Modelling FMD vaccine requirements for multi-country FMD outbreaks in Europe

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Overview

- Introduction to the EuFMDiS model project
- Look at how models can be used to assist disease planning, focussing on use of vaccination
- Case study – multi-country outbreak in central Europe
- Discussion - implications for vaccine supply

EuFMDiS project

- EuFMD-funded project to develop a modelling tool to enable FMD outbreaks to be simulated within and between countries in order to provide a robust, flexible training tool to support FMD planning, training and response by European countries

- Pilot study with seven central European countries
  - Italy, Austria, Croatia, Hungary, Romania, Bulgaria and Slovenia

- Participants have defined
  - Common herd classification (n=9 herd types)
  - Livestock production regions (n=25) that represent different livestock production characteristics and disease risk
  - Country-level disease spread and control parameter values

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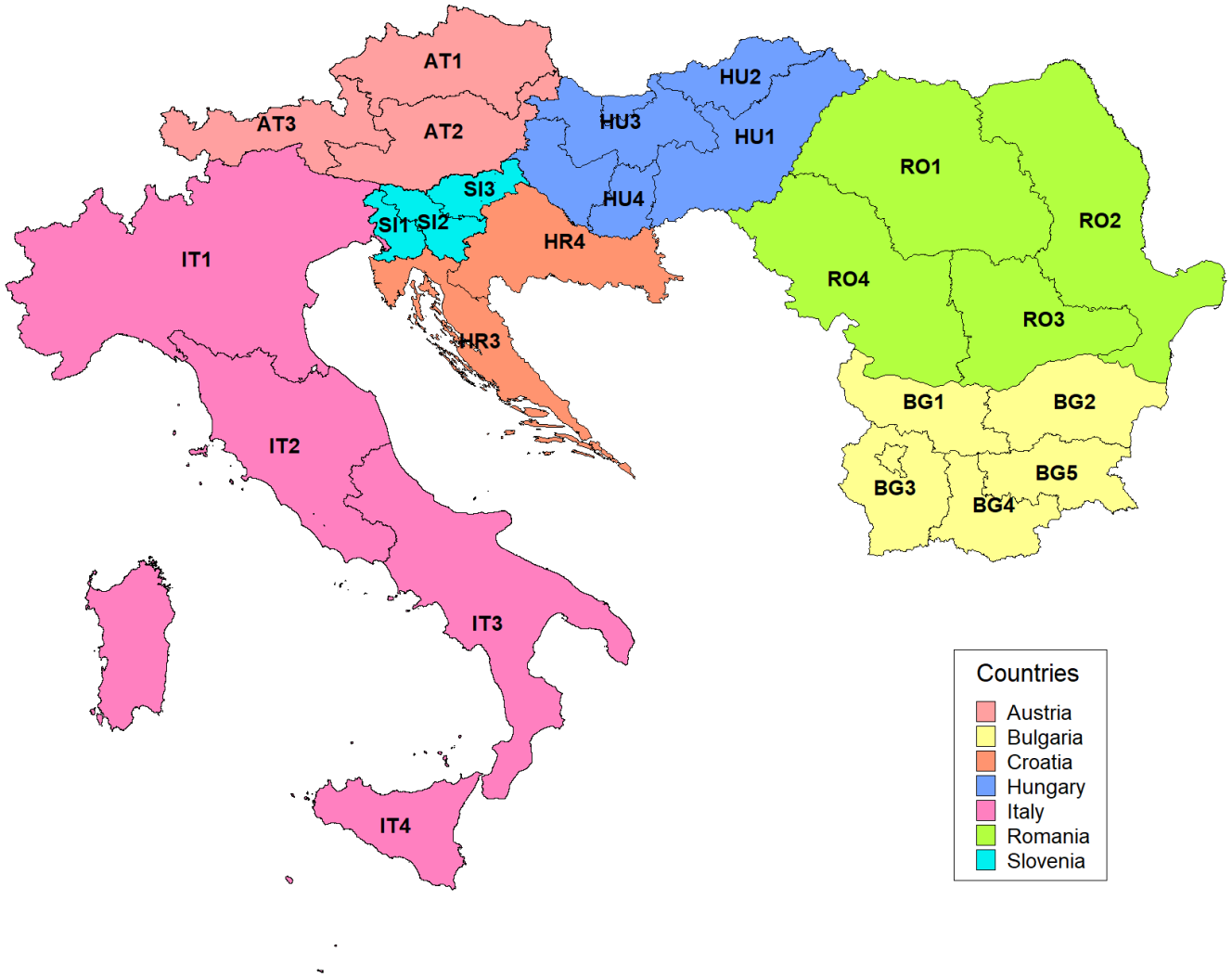
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Bulgaria
Croatia
Hungary
Italy
Romania
Slovenia

