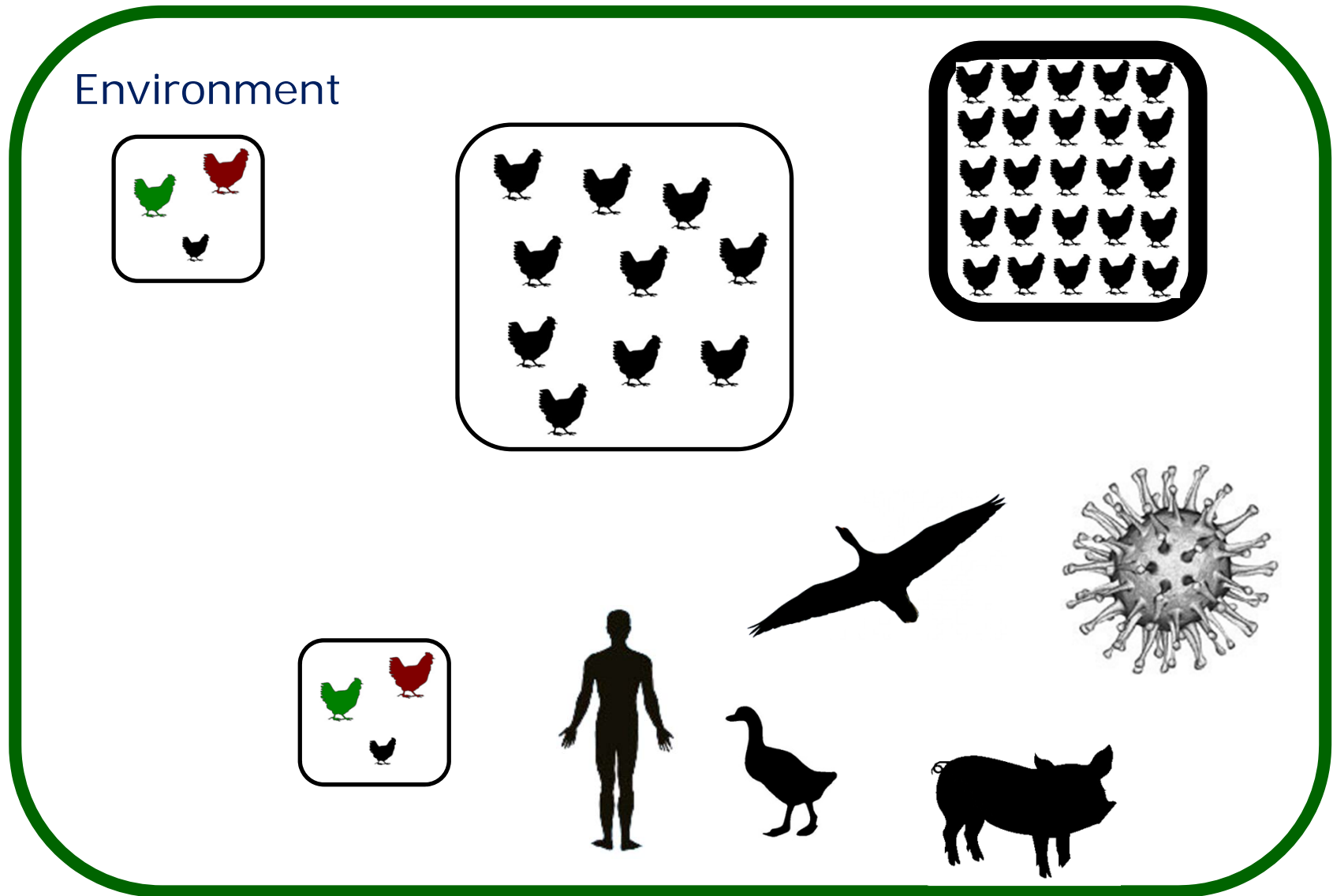
High inputs – high outputs: optimized ratios
(> 10 kg / head / year)



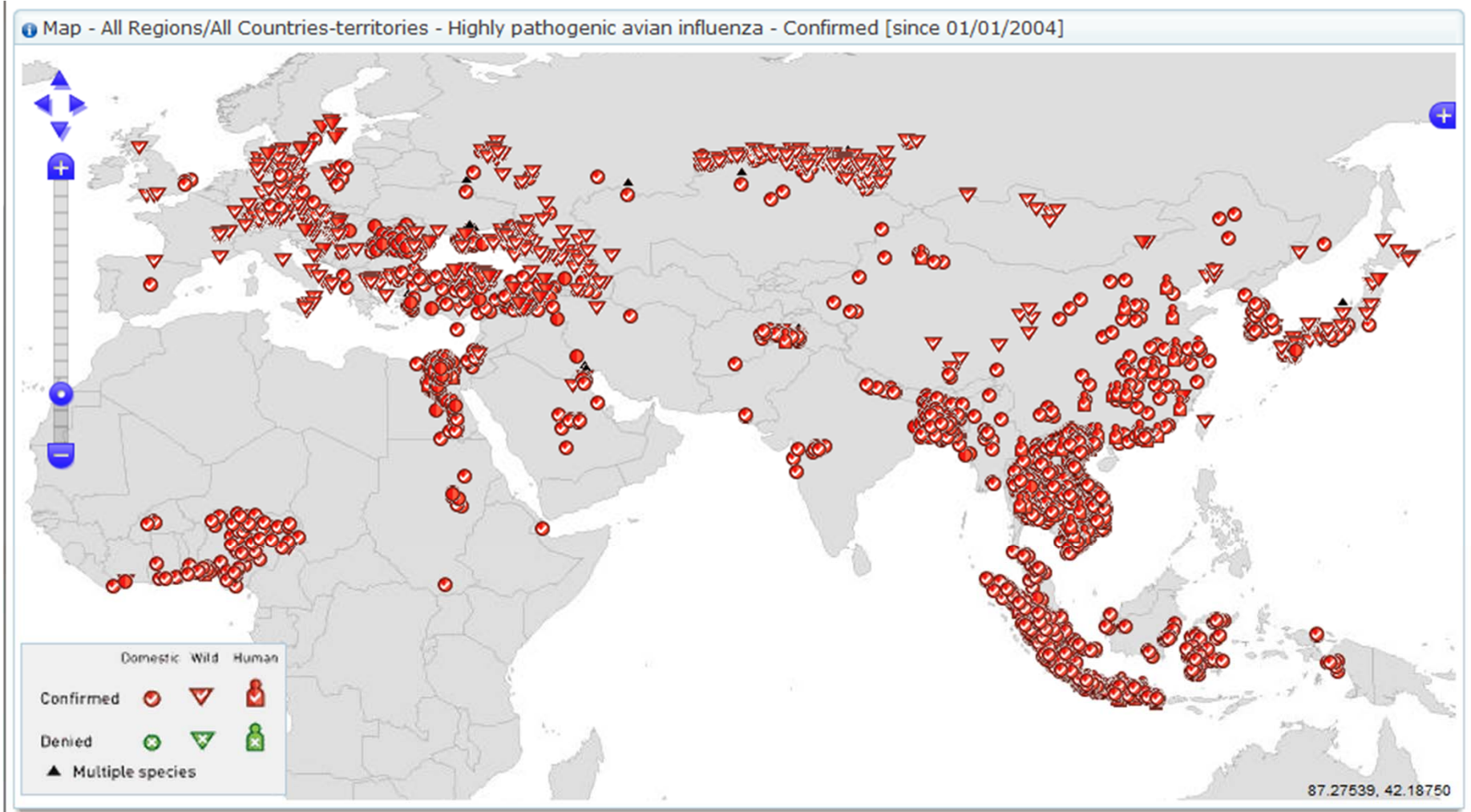
- Thailand: broilers / owner at the sub-district level



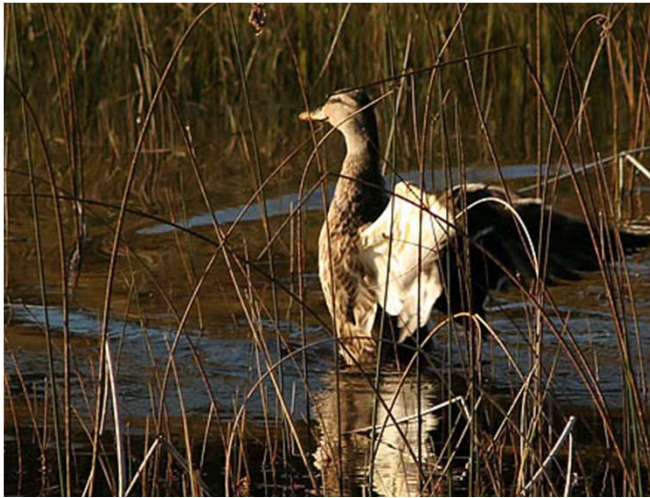
- Real landscapes are a mixture that varies with countries



