Spatial Epidemiology of Highly Pathogenic Avian Influenza H5N6 in Gyeonggi Province, South Korea, 2016-2017

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Background

- Most of epidemioBetween November 2016 and March 2017, there were 123 (32.2%, among 382 cases in Korea) HPAI H5N6 cases were reported in Gyeonggi Province, Korea
- Epidemiological researches for HPAI have been focused on Southeast Asian regions.
- **Purpose**
  - **Identifying the spatial cluster, and risk factors**
  - **Supporting policy decision**

Study Design

2,950 Poultry Farms

629 **Control** farms.
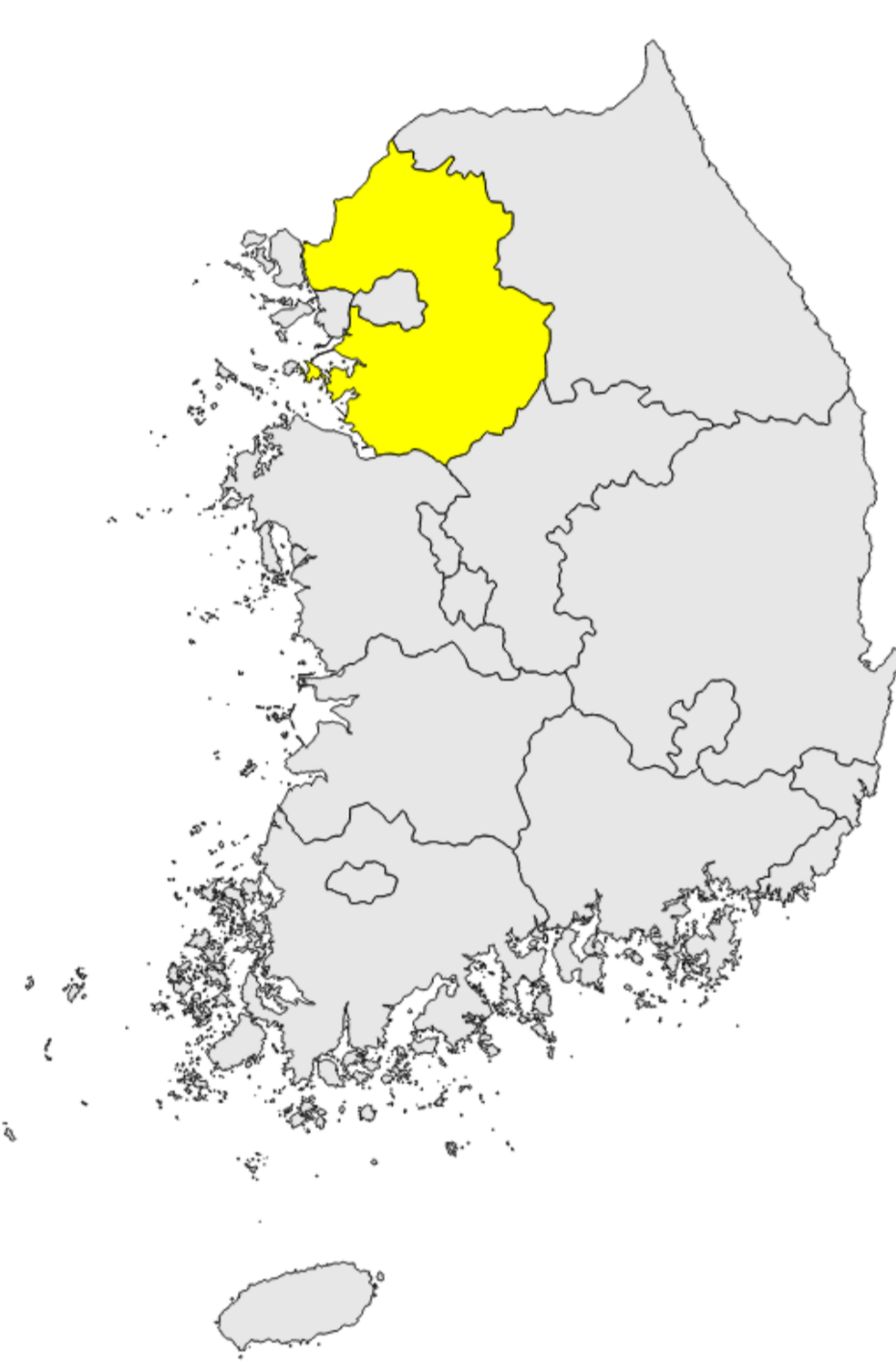
123 **Case** farms