EuFMDiS overview

- Based on the Australian FMD model (AADIS)*
  - modifications to the software and collection and incorporation of European farm population and other data to parameterize FMD transmission and control

- Hybrid model structure:
  - Equation-based modelling (within-herd spread)
  - Agent-based modelling (between-herd spread)
  - Animal movement networks (between regions and countries) based on data from The European Trade Control and Expert System (TRACES)

** Bradhurst RA, Roche SE, Kwan P and Garner MG (2015) A hybrid modelling approach to simulating foot-and-mouth disease outbreaks in Australian livestock. Front. Environ. Sci., 19 March 2015 | http://dx.doi.org/10.3389/fenvs.2015.00017*

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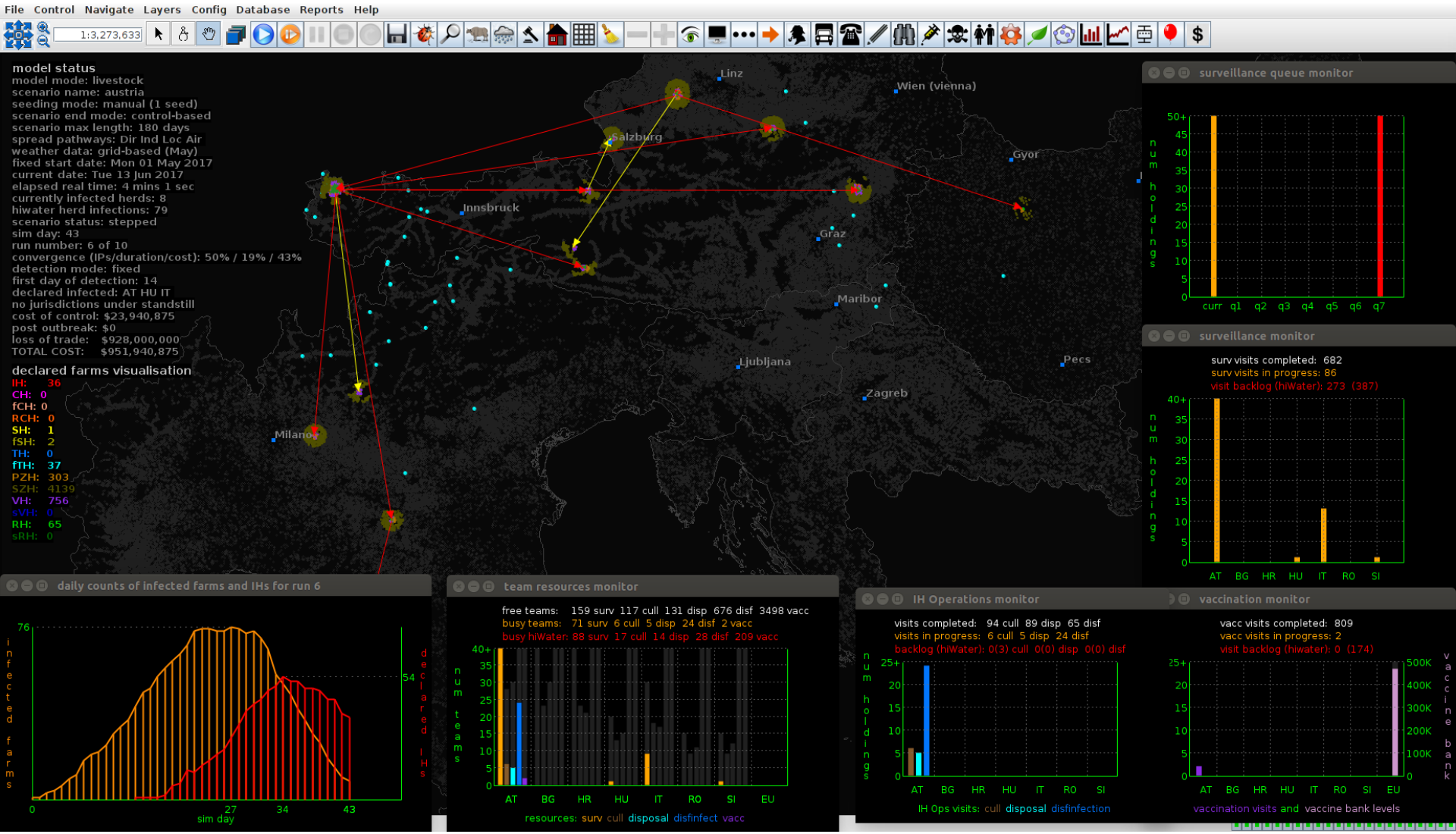
eofmd
european commission for the control of foot-and-mouth disease