■ HPAI H5N1 2004-Present



Empres-i (FAO 2011)



Low pathogenic AI

Waterfowls

- Endemic
- Enteric
- Frequent
- High diversity
- Low virulence

Endemic and seasonal



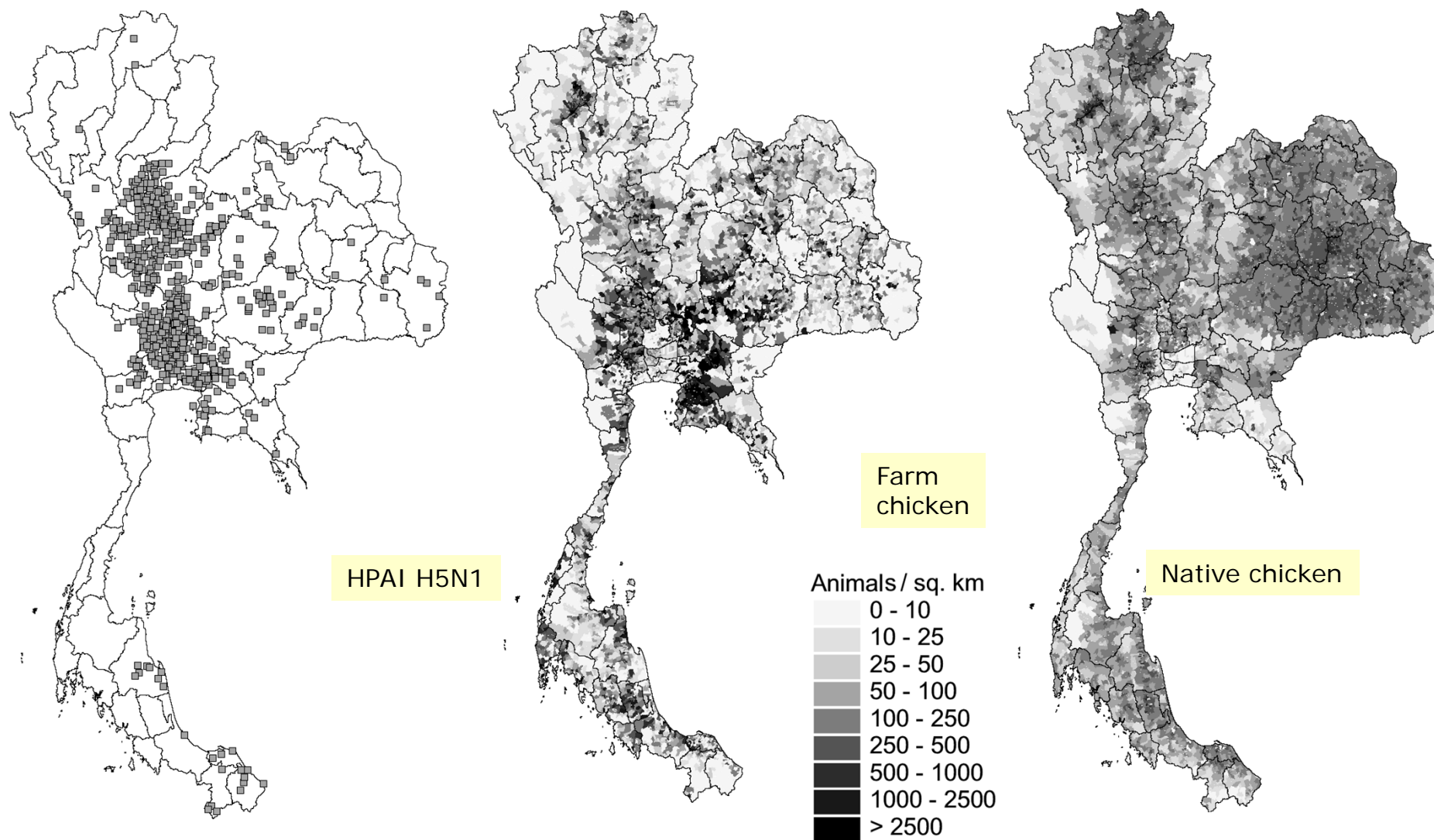
Highly pathogenic AI

Domestic poultry

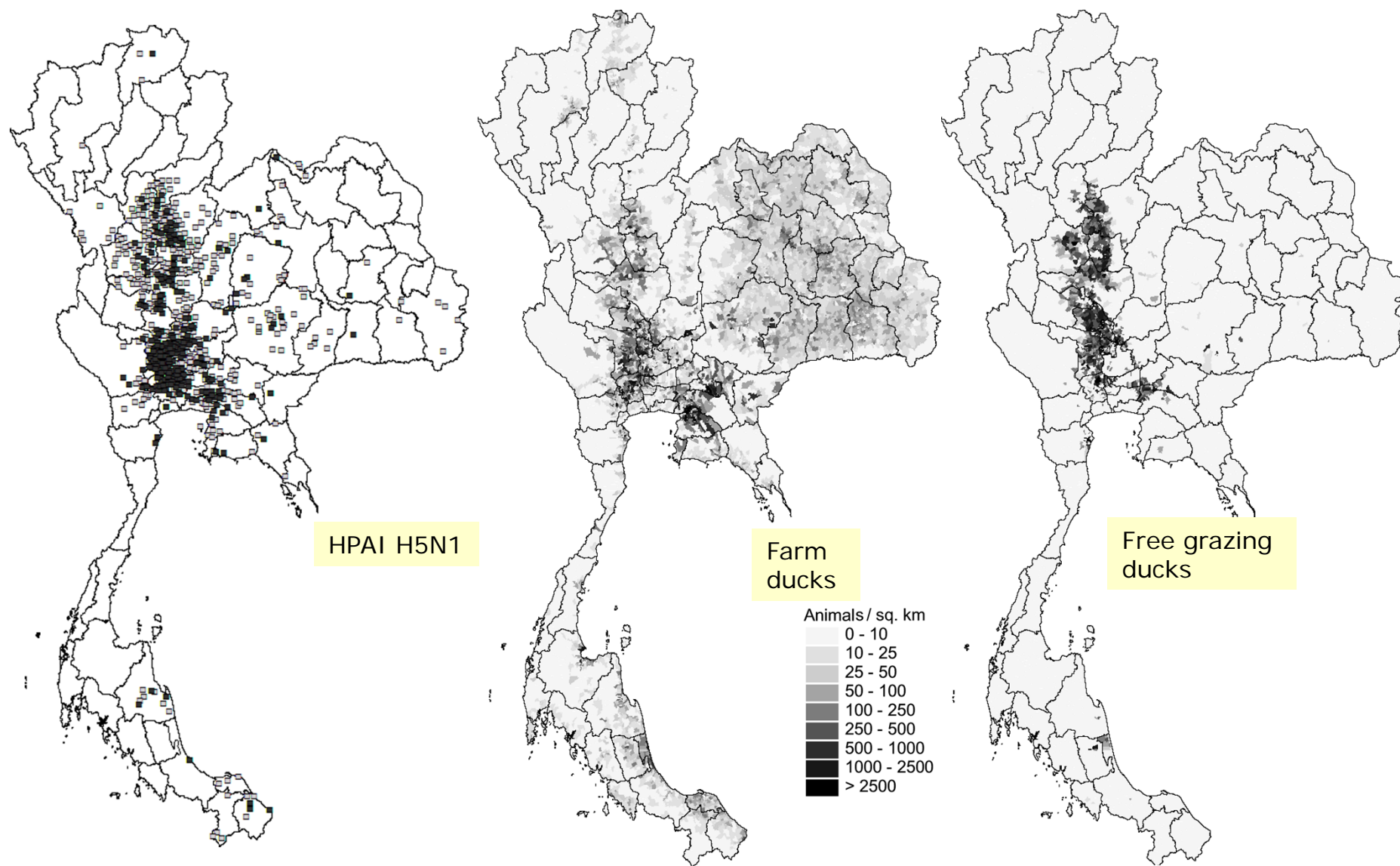
- Epidemic
- Respiratory
- Rare
- One strain
- High mortality

Fast transmission, but
« kills before it spreads »