122 Case farms

1. Detected by Active surveillance
   Test for pre-slaughtered poultry farms
   Periodic mandatory test for all poultry farms
   Test for epidemiologically related farms
2. Detected by Passive surveillance
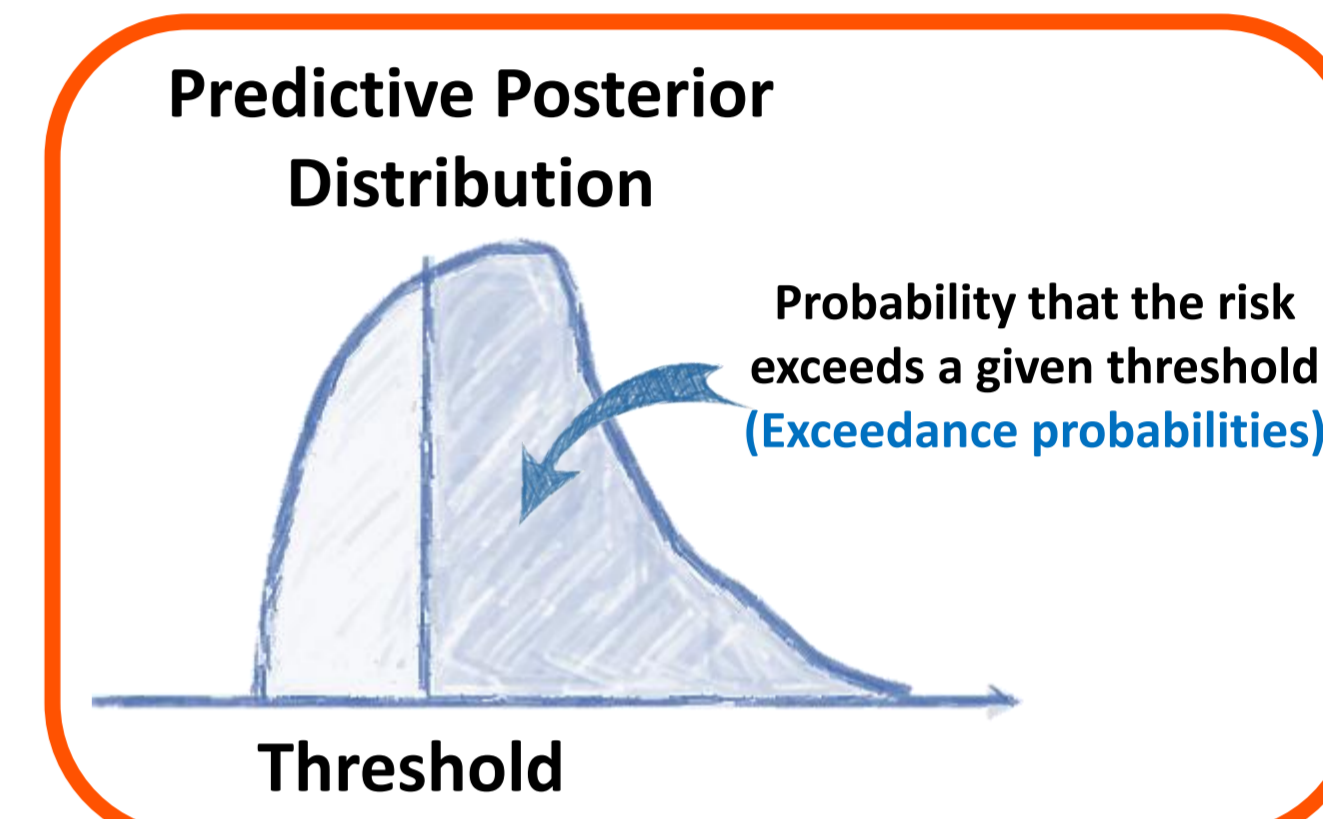