Study aims

1. To demonstrate how EuFMDiS can assist planning and disease preparedness

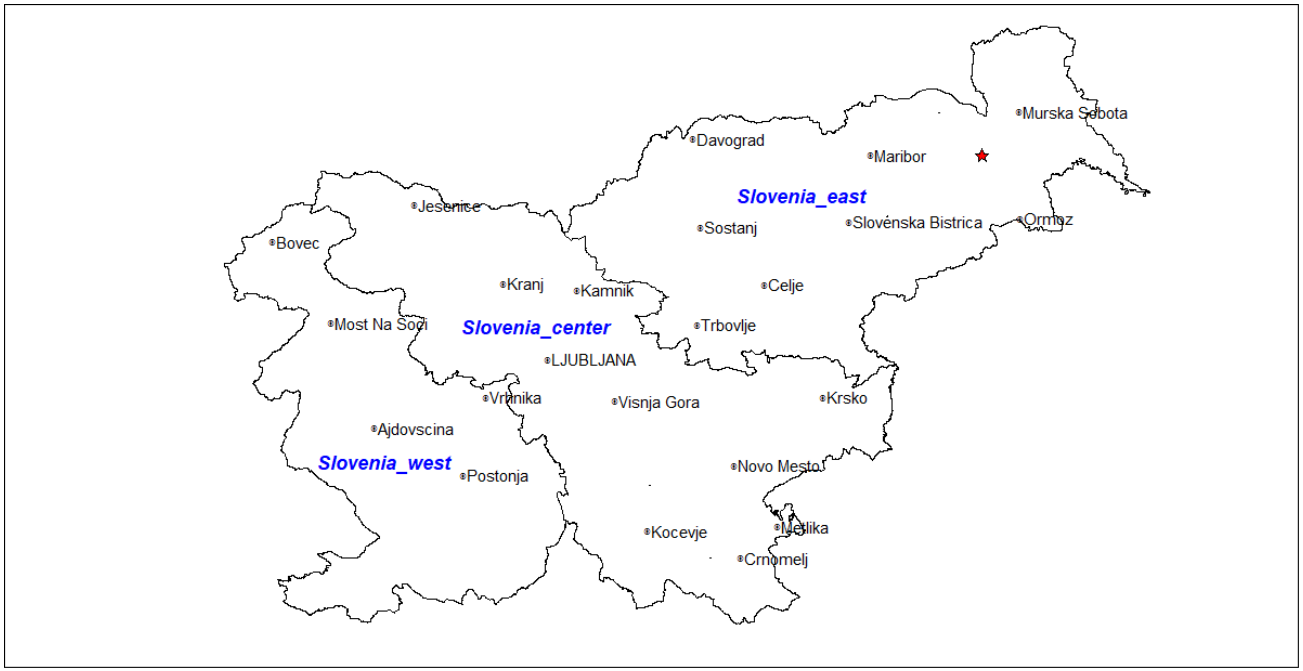
2. Compare response strategies involving various approaches using vaccination

3. Assess potential vaccine requirements in plausible multi-country FMD outbreak in central Europe

- *NB Parameter values have not been finalised for all countries – findings are indicative only*

Outbreak scenario

- Hypothetical outbreak starting in Slovenia
- FMD starts on a small commercial pig farm (ID 354416), n= 332 pigs in eastern region
- Occurs in September
- 21 day delay from first introduction to FMD being confirmed by authorities