- Thailand: no apparent match between chicken outbreaks and densities

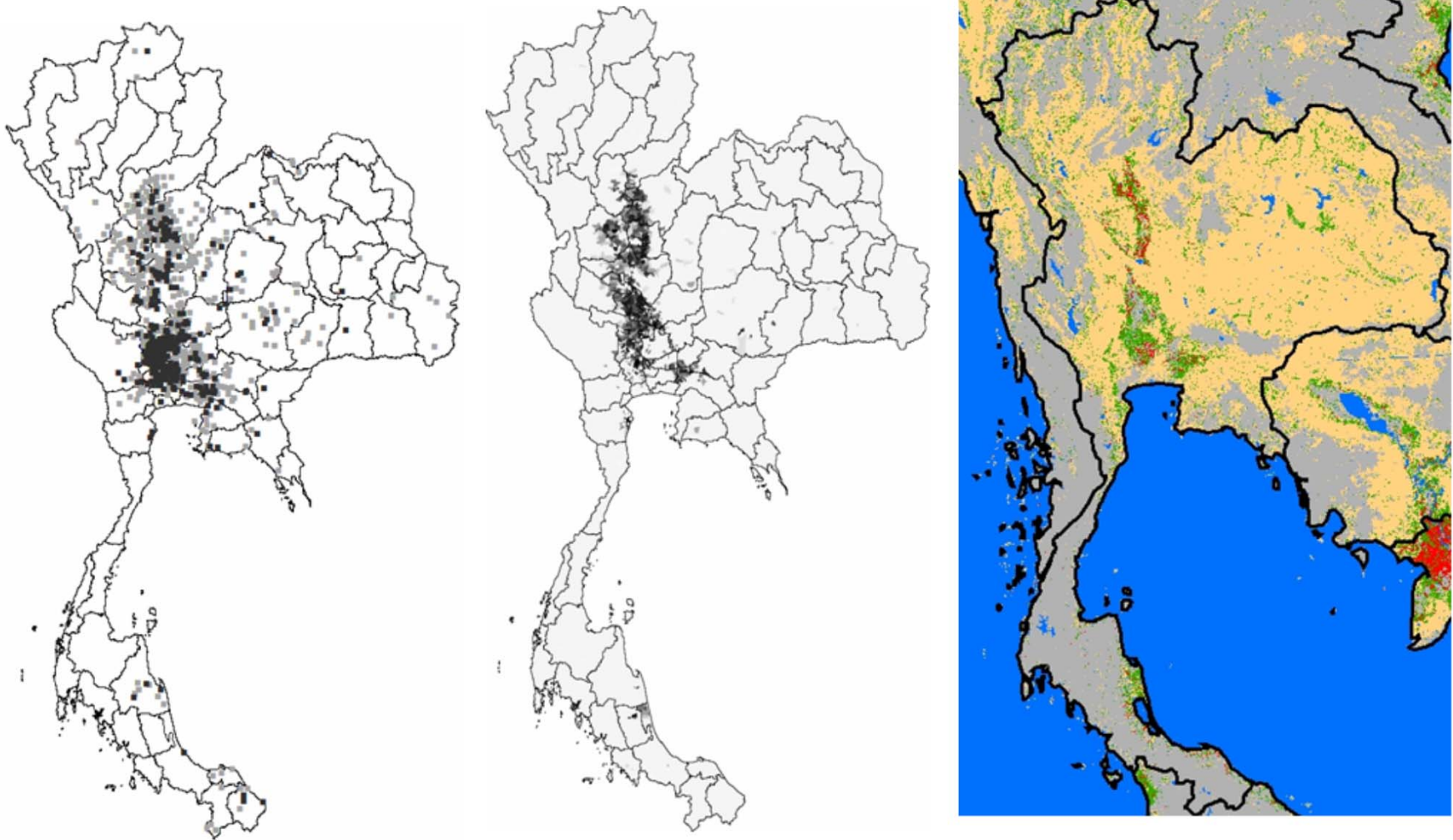


- Thailand: strong correlation with free-grazing ducks

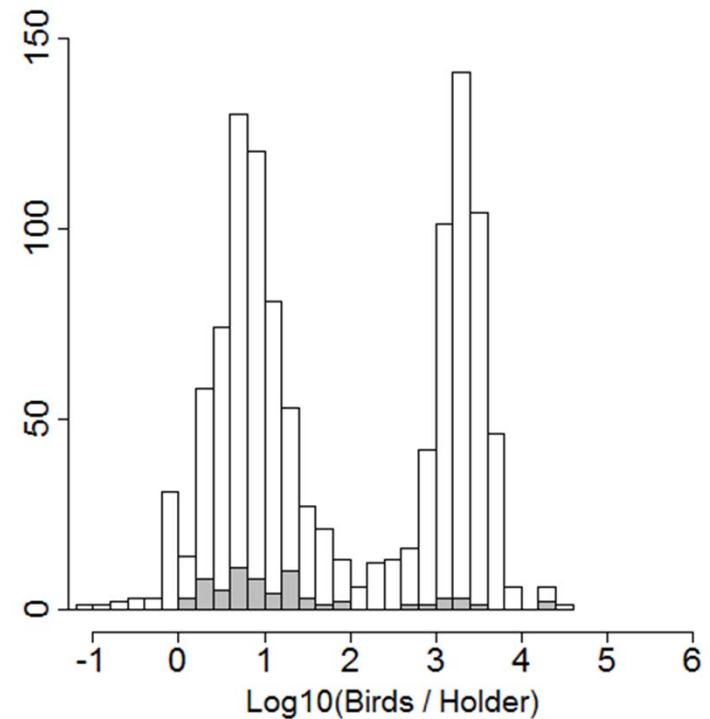


Gilbert et al. (2006) EID 12(2):227-234

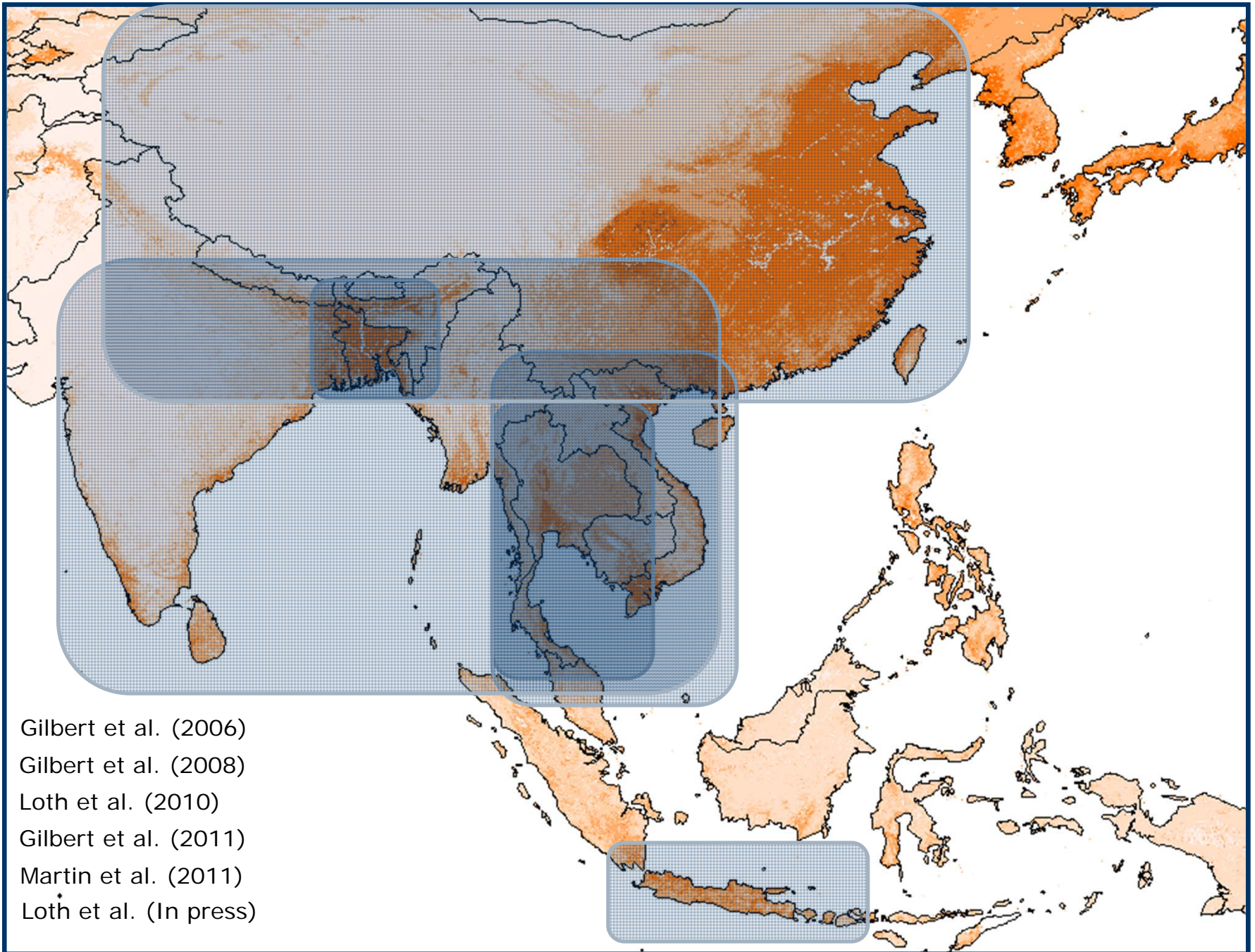
- Thailand: HPAI, free-grazing ducks and rice cropping intensity



- Duck farming in Thailand has many characteristics of intensive farming:



- High densities (> 4000 heads per flock, up to 100,000 heads per owner)
- High movements (a truck can travel > 180 km to transport ducks to rice paddy fields)
- Intensive logistic to collect and sell eggs from 12 millions free-grazing ducks



- In countries where ducks are raised more extensively, their are not such a strong risk factor:
 - Loth, L., *et al.* (2011) Identifying risk factors of Highly Pathogenic Avian Influenza (H5N1 subtype) in Indonesia. *Prev. Vet. Medecine*. Doi:10.1016/j.prevetmed.2011.06.006
 - Gilbert *et al.* (2011) Flying over an infected landscape: distribution of Highly Pathogenic Avian Influenza H5N1 risk in South Asia and satellite tracking of wild waterfowl. *Ecohealth* DOI: 10.1007/s10393-010-0672-8
 - Loth et al. (2010). Risk Factors and Clusters of Highly Pathogenic Avian Influenza H5N1 in *Bangladesh*. *Prev. Vet. Medecine*, 96(1-2):104-113.

