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Prioritization of livestock transboundary diseases in Belgium using a multicriteria decision analysis tool based on drivers of emergence

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Abstract

During the past decade, livestock diseases have (re-)emerged in areas where they had been previously eradicated or never been recorded before. Drivers (i.e. factors of (re-)emergence) have been identified. Livestock diseases spread irrespective of borders, and therefore, reliable methods are required to help decision-makers to identify potential threats and try stopping their (re-)emergence. Ranking methods and multicriteria approaches are cost-effective tools for such purpose and were applied to prioritize a list of selected diseases (N = 29 including 6 zoonoses) based on the opinion of 62 experts in accordance with 50 drivers-related criteria. Diseases appearing in the upper ranking were porcine epidemic diarrhoea, foot-and-mouth disease, low pathogenic avian influenza, African horse sickness and highly pathogenic avian influenza. The tool proposed uses a multicriteria decision analysis approach to prioritize pathogens according to drivers and can be applied to other countries or diseases.

KEYWORDS
Belgium, cluster analysis, drivers, expert elicitation, multicriteria decision analysis (MCDA), prioritization, ranking, sensitivity analysis, transboundary diseases, zoonoses

1 | INTRODUCTION

The Food and Agriculture Organization of the United Nations (FAO) has defined transboundary animal diseases as 'epidemic diseases which are highly contagious or transmissible and have the potential for very rapid spread, irrespective of national borders, causing serious economic and sometimes public health consequences' (Food & Agricultural Organization, 2018). Thus, livestock diseases may be responsible for negative social, economic and environmental impacts, at different levels (locally, nationally, regionally and internationally). Hence, the introduction of a new livestock disease not only has an impact on animal health, but also affects international trade, food supply and, if zoonotic, human health (Food & Agricultural Organization, 2018).

With the societal and technological changes occurring during the twentieth century, novel pathogens have appeared with countries experiencing human and animal diseases they have never seen before (emergence) or that had been eradicated in the past (re-emergence). Noteworthy, examples of (re-)emerging animal diseases are the foot-and-mouth disease (FMD) epidemic in the United Kingdom in 2001 (Knowles, Samuel, Davies, Kitching, & Donaldson, 2001) and in Japan in 2010 (Muroga et al., 2012) and the continuing outbreaks of highly pathogenic avian influenza (HPAI) since 2003–2004 around the world (Elbers et al., 2004), the Bluetongue epidemic in Western

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Europe (Carpenter, Wilson, & Mellor, 2009; Wilson & Mellor, 2009) and the newly identified Schmallenberg disease in Germany in 2011, which has further spread to other parts of Europe, like the Netherlands, Belgium and Northern Ireland (Afonso et al., 2014; Anonimous, 2013). Also, in 2016, cases of HPAI were reported to the OIE from different European member states including Belgium (World Organisation for Animal Health, 2018). Another very important recent emerging livestock disease reported specifically in Belgium at the end of 2018 was African swine fever, although cases so far have been reported only in wild boars (Linden et al., 2019). Its emergence is of great concern for the pig industry of the region and being a disease, which until now has been exotic for Belgium. It shows how diseases may re-emerge unexpectedly with most likely origin attributable to human activity (Saegerman, 2018).

The (re-)emergence of diseases shifts in relation to several underlying set of factors inherent to modern society, that is the so-called 'drivers'. The joint presence of these drivers can create an environment in which infectious disease can (re-)emerge and be maintained in animal and/or human compartments (King, 2004). Many drivers have been identified, such as climate change, global travel, immigration patterns, increase in the human population, environmental degradation and others (Altizer, Ostfeld, Johnson, Kutz, & Harvell, 2013; Daszak, Cunningham, & Hyatt, 2000; King, 2004).

The threat of (re-)emergence is more likely to increase and past experience has shown that no country, however economically well-developed it may be, is capable of ensuring 100% security of its borders, even by imposing measures such as quarantine protocols or import bans on animals and animal products (Ben Jebara, 2004). In Belgium, the monitoring and reporting of livestock diseases are subjected mostly on self-reporting of suspected clinical cases by the farmers to the Federal Agency for the Safety of the Food Chain (FASFC), with an established list of mandatory notifiable diseases for livestock and other species (aquatic, exotic) (Federal Agency for the Safety of the Food Chain, 2019). Each suspicion is then confirmed by laboratory analysis (Federal Agency for the Safety of the Food Chain, 2019). Thus, a rational priority setting approach is needed to assist decision-makers in identifying and prioritize diseases that are more likely to (re-)emerge and as such allocating the right resources tailored to a particular disease threat. One such approach used is disease prioritization, which has as main objectives: to optimize financial and human resources for the surveillance, prevention, control and eradication of infectious disease and to target surveillance for early detection of any emerging diseases (Humblet et al., 2012).

