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Modeling the ASF (African Swine Fever) spread and risk assessment for Poland

Problem: Recent rapid spread of the African Swine Fever (ASF) in the Northeast Poland during summer 2017 encourages us to prepare risk assessment for the whole country and predict future geographical transmission paths. The disease has been occurring in Poland since February 2014, however, only in 2017 it exceeded the so-called population reproduction number of the epidemic (adjusted epidemic reproduction rate). The time is running and most of Poland is currently at the highest risk of becoming endemic. Although the Polish Veterinary Inspection with and National Research Institutes are monitoring and controlling the disease spread, a mathematical model of the spatial and temporal dynamics of the disease spread is missing.

Aims: We focus on a predictive stochastic ASF model based on empirical geographical data incorporating organizational network of regions, empirical forest, swine, and wild boar density theoretical organizational structure of the pork production supply chain. This model would be equipped with decision support systems as a tool for epidemiologists. In the preliminary setup, we perform early epidemic growth estimation and simulate landscape-based propagation.

Methods and Data: The early growth estimation can be easily done by matching incidence trajectory to the exponential function, resulting in the approximation of the force of infection. With these calculations the basic reproduction rate of the epidemic, the effective outbreaks detection and elimination times could be estimated. In the spatial model we use forest coverage, pig population in poviats and the distance between centroids of poviats. We use pseudo-gravitational models of short and long-range interactions referring to the socio-migratory behavior of wild boars and the pork production chain. We estimate the model parameters specific for Poland, using a prior Russian and Ukrainian data on ASF spread.

Results and Preliminary Conclusions: Early epidemic growth estimation indicates that to keep the epidemiological status quo will require a very fast response from veterinary services (less than one week after detection to eliminate a single outbreak). Spatial modeling in a certain range of parameters proves the existence of a natural protective barrier within boarders of the 'Congress Poland'. The spread of the disease to the 'Greater Poland' should result in the accelerated outbreak of ASF.

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