- What matters is the duck presence but also how intensively they are raised

- Summary

- **Duck density associates with increased disease risk when intensively raised;**

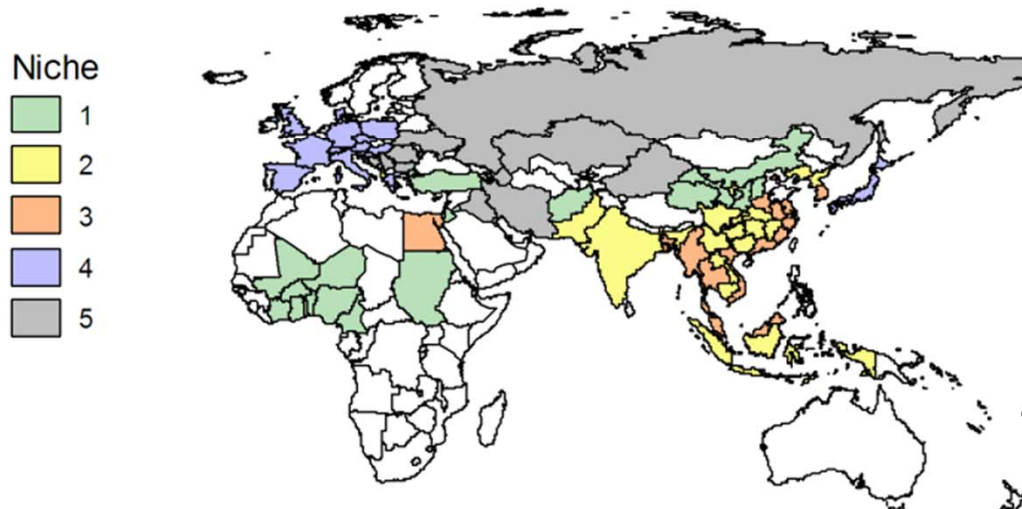
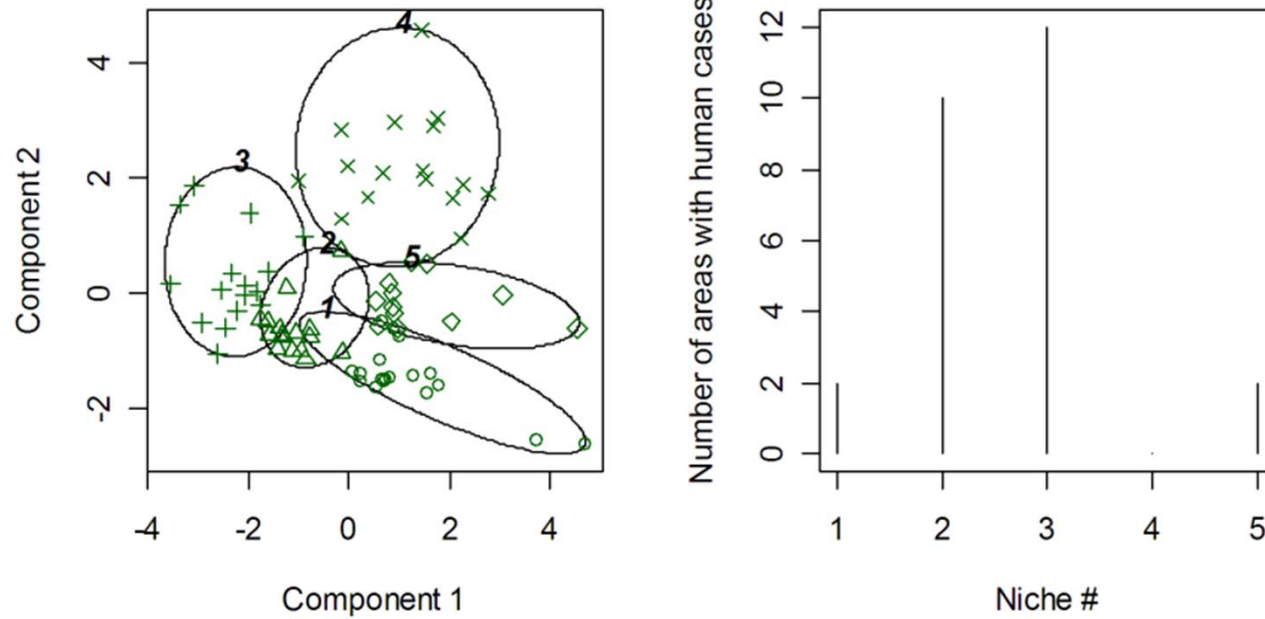
- Study on HPAI H5N1 at the global level with several types of variables:

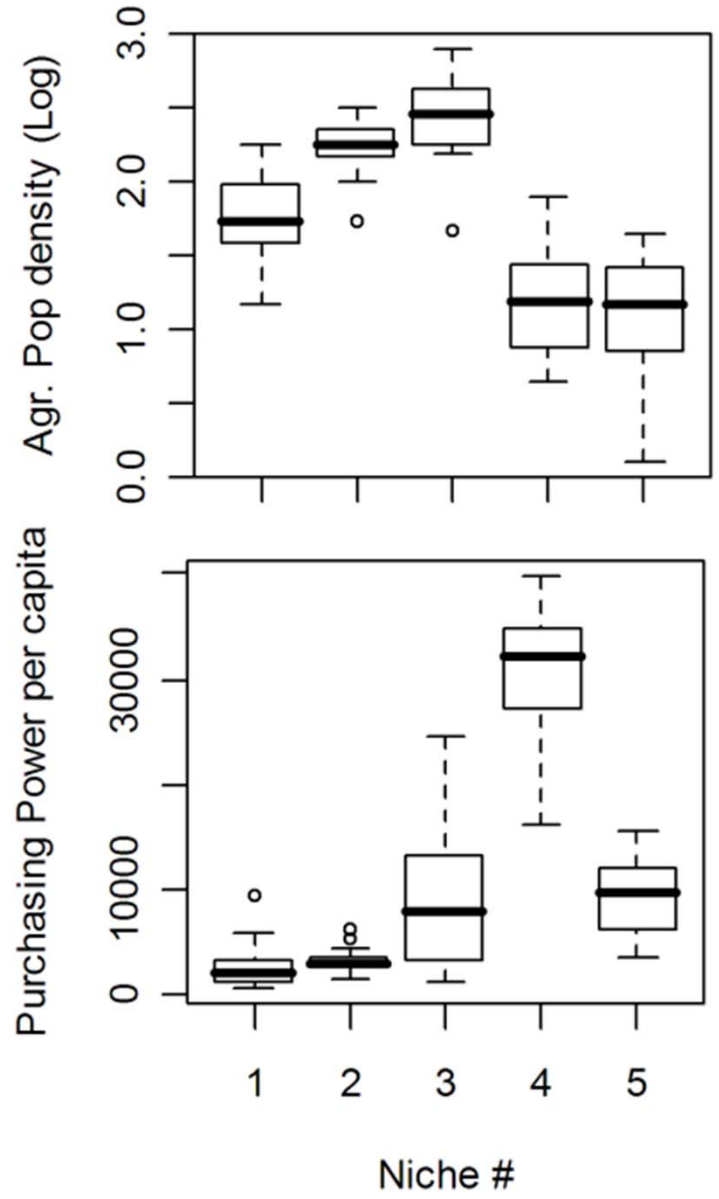
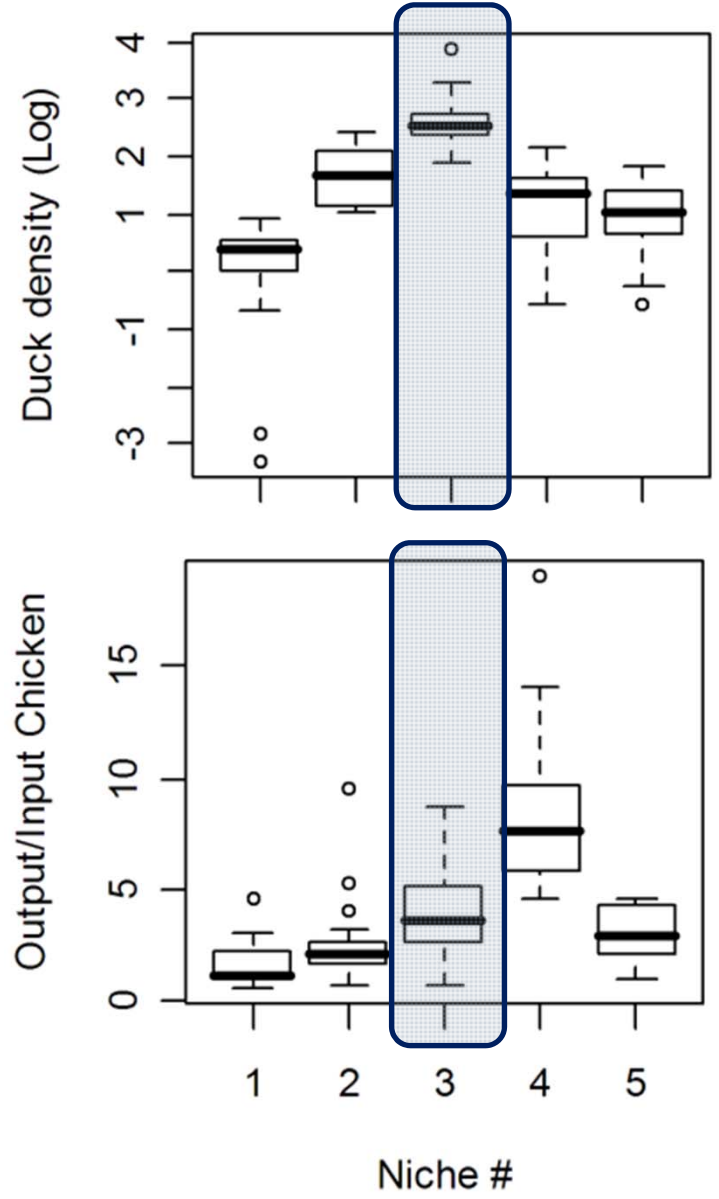
- Environmental;
- Poultry
- Anthropogenic
- Socio-economic;