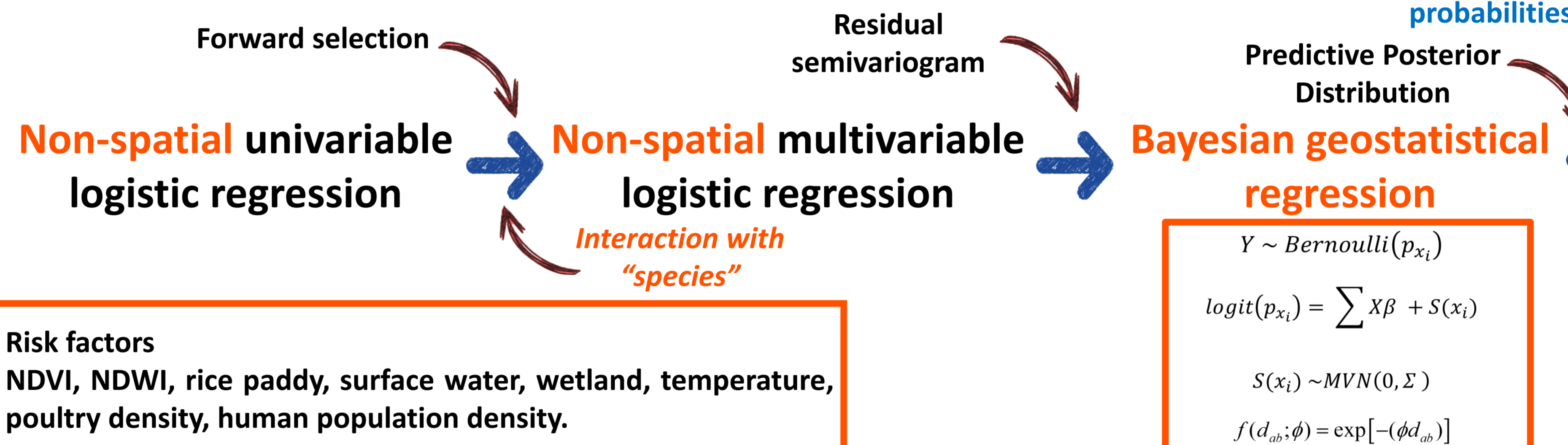   Report by farmers
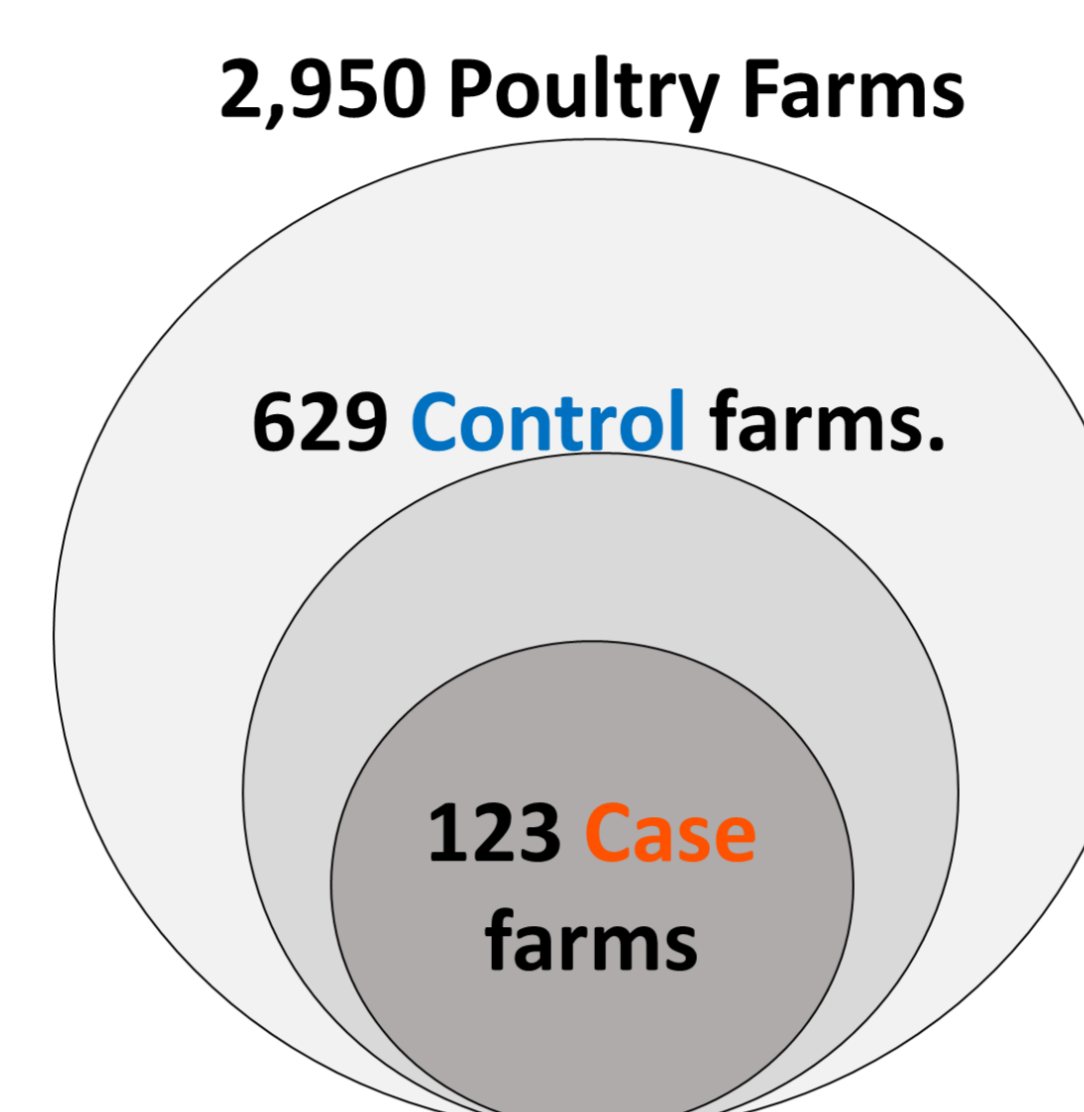
629 Control farms

