Evaluation of risk factors for Classical swine fever in Bulgaria using a Bayesian mixed logistic regression model

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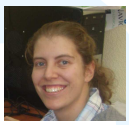

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INTRODUCTION

This study was aimed to explore the risk factors contributing to the occurrence of classical swine fever (CSF) in Bulgaria, with special interest in evaluating the epidemiological role of backyard pigs (BYP) and identifying high risk areas for CSF-occurrence where risk-based surveillance strategies may be target to more cost-effectively prevent and control CSF.

MATERIAL AND METHODS

A Bayesian mixed multivariable logistic regression model was used to evaluate the nature and extend of the association between the hypothesized risk factors (and their second-order interactions) and the probability of CSF occurrence in Bulgaria per municipality *i* (p_i) (**Eq 1**). Predictors were defined using data provided by the Bulgarian authorities regarding pig demographics (i.e. backyard, industrial, type A, type B and East Balkan pigs), pig movements (from Jan 2010 to Oct 2010) and other environmental and anthropogenic factors suck as human population, proportion of roads, proportion of water areas and wild boar suitable areas (this last one calculated using Corine Land Use 2006) (**Figure 1**). The response variable was whether or not the municipality reported CSF outbreaks from 1994 to 2010 (**Figure 2**). The value of the quantitative covariates was standardized to reduce correlation between beta coefficients and to normalize results.

$$\text{logit}(p_i) = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots \beta_k X_{ki} + S_i + U_i \quad \textbf{(Eq1)}$$

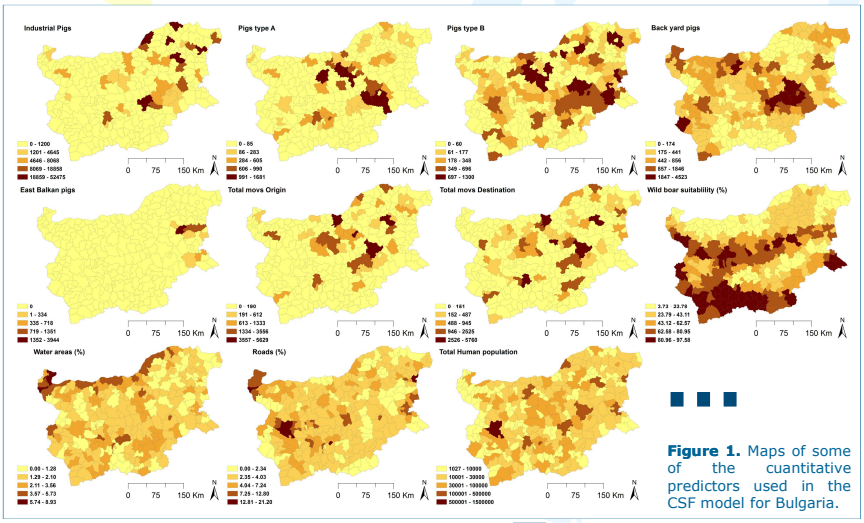

Figure 1. Maps of some of the cuantitative predictors used in the CSF model for Bulgaria.

Spatially unstructured (U_i) and structured (S_i) random effects were included in the model to address possible overdispersion and spatial autocorrelation, respectively. The model was fitted using WinBUGS14 with 30,000 iterations (first 500 samples were burned out). Model was built by trying all possible combinations introducing one covariate at a time. Non-informative priors and hyper priors used were similar to those described elsewhere [1,2]. The best fitting model was assumed to be the one with the lowest deviance information criterion (DIC) value [3]. Convergence of the model was checked by using Gelman-Rubin Plots.

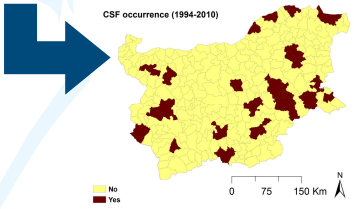

Figure 2. Map of the CSF occurrence (yes/no) in Bulgaria from 1996 to 2010.

RESULTS AND DISCUSSION

Results revealed that backyard pigs, East Balkan pigs and a high number of human population in the municipality were significant risk factors for CSF occurrence in Bulgaria whereas the proportion of roads in the municipality was found to be a protective factor (**Figure 3**). Highest risk of CSF occurrence was concentrated in seven municipalities of Bulgaria (**Figure 4**). Both Si and Ui were very low which may indicate no significant presence in the model of spatial autocorrelation and overdispersion as well as a good fit of the model (**Figure 5**). Convergence was meet after 300 iterations and no problems of autocorrelation within chains were found for the posterior inferences.

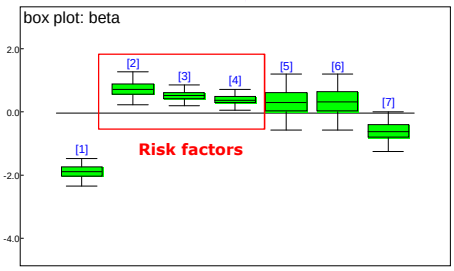

Figure 3. Posterior inferences for the betas (β_k) included into the final model.

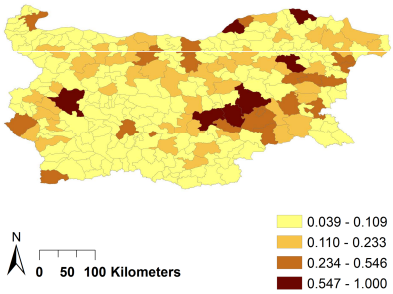

Figure 4. Estimated probability of CSFV outbreaks occurrence in Bulgaria (p_i) .

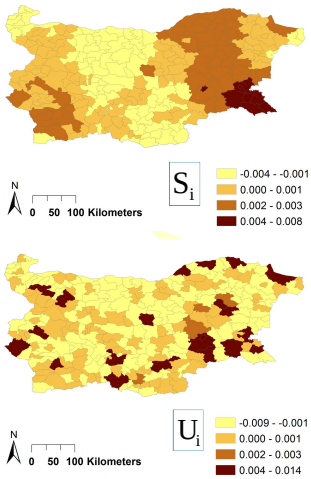

Figure 5. Structured (S_i) and Unstructured (U_i) random effects.

CONCLUSIONS

Results of the model suggest that BYP and Balkan pigs may be a risk factor for CSF occurrence into Bulgaria, most likely because they become infected by contact with infected wild boar populations or other contaminated fomites (they are low biosecurity premises), but their role in the potential transmission of the disease to industrial pigs is still unclear. In fact, the transmission from BYP or Balkan pigs to industrial pigs may be relatively low as those types of premises do not directly contact or move animals to industrial pig farms (data not shown). Further investigations should be performed to evaluate the risk of CSF transmission to industrial pigs, particularly, from type B farms, which may have a higher risk for CSF potential transmission than BYP or Balkan pigs.

REFERENCES

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