- Can we contrast different conditions of HPAI H5N1 persistence ?

■ Identification of 5 clusters or agro-ecological niches

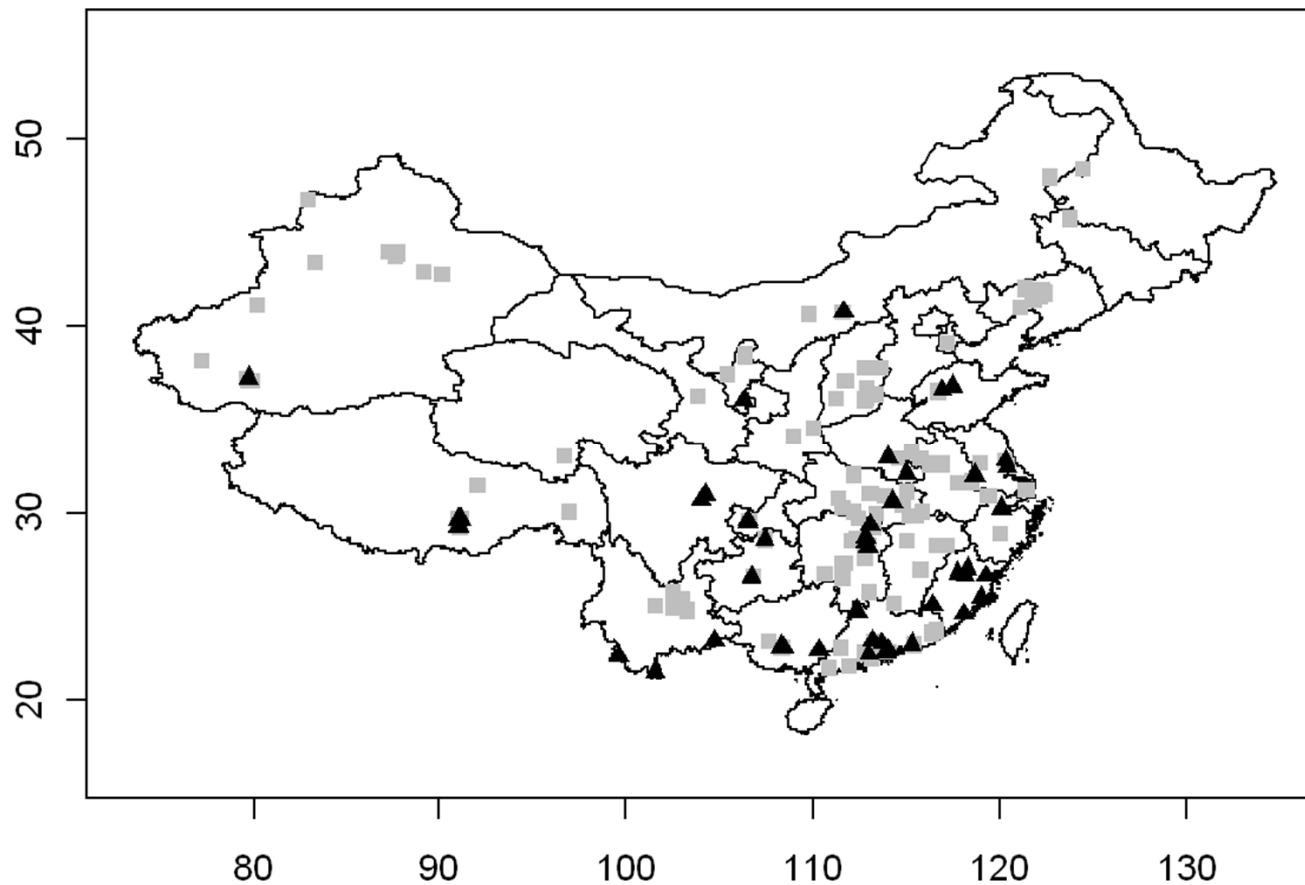


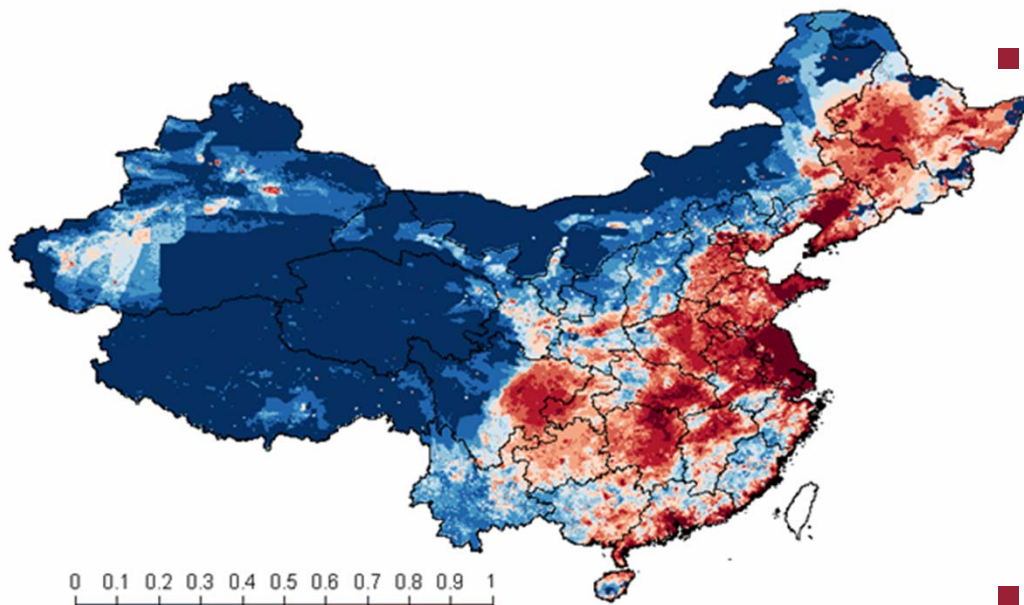


■ Summary

- Duck density associates with disease risk when intensively raised;
- **HPAI H5N1 persisted more strongly in regions with high densities of ducks and increasing productivity;**