1. Farms operated during entire study period with HPAI-negative
2. Farms breeding HPAI-susceptible species
3. Farms holding less than 200 animals

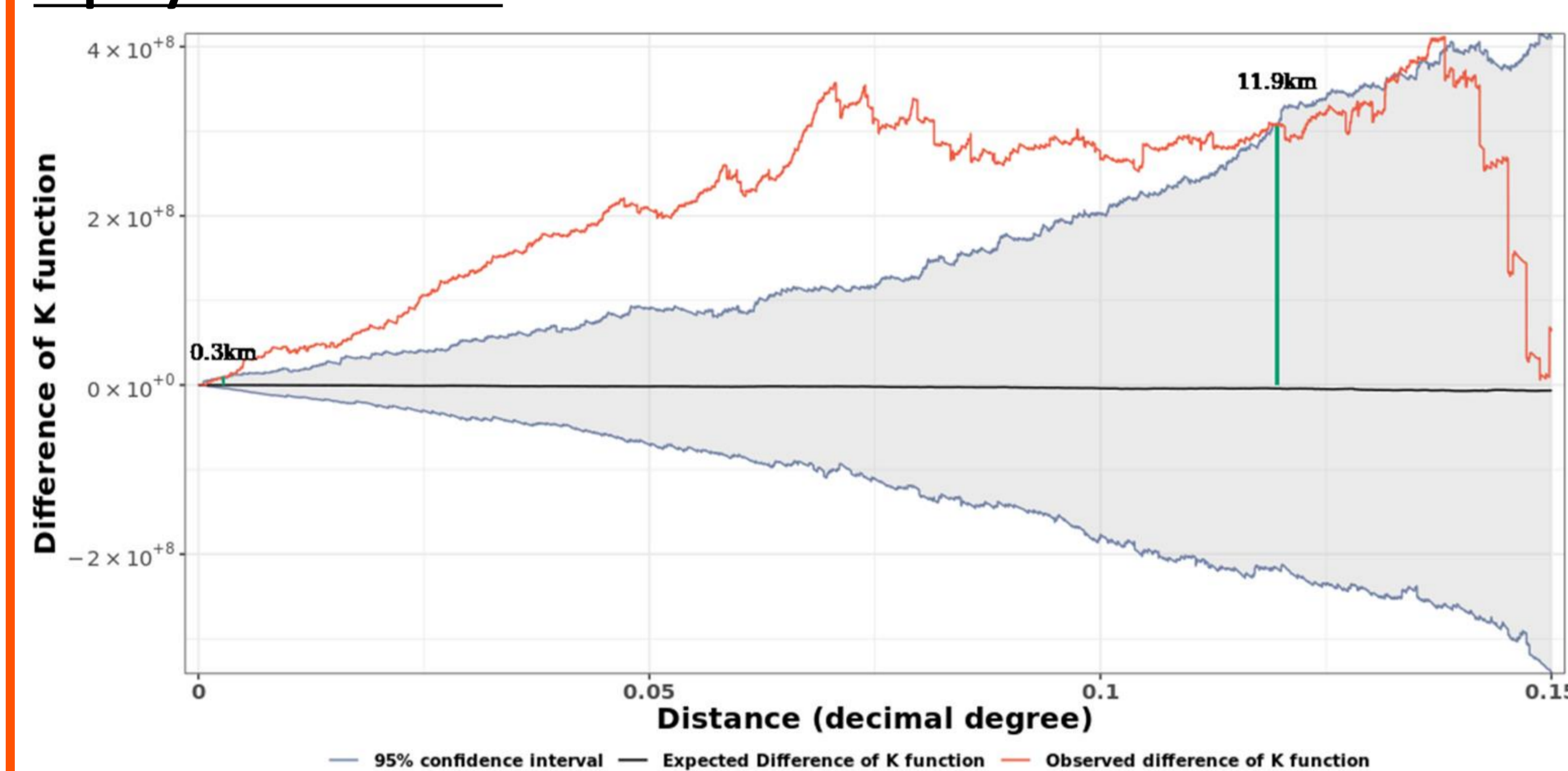**Ripley's K-function**

$$D(s) = K_{case} - K_{control}$$

Predictive Posterior Distribution

Probability that the risk exceeds a given threshold (Exceedance probabilities)

Threshold

Model building

Forward selection → Residual semivariogram → Exceedance probabilities

Predictive Posterior Distribution

Non-spatial univariable logistic regression → **Non-spatial multivariable logistic regression** → **Bayesian geostatistical regression** → **Supporting Decision**

Interaction with "species"

Risk factors
NDVI, NDWI, rice paddy, surface water, wetland, temperature, poultry density, human population density.

$$Y \sim Bernoulli(p_{x_i})$$
$$logit(p_{x_i}) = \sum X\beta + S(x_i)$$
$$S(x_i) \sim MVN(0, \Sigma)$$
$$f(d_{sh};\phi) = \exp[-(\phi d_{sh})]$$

We defined

High risk region as
- Exceedance probabilities > 0.7
- Threshold: 0.9

Results & Discussion

Ripley's K-function

11.9km

0.3km

Distance (decimal degree)

Difference of K function

— 95% confidence interval — Expected Difference of K function — Observed difference of K function