Key assumptions

- Resources for control based on individual country estimates
- Vaccination starts 7 days into control program
- Vaccine applied prospectively, plus any infected holdings detected in previous 3 days
- Both suppressive and protective vaccination strategies considered
- Vaccination from outside-in
- Priority for vaccination: 1. Cattle 2. Pigs 3. Small ruminants.
- Potential access to 1 million doses in EU stockpile

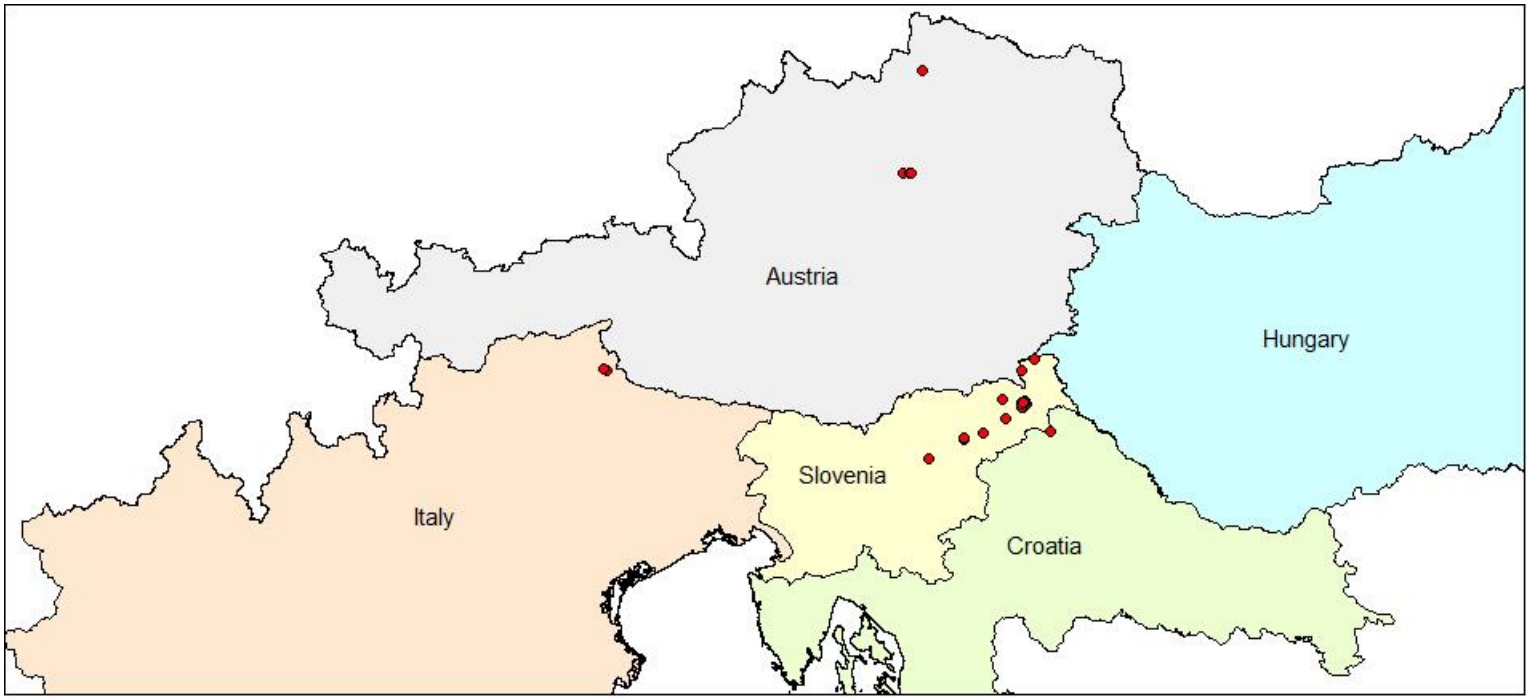
Vaccination strategies

1. No vaccination (stamping out only): *SO*
2. Suppressive ring vaccination (3 km radius) – all species: *SORV_all*
3. Suppressive ring vaccination (3 km radius) – cattle only: *SORV_bov*
4. Protective ring vaccination (3-8 km) – all species: *SOPV_all*
5. Protective ring vaccination (3-8 km) – cattle only: *SOPV_bov*

- Compare effectiveness of the different strategies
- 100 simulations run for each strategy