- China (75% of all world ducks)
 - Outbreaks (mainly in chicken farms)
 - Positives from apparently health birds obtained through surveillance



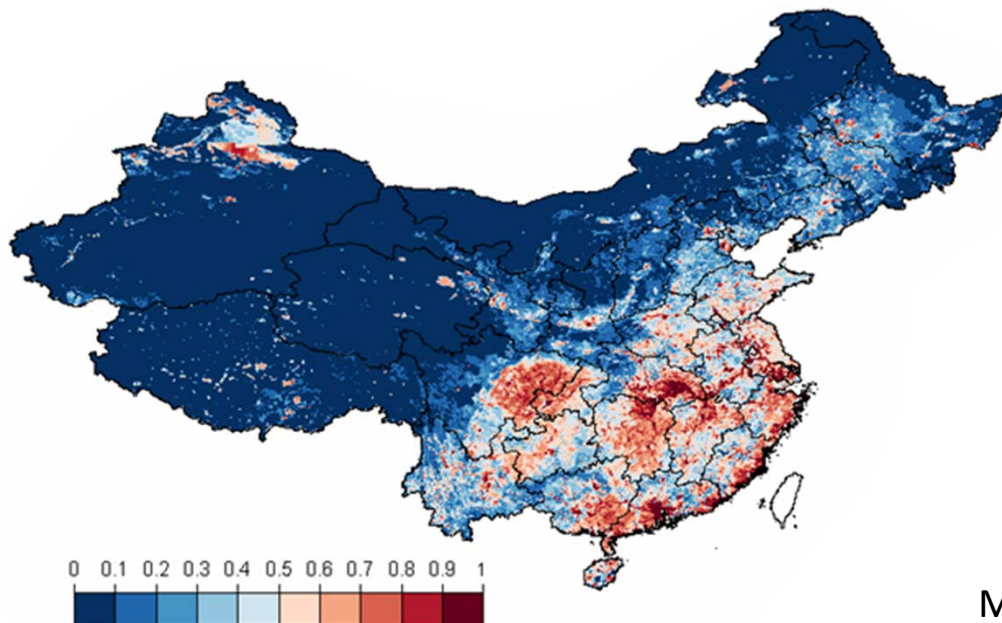


■ Outbreaks

- Chicken and people density;
- In the intensive productions areas

■ Silent circulation (reservoir & evolution):

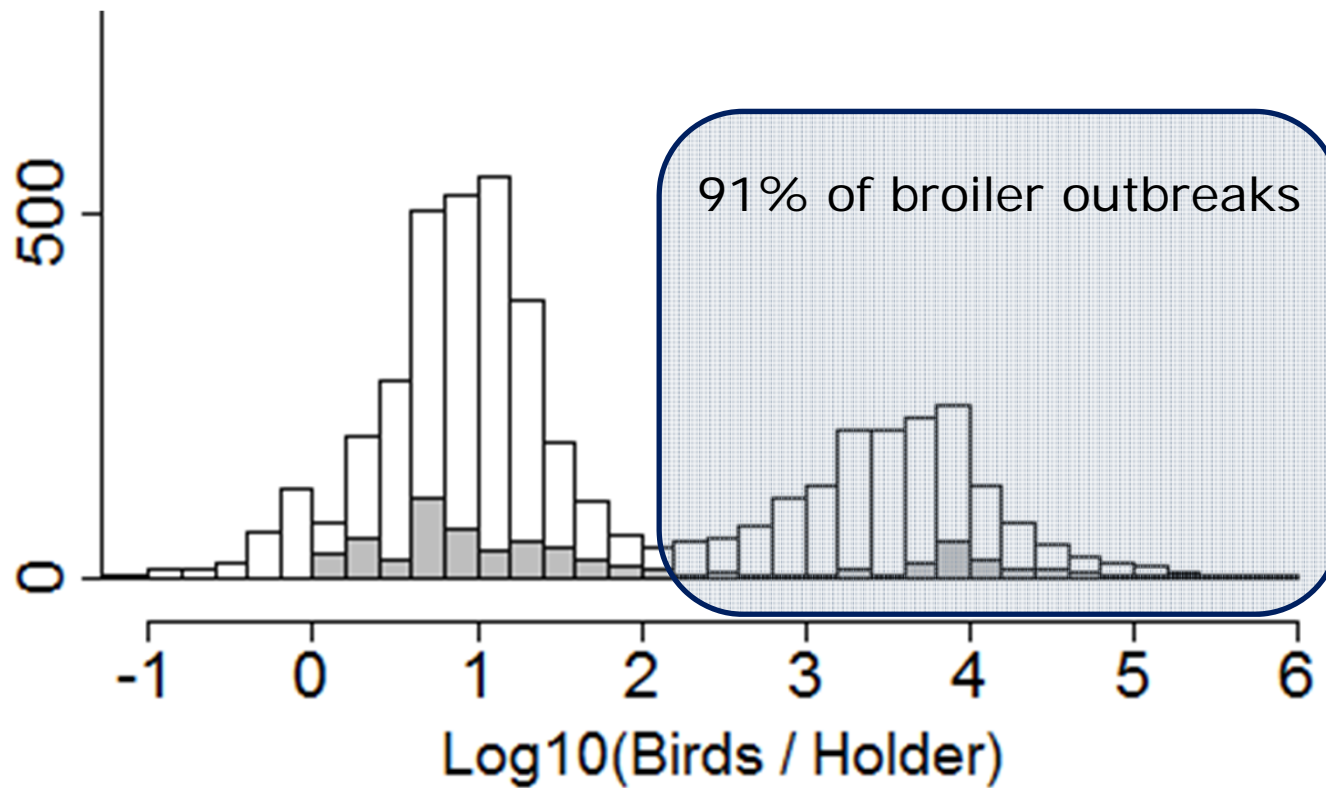
- Duck/rice ecosystem in the south
- Water-related variables



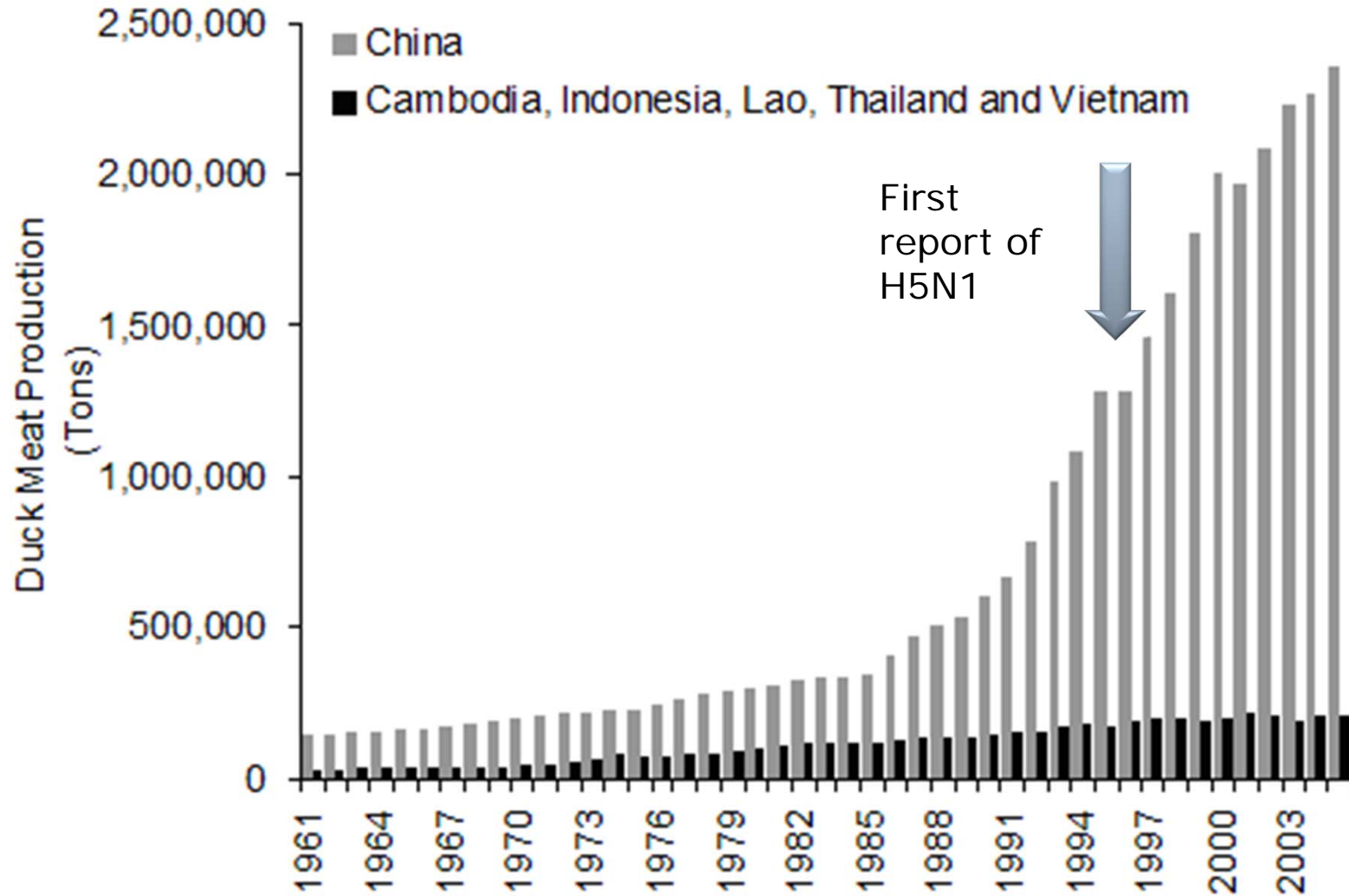
■ Summary

- Duck density associates with disease risk when intensively raised;
- HPAI H5N1 persisted more strongly in regions with high densities of ducks and increasing productivity;
- **In China, despite mass-vaccination, i) HPAI circulates silently in duck/rice/water agro-ecosystems; ii) causes outbreaks in intensive chicken farms;**

