Workshop on Incorporating Wildlife Compartments in FMD Simulation Modelling

European Food Safety Authority
and the European Commission for the Control of Foot-and-Mouth Disease (EuFMD)

Abstract

An expert meeting, held in 2019, was organised between EFSA and FAO with the objective to discuss the integration of a wildlife compartment in the current EuFMDis model. Experts in the field of mathematical modelling, animal disease spread models, virology, veterinary epidemiology and animal health discussed i) features and structure of the current EuFMDis model ii) EFSA’s models used on spread of animal diseases and simulation modelling iii) ENETWILD project and interface between domestic populations (e.g. pigs) and wildlife (e.g. wild boar) iv) available data sources for simulating spread and control of FMD in different wildlife species and iv) EFSA’s SIGMA project (standardised data collection). It was concluded that the addition of a wildlife spread component in the EuFMDis is a priority in order to evaluate contingency plans associated with wildlife. Two scenarios were proposed, and key issues were identified to integrate the wildlife spread component in the EuFMDis model. It was concluded that control measures may be parametrised for FMD and maybe for other diseases, but available data are limited.

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Key words: EuFMD, Simulation Model, AADIS, SIGMA, African Swine Fever (ASF)

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Summary

In the context of the EuFMD project, the Australian Animal Disease Spread model (AADiS) was tailored to the European context (the EuFMDiS model). The model has interesting features and its relevance has been demonstrated by a pilot study with 7 countries. The EuFMD team, including the developers of the spread model, are planning to add a wildlife component to assess the actual impact of wild animals on the spread of foot-and-mouth disease (FMD). The workshop aimed at gathering relevant experts having experience in epidemiology, modelling and wildlife. The model attracted the attention of EFSA in relation to the SIGMA project, the aim of which is to optimise the animal health data submission to EFSA. The main achievement is to support the data providers with scientifically sound and timely risk assessment: by means of an increased quality of the data received, EFSA will be able to run more sophisticated risk assessment analysis. The high-quality data that will be available should put the EuFMDiS model in the best conditions to generate accurate outputs. Considering the high flexibility of the model, it is conceivable to think about tailoring it to different diseases other than FMD. It was concluded that it was worth using the available data to develop the wildlife compartment by parameterising the model with information on Classical Swine Fever (CSF). Should the exercise be successful, (i) the EuFMDiS model will have improved, incorporating a component (the wildlife) about which little is known on its impact and role and (ii) its flexibility will be demonstrated, as it will have been run on CSF.
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2. **Introduction**

KM introduced the EuFMD project and the members of the team to the audience. All participants introduced themselves. EuFMD is asked to distribute the publications that describe the AADiS model. EFSA expressed its interest in a model that combines domestic and wild fauna, to be used for ASF and other diseases. RB and GG highlighted the extreme flexibility of the tool.

MP introduced the EuFMDiS model and emphasised the use of EU-wide herd classifications in the model.

The EuFMDis model (European Food and Mouth DIsease Spread model) is a model based on the conceptual hybrid modelling approach that was developed for the Australian Animal Disease Spread model (AADIS) (Bradhurst et al., 2015) with funding by the Australian government and consists of a sophisticated disease modelling platform and decision-support tool for foot and mouth disease (FMD) (FAO, 2019). A formalised agreement between EuFMD and the Australian Department of Agriculture and Water Resources has provided royalty-free access to the AADIS software. The model contains the following components: 1) Regions within countries 2) herds and herd types 3) within and between herd transmission as well as within and between country transmission 4) control measures and 5) economic impact. The herd is considered as an epidemiological unit and different attributes (type, size, production system) for each herd are defined. Depending on the production system a different epidemiological unit can be defined. For the transmission within-country and between-country detailed transmission pathways (direct contact spread, indirect contact spread, air-borne, etc) are considered. Control measures in the model are aligned with the EU FMD Directive Nr 2003/85/EC and include: movement restrictions, surveillance, tracing, suspect premises reporting, pre-emptive culling, infected premises operations, vaccination and post-outbreak management. The cost and economic impact module aims to compare relatively the costs of different control strategies and allows the decision makers to compare the different options in different situations. The EuFMDiS model allows the evaluation of the control measures in a flexible and configurable way. The success of the measures depends on the effectiveness of the measures and the resources available for control. The data required are obtained from three core components that need to be considered in building an animal disease spread model to simulate spread and control of FMD: livestock populations, FMD spread and modelling, and disease control. Therefore, detailed instructions and spreadsheet templates were prepared to assist EuFMDiS countries in collecting the right data for parameterizing the model. Finally, the requirement related to the hardware and software to run the EuFMDiS model were listed and discussed. Installation of EuFMDiS will also require administrator rights to overcome any security blocks on the PC/laptop.
The EuFMDis model is used to simulate FMD outbreaks within and between countries in Europe in order to provide a robust, flexible tool for FMD contingency planning, training and responses by EU countries. In order to set up EuFMDis, two workshops were organised with participants from the countries involved (AT, BG, HU, IT, HR, RO and SI). These countries were able to define a common herd classification, livestock production regions and provided regional and country specific disease spread and control parameter values.