Results

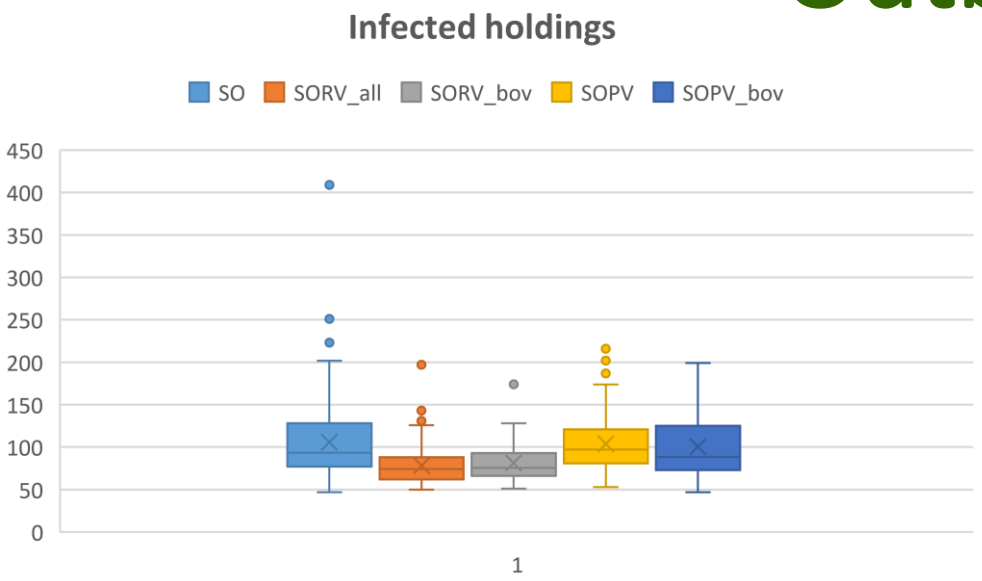
- On Day 1 of the control program, when the authorities are aware of the first case of FMD, there are already 35 infected farms in three countries - Slovenia (29), Austria (4) and Italy (2)

