

# REALTIME MODELING THE 2025 FOOT-AND-MOUTH DISEASE OUTBREAK IN THE HUNGARY-SLOVAKIA BORDER REGION

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After more than five decades without foot-and-mouth disease (FMD) in Hungary, a new outbreak was detected in March 2025 near the Hungarian–Slovak border. The epidemic remained small, ultimately affecting 11 cattle farms, but this small size makes its quantitative analysis non-standard: detailed simulation systems require many poorly identifiable parameters, while classical likelihood-based inference has little data to work with. Still, during such an outbreak, decision makers need timely estimates of quantities such as the probability of further spread, the effect of control measures, and the point at which the epidemic can be regarded as having faded out.

To address this challenge, we developed a deliberately reduced modelling framework for this situation. First, a static spatial risk model is used to describe the background vulnerability of farms from their location, herd size and species composition. The temporal part of the epidemic is then modelled as a continuous-time farm-level branching process, in which each infected farm may generate further infected farms according to a small number of interpretable parameters. Since the likelihood is difficult to use reliably with so few observations, inference is carried out by approximate Bayesian computation (ABC). Simulated epidemics are accepted when they satisfy biologically motivated constraints and reproduce the main temporal features of the observed outbreak.

The resulting posterior simulations provide a direct way to estimate epidemiologically relevant quantities, including the time-varying reproduction potential, the effectiveness of interventions, and the conditional probability that no further infections will occur after a sufficiently long silent period. Rather than building a highly detailed national-scale simulator, our aim is to show that a transparent and computationally efficient stochastic model can still provide useful real-time information from very sparse outbreak data.