RB demonstrated the features and structure of the model and emphasised the hybrid modelling approach which combines equation-based simulation of within-herd spread with agent-based simulation of between-herd spread.

3. **Wildlife and its role in spreading FMD**

The discussion focussed on the key requirements of a wildlife component in EuFMDis (the AADiS model tailored to the European context) for simulating spread and control of FMD in different susceptible wildlife species and its interaction with the livestock population.

GG explained the options for using a combined domestic-wildlife population model. The objectives and priorities of such a model and the control activities to be considered were discussed. Specific functionalities are:

- Representing wildlife populations through spatial distribution, animal densities and key population dynamics.
- Representing disease transmission, i.e. in wildlife, in domestic animals and between domestic and wildlife populations. Measuring contact rates may be very difficult.
- Representing control activities, i.e. on domestic animals and on wildlife.

Further studies are necessary to clarify the factors influencing the probability of transmission of FMD from wildlife to domestic animals. In the case of an FMD outbreak in a European country, if wildlife is infected, the most probable primary transmission route to wildlife has long been considered as being an overspill from domestic to wildlife populations, but in the case of two different outbreaks in Bulgaria since 1990, the domestic source for wildlife infection may have been in a different country (via meat or products), and therefore wildlife may be the primary live animal source of infection in the incursion.

Further studies are also needed to understand the factors influencing persistence of infection within wildlife populations (“persistence” has not been defined but a working definition might be – longer than 3 incubation periods (42 days) after the last detected wildlife case). Therefore, two distinct tracks in wildlife interference should be considered:

- spill-over from domestic to wildlife
- wildlife as a disease reservoir, and wildlife-domestic interaction

A pragmatic approach should be taken, not considering specific wildlife species and starting with the simple interactions. Another complicating factor is that wildlife populations are more mapped in terms of abundance rather than densities. Density maps are difficult to generate.

4. **Initiatives on animal disease simulation modelling in wildlife populations**

4.1. **ENETWILD project**

JVB explained the activities of the ENETWILD project ([http://www.enetwild.com/](http://www.enetwild.com/)). It is a 6-year project on collecting wildlife data, mostly distribution, abundance and hunting data for migratory birds, wild ungulates, wild carnivores and wild boars.

The project will develop standards for species distribution/abundance assessment which can be used for mapping and modelling to serve risk assessments. Especially for wild boar abundance and distribution several models have already been developed. The project also looks at the interface between pigs and wild boars where the human interaction component is added to develop risk maps.
4.2. Helmholtz Centre for Environmental Research

HHT presented the many modelling approaches for wildlife that have been developed by the Ecological Epidemiology Group of the Department of Ecological Modelling of the Helmholtz Centre for Environmental Research. All models can be found at www.ecoepi.de and are well documented. The models deal with infections in wild boar for African Swine Fever, Classical Swine Fever and Foot-and-Mouth Disease.

4.3. the DTU-DADS model

TH presented the DTU-DADS model (original from Davis University) that is used for providing decision support to the Danish Veterinary Services. Tariq is currently developing the model for ASF in domestic pigs and wild boar.

5. EFSA initiatives on data collection

Gabriele presented the EFSA SIGMA project. At the moment, EFSA data models are not completely harmonised; EFSA’s data warehouse is not connected with the EC’s ADNS and data submission and validation is not automated. The animal health data collections are labour intensive for both EFSA and the data providers of the Member States (MS). EFSA’s aim is to work together with Member States on the technical aspects of ‘ad hoc animal health data collections’, in order to:

- reduce the manual input of the data to be submitted by the Member States to EFSA;
- avoid double reporting to EFSA and, possibly, to other systems;
- provide the Members States with instruments to automatically produce draft national reports on animal health and surveillance in a protected environment (secure connections, login credentials) to ensure data protection;
- increase the quality and the comparability of the data received from the Member States;
- shorten the time to retrieve up-to-date data, relevant for risk assessment purposes, and
- release sound scientific advice.