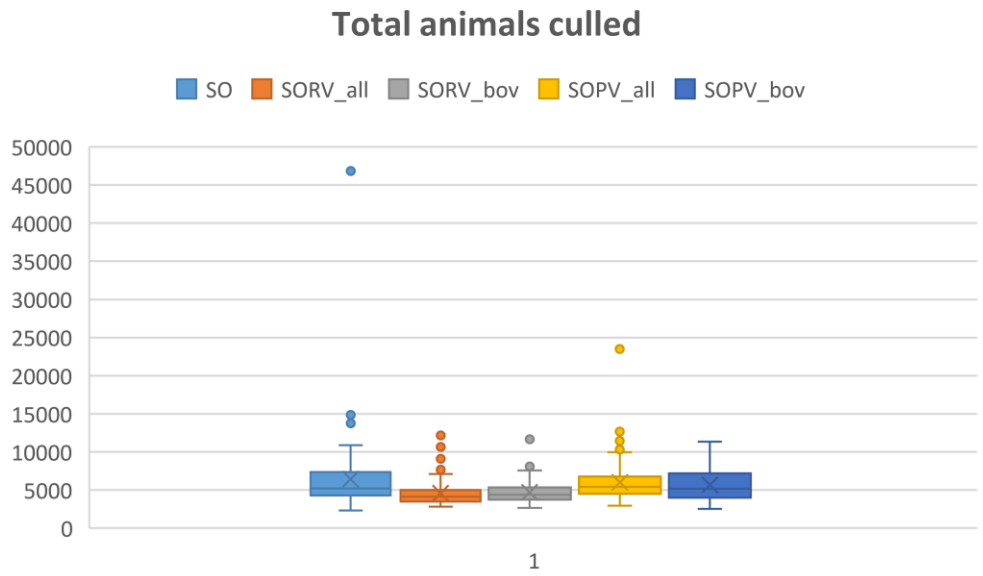


Comparing strategies

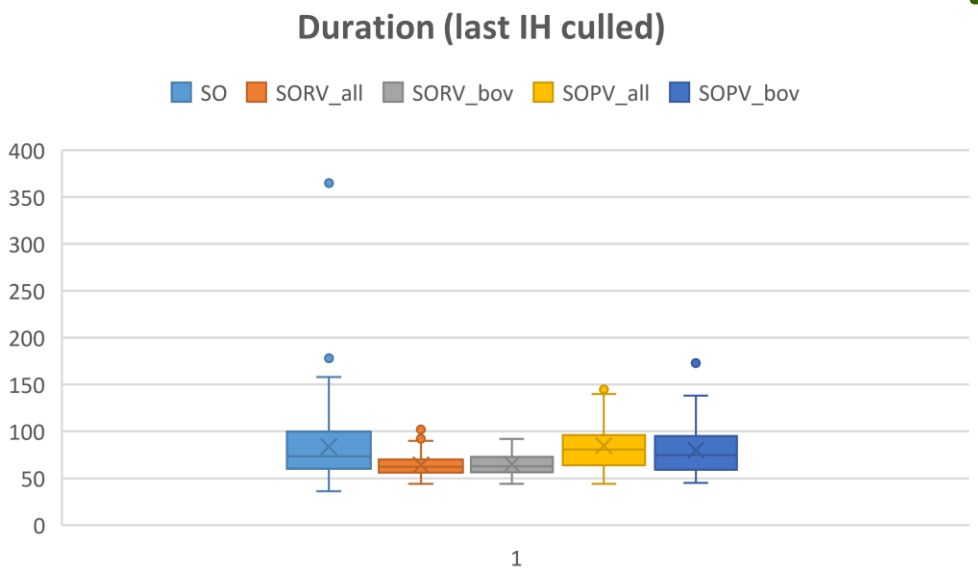
- How do we measure success?
- Reduce number of infected holdings
- Shortest duration
- Lowest number of animals culled
- Control program costs