Some studies identified key characteristics of potential emerging infectious diseases and prioritized infectious diseases according to their risk of (re-)emergence or impact in some countries (Cardoen et al., 2009; Cox, Sanchez, & Revie, 2013; Havelaar et al., 2010; Humblet et al., 2012). Hence, these focused on human or zoonotic diseases and the impact they would have in certain countries. In this study, the focus is livestock epidemic diseases and the aim was to identify (re-)emergence drivers' criteria and with it use expert elicitation to prioritize livestock epidemic diseases that may emerge in Belgium.

A multicriteria decision analysis (MCDA) method was chosen because it provides a systematic way to integrate information from a range of sources (Cox et al., 2013) and it aims to improve transparency and repeatability (European Centre & for Disease Prevention & Control, 2015). Multicriteria decision analysis requires identifying criteria and scoring criteria according to the pathogen/disease. By weighting each criterion and calculating weighted scores from the criteria, an overall score per pathogen/disease was calculated (European Centre & for Disease Prevention & Control, 2015; Humblet et al., 2012).

This is the first study to prioritize livestock epidemic disease using drivers as criteria. This prioritization list could be an aid to decision-makers to make an informed decision on course of actions to be taken and use the correct resources when there is a threat of a disease (re-)emerging in Belgium.

2 | MATERIALS AND METHODS

2.1 | Selection of diseases

We compiled a list of livestock-associated infectious diseases (Figure 1) using a systematic approach. This was done by collating in a single database notifiable terrestrial animal diseases from different governmental official lists from Belgium (Federal Agency for the Safety of the Food Chain, 2015) and neighbouring countries (Luxembourg was excluded because of high similarity), that is Germany (Federal Ministry of Food & Agriculture of Germany, 2015), France (Légifrance, 2015a, 2015b), the Netherlands (Ministerie van Landbouw, 2015) and Great Britain (Scottish Government, 2015). In order to broaden the spectrum, diseases included in two other lists of official international organizations, that is the World Organisation for Animal Health (OIE) (World Organisation for Animal Health, 2015) and the European Union (European Commission, 2012), were also added to the database. Only diseases that affect cattle, sheep, goats, swine and poultry (livestock) were selected from the official lists and included in database.

After completion of the database, diseases were excluded if: (a) they were not of the epidemic type; (b) by the time the list was compiled (January 2015) no cases were reported in Belgium over the past year (i.e. during the year 2014). The disease duplicates were removed. Four diseases that were not in any of the official lists were added to the list of diseases for prioritization: Schmallenberg, Aino, Akabane and novel swine enteric coronavirus. Schmallenberg virus is a novel pathogen detected in 2011 in three adjoining countries: Germany, the Netherlands and Belgium, which eventually caused an outbreak in Northern Europe from 2011 to 2013 (Lievaart-Peterson, Luttikholt, Brom, & Vellema, 2012). Aino and Akabane viruses were added because both viruses belong to the same Simbu serogroup of the genus *Orthobunyavirus* of the *Bunyaviridae* family as Schmallenberg virus. Additionally, a number of publications have highlighted that viruses from the Simbu group circulate within the Mediterranean basin (Azkur et al., 2013; Chaintoutis et al., 2014; Lievaart-Peterson et al., 2012; Yilmaz et al., 2014). Thus, the risk of any of these viruses to (re-)