Residuals semivariogram of multivariable logistic regression

NDVI, NDWI, elevation, surface water, wetland,

semivariance

distance
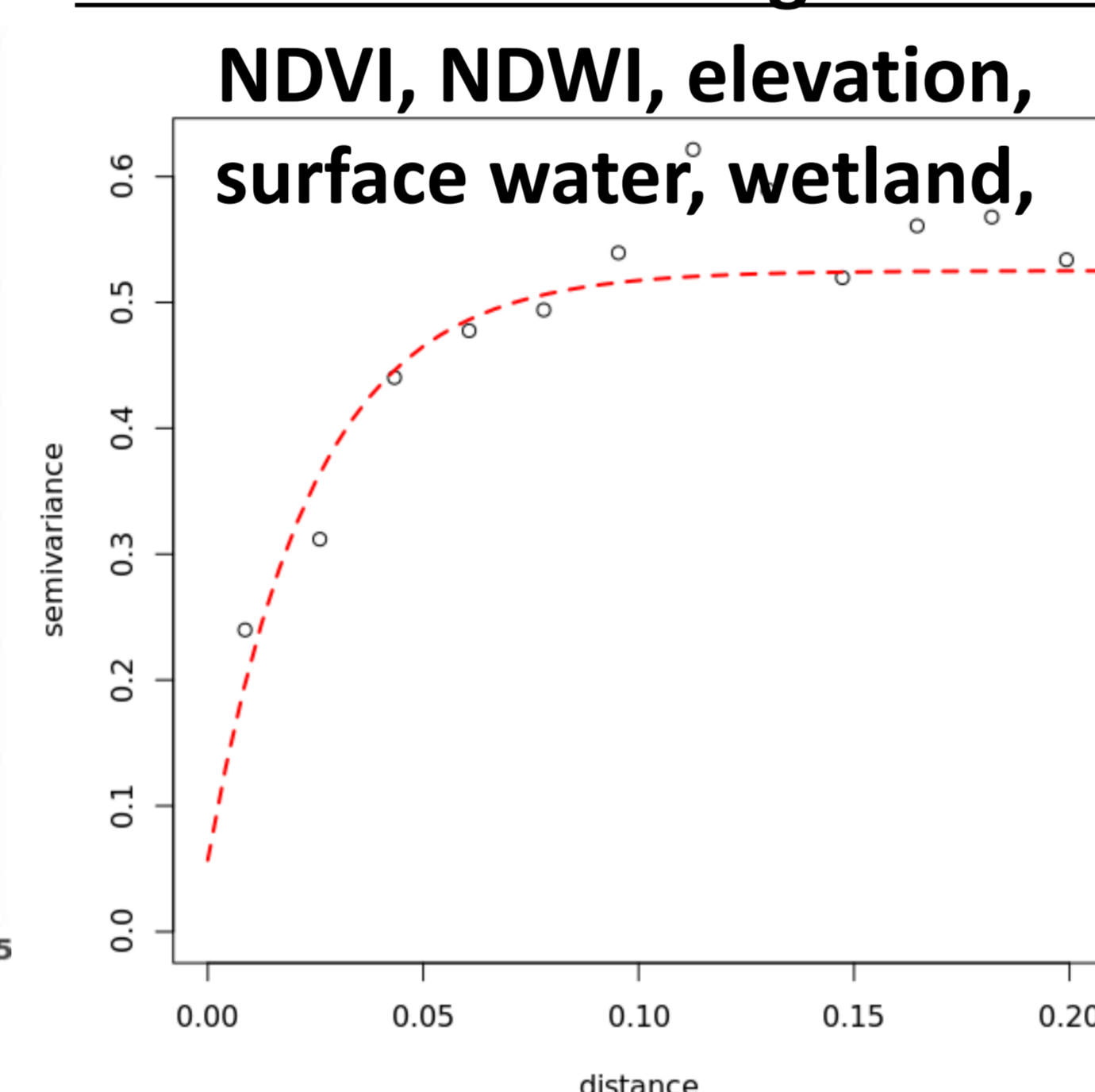
Non-spatial Multivariable logistic regression include
1. Poultry density
2. Species (dummy, chicken(ref); duck; others;)
3. Area of rice paddy
4. Interaction between species and area of rice paddy

Parameters	Value
Partial sill	0.47
Nugget	0.06
Practical range (decimal degree)	0.07

When accounting for the effects of risk factors

**Spatial Clustering _From 11.9km to 7km_**

Sources for control and interventions can _be allocated in more focused spatial range_

Maybe suggesting the possibility

Bayesian geostatistical models

Variables	Chicken OR (95% CrI)	Duck OR (95% CrI)	Others OR (95% CrI)
Poultry density		20.31 (6.54 – 136.73)	
Area of rice paddy	3.41 (1.18 – 15.20)	16.02 (1.06 – 632.70)	0.55 (0.03 – 11.77)
Intercept	0.01 (0.00 – 0.27)	0.05 (0.01 – 4.35)	0.04 (0.00 – 3.18)