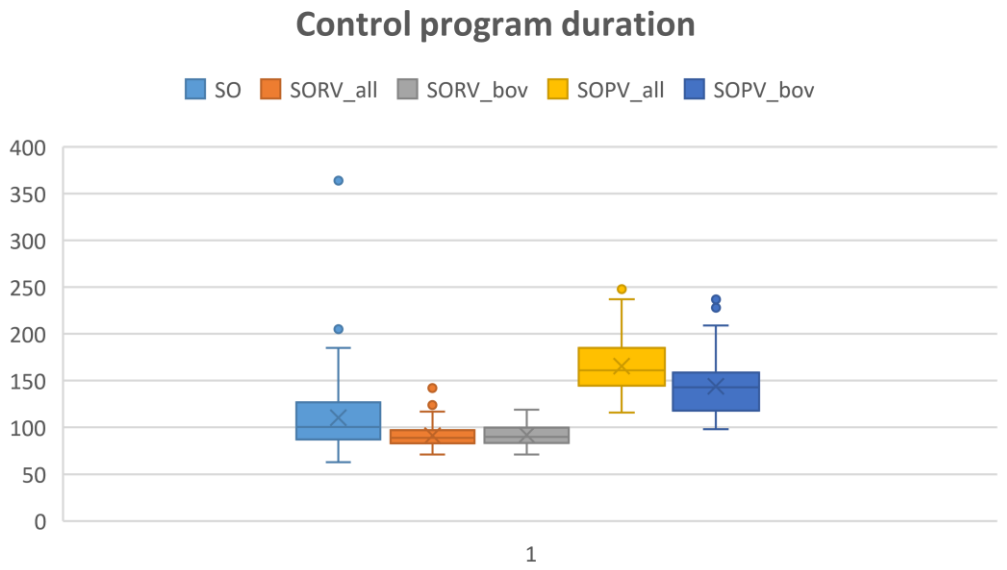
Outbreak size



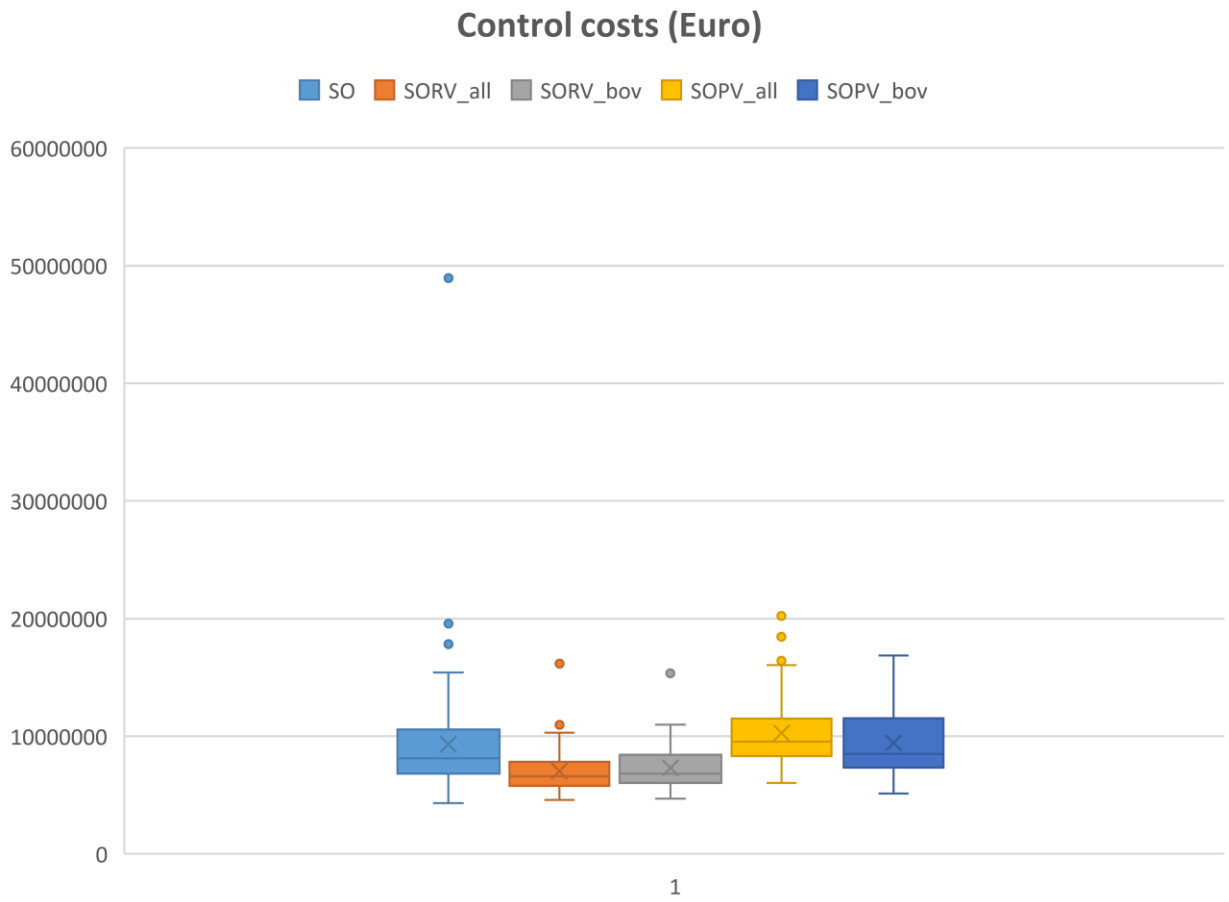


Duration

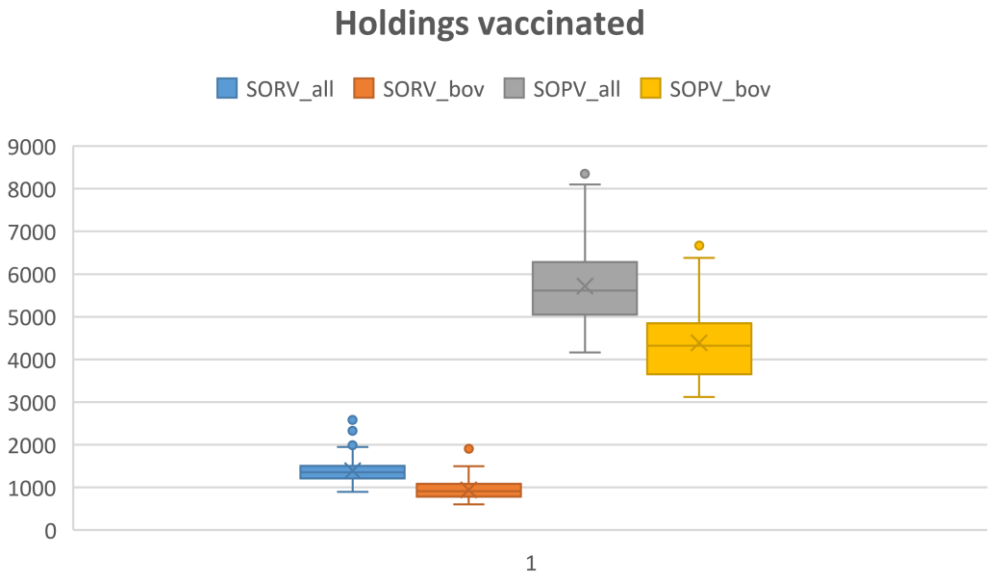

Duration (last IH culled)
SO
SORV_all
SORV_bov
SOPV_all
SOPV_bov
400
350
300
250
200
150
100
50
0
1