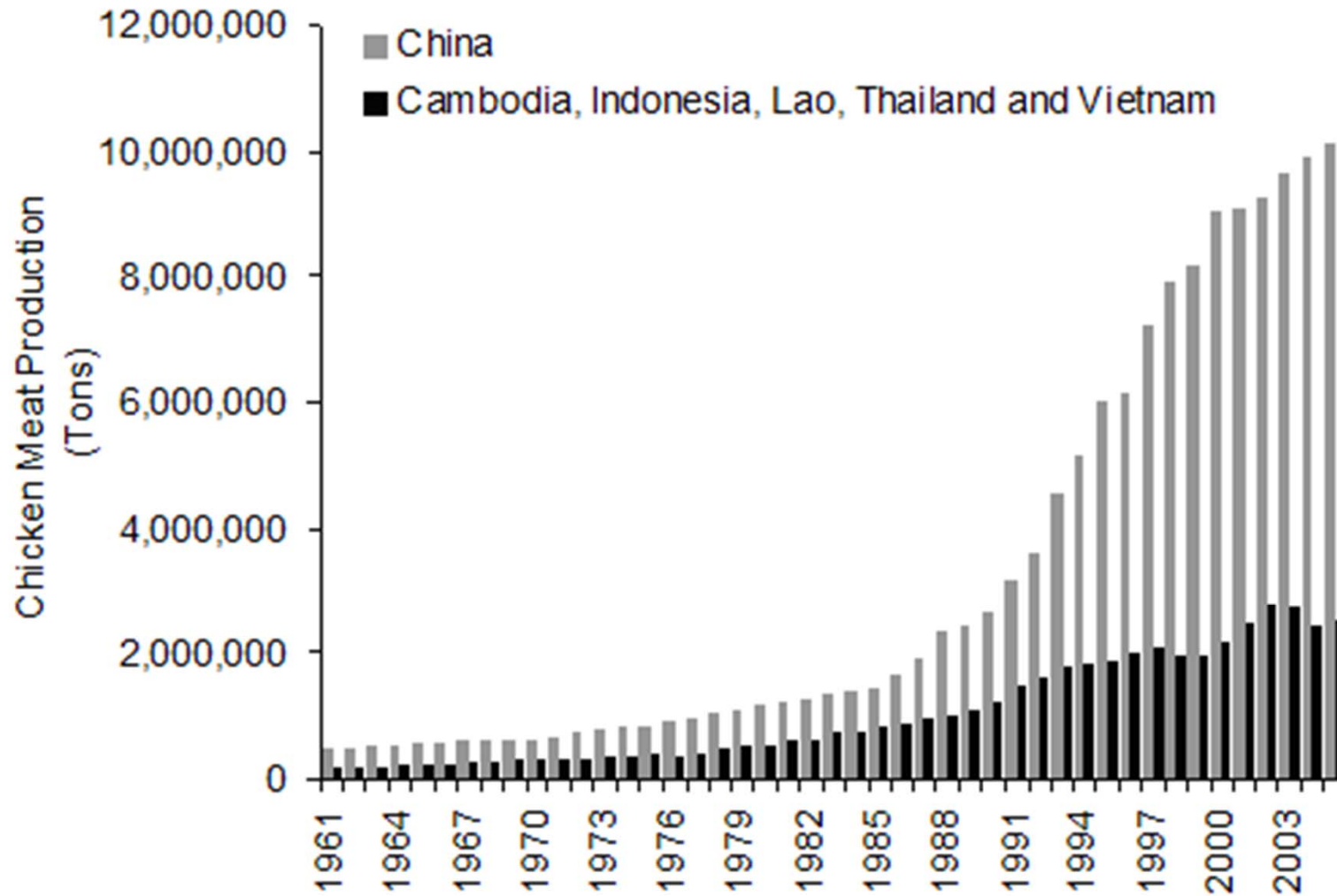
- Thailand: broilers / owner at the sub-district level



- Intensification of duck production in East & Southeast Asia



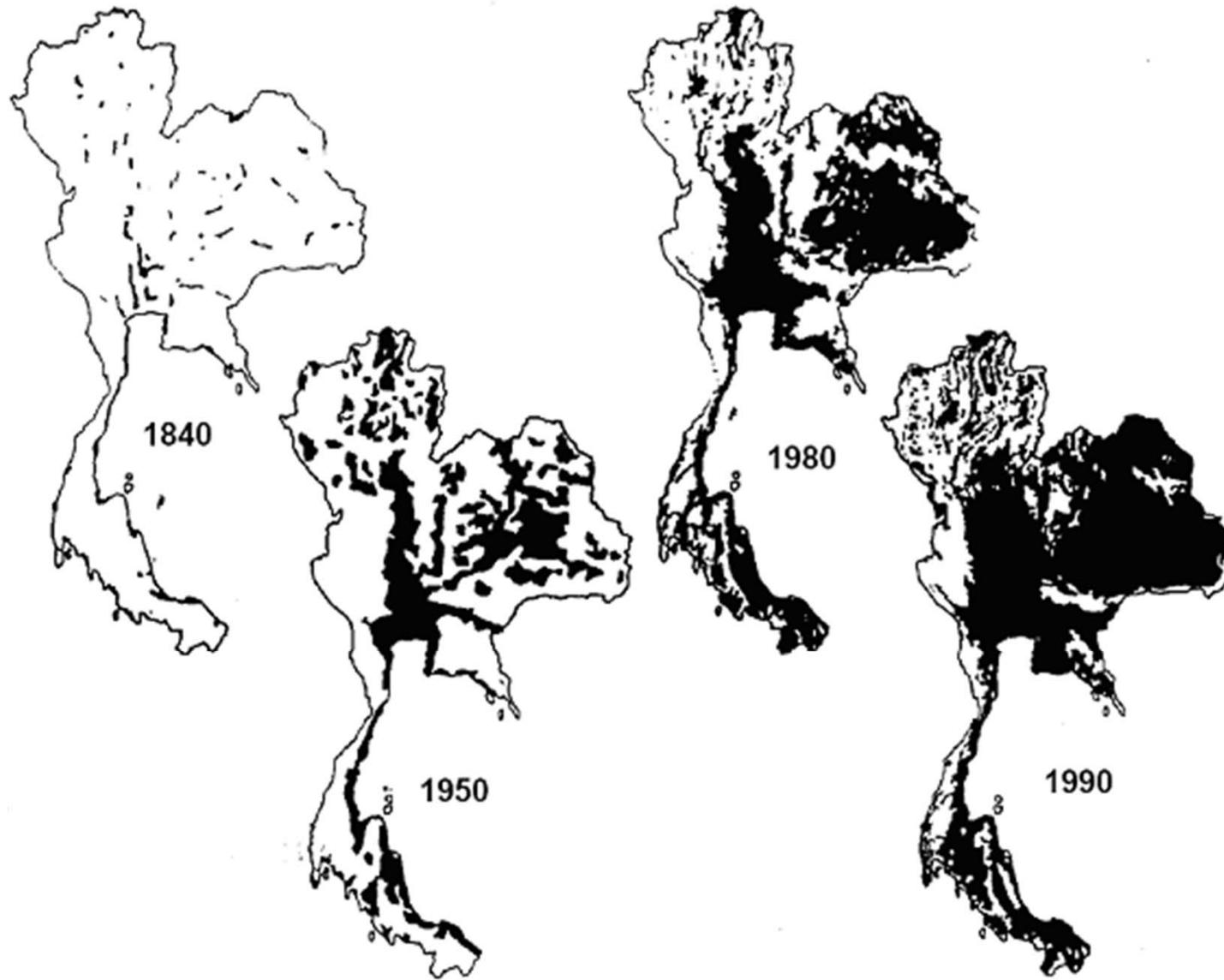
- Intensification of chicken production in east and southeast Asia