EFSA, at this time, is collaborating with some EU MS that, on a voluntary basis, engaged with the pilot phase of the SIGMA project. At the end of this pilot phase, the volunteering EU MS will have at their disposal an automated system for the submission to EFSA of livestock population data and sample level laboratory results data.

6. Technical considerations on the wildlife component

Addition of a wildlife spread component to EuFMDiS is a priority for the EuFMD Executive Committee to support epidemiologists and disease contingency planners and to evaluate and manage contingency plans associated with wildlife. Two risk scenarios are of interest:

- wildlife populations as an additional transmission route for spreading disease between domestic animals;
- risk of disease incursion in domestic animal populations from infected wildlife.

Key issues that need to be addressed when including a wildlife spread component in the EuFMDiS model are:

- representing wildlife population for disease modelling purposes in terms of abundance or density maps (see section 6.1);  
- representing disease transmission within wildlife and between domestic animals and wildlife (see section 6.2);  
- representing control activities that inhibit disease spread between domestic animals and wildlife and within wildlife populations (see section 6.3).
6.1. **Representing wildlife populations:**
Wildlife populations can be represented as individual epidemiological units being discrete entities with locations (points or polygons) or as raster data layers being abundance or density grids. Different approaches are available for both options. The work done by the Ecological Epidemiology Group in Leipzig or by the ENETWILD project can be of value and needs to be explored. FAO also has valuable data available.

6.2. **Representing disease transmission:**
Disease transmission can be represented by separate discrete exposure pathways involving direct and indirect contact or by using an ‘effective contact rate’ of different groups coming into contact sufficiently close that disease transmission could occur, irrespective of the type of contact.

Data are not really available for FMD to explore these contacts and estimate rates. The Bulgarian FMD outbreak is the only known case where transmission from domestic animals to wildlife occurred. Existing data on this outbreak need to be explored. There is also an option to collect data in Turkey as domestic-wildlife interaction for FMD is likely to occur there as well.

Another option to parameterise the disease transmission may be using an acceptable proxy. A lot of information and data are available for the transmission of Classical Swine Fever (CSF). Models for within livestock and within wildlife spread are available from different sources. The challenge still lies in modelling the livestock-wildlife interactions. Data on this interaction are available for Spain. It would therefore be an opportunity to model disease transmission for CSF in Spain.

6.3. **Control activities that inhibit disease spread:**
Three types of control measures need to be considered in the model:

- Control measures in livestock to reduce the risk of transmission to wildlife;
- Control measures in wildlife to reduce the risk of transmission to livestock;
- Control measures in wildlife to reduce disease spread within wildlife;

Control measures that can be considered are enhancing biosecurity for domestic livestock and managing and/or vaccinating wildlife populations. These control measures can be parameterised for FMD but there again available data are limited. An alternative would also here be using CSF spread in Spain as a proxy.

7. **Conclusions**
The EuFMDIS model, based on the original AADIS, has interesting features, among which the most relevant for EFSA is the flexibility. Ideally, the model, following an appropriate parameterisation, could be adapted to any animal disease. An evaluation will be done at a later stage of the SIGMA project on the possibility of including this tool among the ones offered to EU Member States.

This flexibility is at the basis of the hypothesis of using the only available data on wildlife (wild boar in Spain) and running the model for Classical Swine Fever (CSF). Should the wild boar component for CSF be successfully incorporated in the EuFMDIS, it’s reasonable to think that the same model could work on FMD.

8. **Recommendations**
EuFMD and EFSA should update each other, communicating achievements and progress in the respective relevant projects.

ENETWILD is a project procured by EFSA. The data collected in this context, as part of the deliverables, are EFSA’s property. Regardless of the purpose, any sharing of this information has to be previously agreed with EFSA and with the data owners. It is important to remember the aspects linked to data confidentiality and data protection.
References


## Abbreviations and Glossary

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<td>Australian Animal Disease model</td>
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Annex D – EcoEpi Wildlife models (presentation from Hans Hermann Thulke)

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