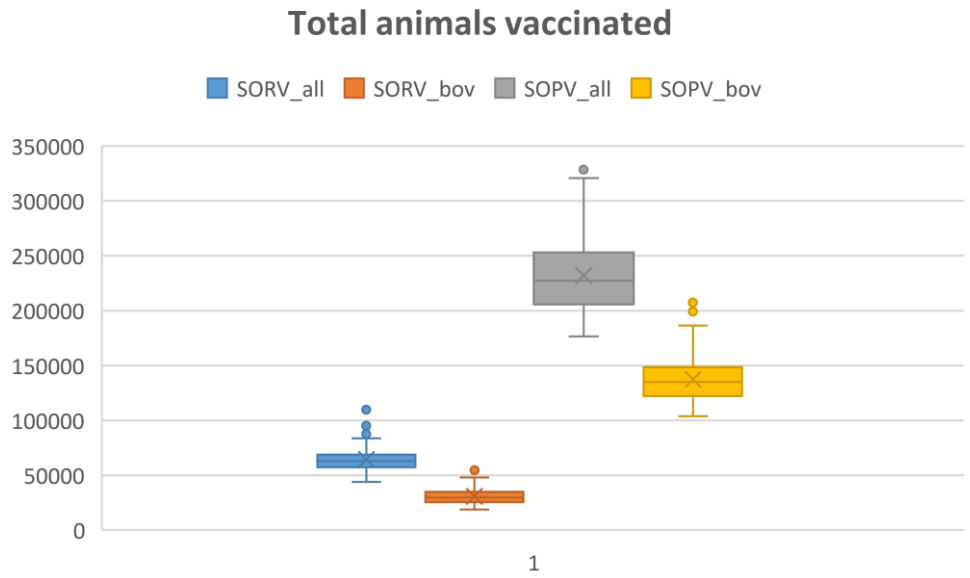

Control program duration
SO
SORV_all
SORV_bov
SOPV_all
SOPV_bov
400
350
300
250
200
150
100
50
0
1

Control program costs



Size of the vaccination operations?





Discussion

- We have considered a moderate outbreak scenario, involving infection in three countries in central Europe

- Most of the time, based on countries estimates of resources for control and expected effectiveness of measures, the outbreak is able to be controlled relatively quickly
    - Under the SO strategy on average the outbreak would last just over 3 months with around 90-100 IHs
    - Under worst case, the outbreak would involve >400 IHs and last >1 year

- Suppressive ring vaccination was effective in reducing size, duration and control program cost of an outbreak in this setting

- PV was less effective and can prolong the duration of the control program due to time required to vaccinate the larger numbers of herds

Implications for vaccine supplies

- Under suppressive ring vaccination strategy, on average, around 65,000 animals would be vaccinated. In worst case around 110,000 animals were vaccinated

- Protective ring vaccination strategies would require more vaccine. On average around 232,000 animals would be vaccinated and in worst case, around 330,000 animals were vaccinated

- In this study, for this region, suppressive ring vaccination of cattle only was very effective
    - It was almost as effective as vaccinating all species in reducing size and duration of the outbreak while significantly reducing the number of animals vaccinated (on average by more than 50%)

Conclusions

- The EuFMDiS model is a sophisticated powerful tool that can be used to study multi-country outbreak scenarios in Europe and assess implications of various approaches to control, including resource management and vaccine supply issues.

- In this study we have looked at a single outbreak in central Europe starting in Slovenia.

- In this situation, suppressive ring vaccination was shown to be effective in reducing size, duration and control program costs compared to stamping out without vaccination

- The purpose of the study is not to provide definitive answers to what is the best approach to FMD control

- Rather it is to show how new generation tools can be used by epidemiologists and disease managers to explore different outbreak scenarios and test alternate approaches to control

Thank you