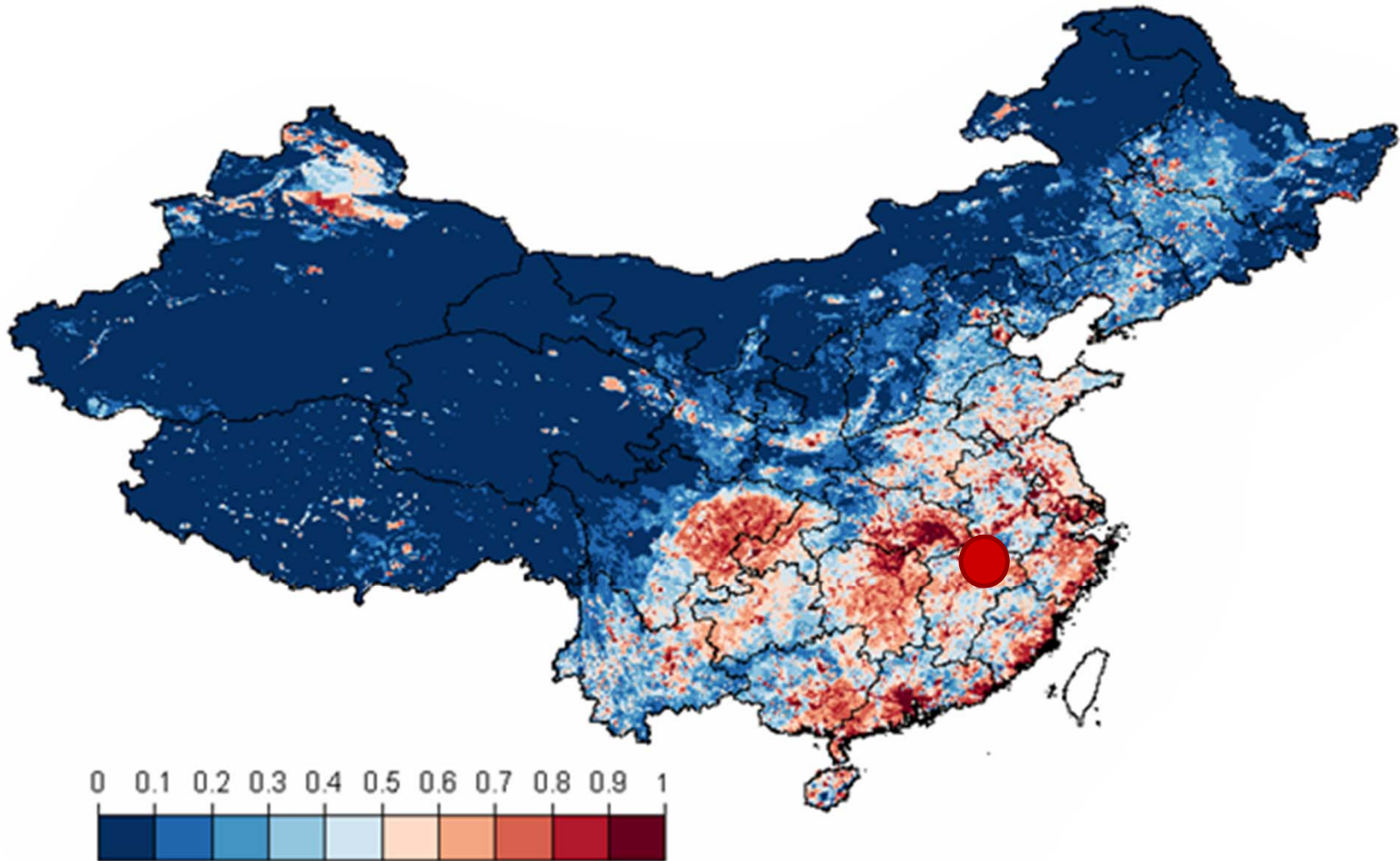
■ Summary

- Duck density associates with disease risk when intensively raised;
- HPAI H5N1 persisted more strongly in regions with high densities of ducks and increasing productivity;
- In China, despite mass-vaccination, i) HPAI circulates silently in duck/rice/water agro-ecosystems; ii) causes outbreaks in intensive chicken farms;
- **China dramatically intensified duck production in the last decades;**

- Crop expansion in Thailand



- Poyang lake: main lake for migratory waterfowls









■ Summary

- Duck density associates with disease risk when intensively raised;
- HPAI H5N1 persisted more strongly in regions with high densities of ducks and increasing productivity;
- In China, despite mass-vaccination, i) HPAI circulates silently in duck/rice/water agro-ecosystems; ii) causes outbreaks in intensive chicken farms;
- China dramatically intensified duck production in the last decades;
- **Intensification of duck production is taking place in areas encroaching wetlands with high wild waterfowls populations (and hence a diverse genetic pool of virus)**

■ Conclusions

- Intensification of duck production in China allowed the development of a highly pathogenic AI in ducks ?
 - Varying levels of pathogenicity in domestic ducks;
 - Highly pathogenic to chicken;
 - Highly pathogenic to some species of waterfowls;
- The success of H5N1 is due to it's capacity to:
 - Circulate partly silently in ducks;
 - Spread through trade of live poultry and poultry products;
 - Spread over long-distance through migratory birds
- This contrasts to previous HPAI epidemics that implied mainly evolution in chicken:
 - In intensive chicken production regions surrounded by waterfowl step-over sites;
 - Primarily in terrestrial poultry (chicken, turkey);
 - No return to waterfowls;

A satellite map of a river delta region, likely the Yangtze River Delta, with a semi-transparent blue overlay containing text. The map shows a complex network of waterways and land. Several locations are marked with red dots and labeled: Zhangtiandu (top right), Sanchagang (center), Sishijiang (right), Poyang (bottom right), and Tujlabu (left). The text is white and lists applications of Remote Sensing (RS) in the context of HPAI transmission dynamics and wildlife habitat.

■ How does RS help us ?

- Quantifying the role of water in HPAI transmission dynamics;
- Quantifying and mapping cropping intensity;
- Mapping the interface between wild & domestic waterfowl habitat in space and time;
- Fine-resolution predictors used to disaggregate livestock census data;
- Spatio-temporal models of wildlife habitat;

Thank you

Acknowledgments:

L. Hogerwerf, V. Martin, T. Van Boeckel (PhD, ULB)

L. Loth, Scott Newmann (FAO)

R. Wallace (U. Minnesota)



Selected references

- Martin, Met al. (In press) Value chain and social network analysis in the planning and implementation of risk-based surveillance for avian influenza control in South China. *Preventive and Veterinary Medicine*.
- Loth, L., et al. (2011) Identifying risk factors of Highly Pathogenic Avian Influenza (H5N1 subtype) in Indonesia. *Prev. Vet. Medecine*.
Doi:10.1016/j.prevetmed.2011.06.006
- Van Boeckel et al. (2011) Modelling the distribution of domestic duck in Monsoon Asia. *Agriculture, Ecosystems and Environment*. Doi: 10.1016/j.agee.2011.04.013
- Martin et al. (2011) Spatial distribution and risk factors of highly pathogenic avian influenza (HPAI) H5N1 in China. *Plos Pathogens*. PLoS Pathogens 7(3): e1001308.
- Gilbert al. Flying over an infected landscape: distribution of Highly Pathogenic Avian Influenza H5N1 risk in South Asia and satellite tracking of wild waterfowl. *Ecohealth* DOI: 10.1007/s10393-010-0672-8
- Loth et al. (2010). Risk Factors and Clusters of Highly Pathogenic Avian Influenza H5N1 in Bangladesh. *Preventive Veterinary Medicine*, 96(1-2):104-113 (FI 1.506).
- Hogerwerf et al. (2010) Persistence of highly pathogenic avian influenza H5N1 virus defined by agro-ecological niche. *EcoHealth* 7(2):213
DOI: 10.1007/s10393-010-0324-z
- Gilbert M.,et al.. (2008) Mapping H5N1 highly pathogenic avian influenza risk in Southeast Asia. *Proceedings of the National Academy of Science, USA*, 105: 4769-4774 (FI 9.38)
- Gilbert et al. (2007) Avian influenza, domestic ducks and rice agriculture in Thailand. *Agriculture, Ecosystems and Environment* 119:409-415. (FI 1.207)
- Gilbert et al. (2006) Free-grazing Ducks and Highly Pathogenic Avian Influenza, Thailand. *Emerging Infectious Diseases* 12(2):227-234

See <http://lubies.ulb.ac.be/publications.html> for full list