(+) (+++) (+/-)
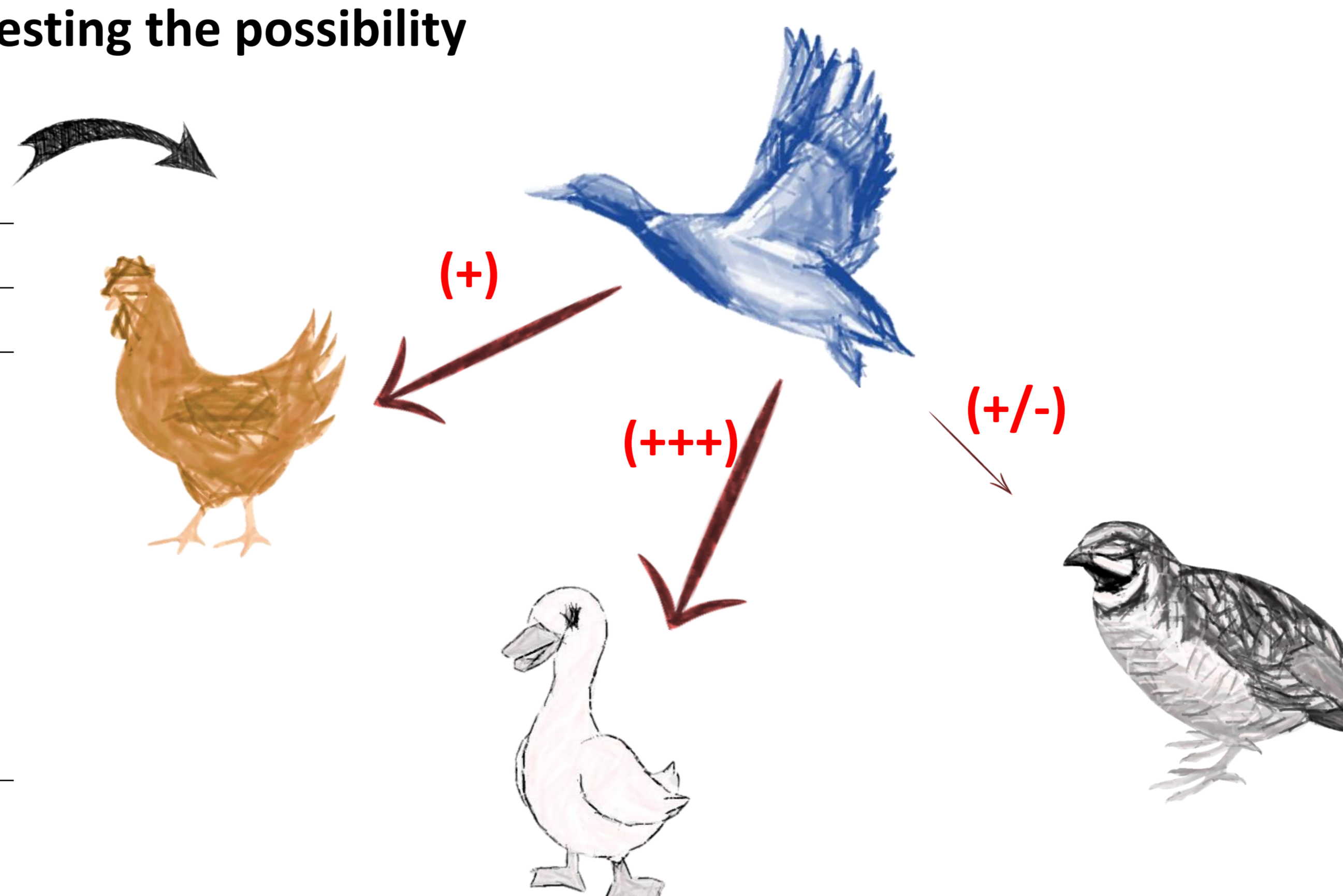
Risk of HPAI H5N6 in chicken farm
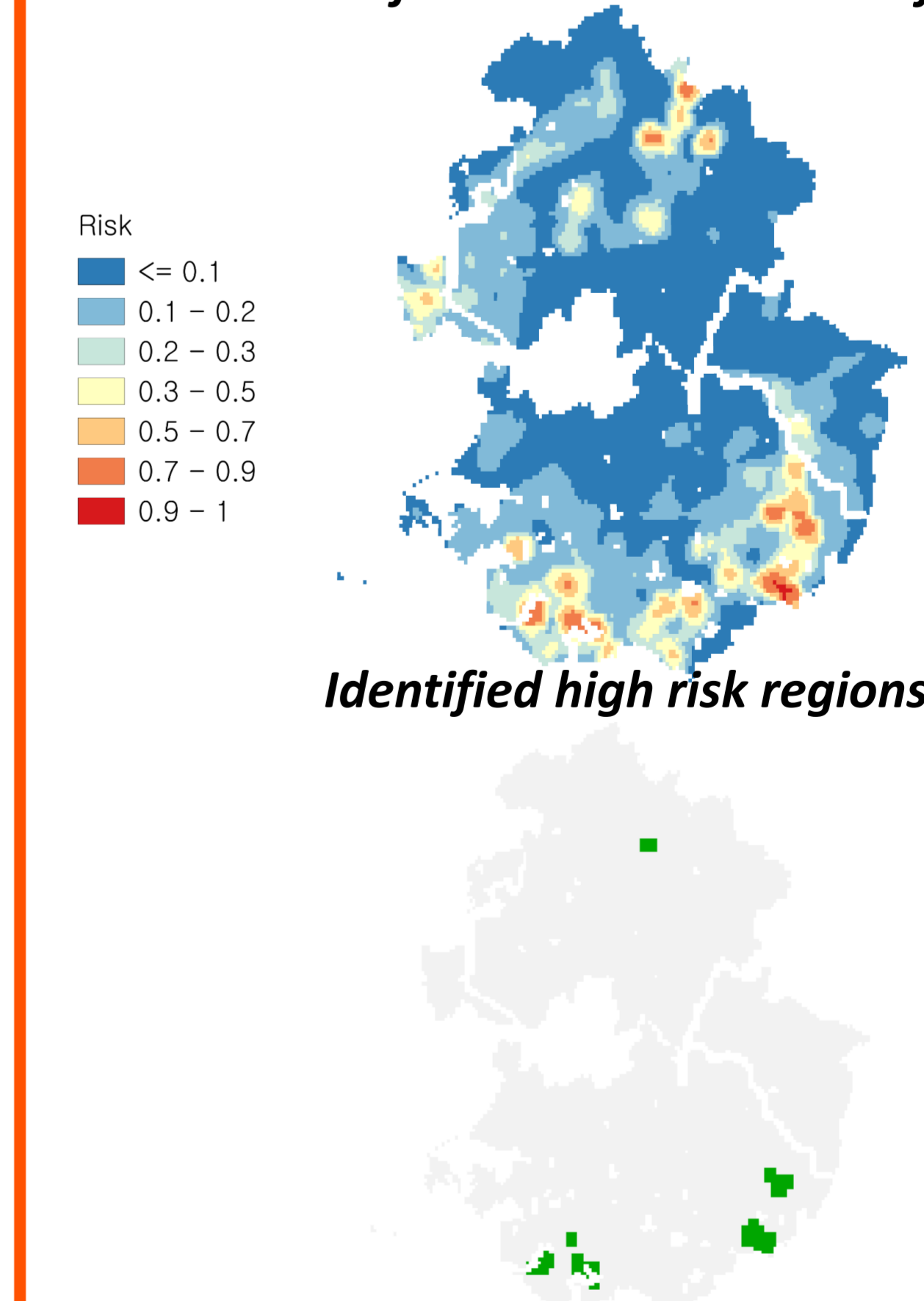
Risk
- <= 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 0.9
- 0.9 - 1

Identified high risk regions

Acknowledgement

Conclusion

- Control strategies can be focused on more localized regions when accounting for risk factors.
- Rice paddy was identified as spatial risk factors only for duck and chicken farms.
- Risk map and identified high risk regions in this study could be useful for supporting policy decision.