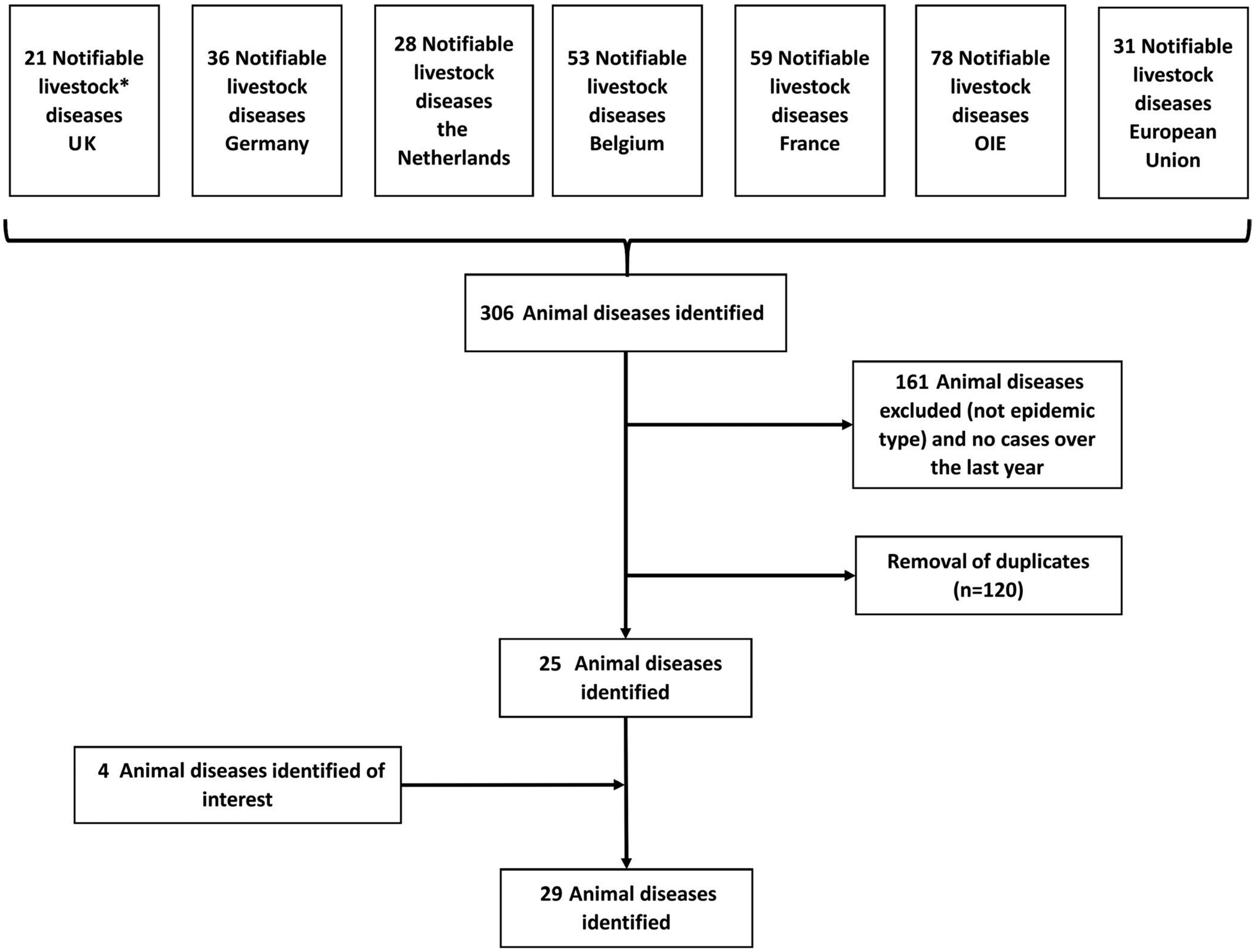

FIGURE 1 Systematic process for selecting the livestock diseases. * Livestock diseases were those which affected cattle, sheep, goats, swine and poultry

emerge may be present, which further prompted the necessity of adding these three viruses to the list of diseases to be prioritized. The appearance of the novel swine enteric coronavirus disease, first in the United States in February 2014 and later in March 2014 in Ontario Canada (European Food Safety Authority, 2014; 2014), raised concerns in the European Members States, as this emerging diseases could affect the health status of pig holding in Europe and their production. For this reason, we decided to include it in the final list of epidemic livestock diseases.

2.1.1 | Questionnaire design

The main objective was to prioritize the diseases according to drivers of (re-)emergence. A driver was defined as a factor, which has the potential to directly or indirectly precipitate ('drive') or lead to the (re-)emergence of a livestock infectious disease. We identified different criteria considered as drivers through scientific literature and previous disease prioritization exercises, and discussion with experts from academia, government agencies and international bodies.

A total of 50 criteria were identified and classified under 8 different domains (Table 1): (A) pathogen/disease characteristics (*N* 9 criteria); (B) distance to Belgium (*N* = 3 criteria); (C) ability to monitor, treat and control the disease (*N* = 7 criteria); (D) farm/production characteristics (*N* = 7 criteria); (E) changes in climate conditions (*N* = 3) criteria; (F) wildlife interface (*N* = 6 criteria); (G) human activity (*N* = 6 criteria); and (H) economic and trade activity (*N* = 9 criteria). The questionnaire was formatted in Excel® (Microsoft, Redmond, WA, USA, 2013) file with one spreadsheet per domain including corresponding criteria with an addition of a last spreadsheet, with the eight listed domains (*N* = 8 domains).

Each criterion had a definition of the coefficient, which ranged from 0 to 4 accordingly (Appendix A).

2.1.2 | Scoring and weighting system

Each domain spreadsheet had a number of criteria. For each criterion, coefficients were clearly defined for a good comprehension and standardization. Coefficients were from scores of 0 to 4 or from 1 to 4 (a number of criteria could not be scored with a zero, e.g. current

TABLE 1 List of criteria used to prioritise (re)emerging infectious diseases, according to their likelihood of (re)emergence in Belgium in response to different categories of drivers

A. DISEASE/PATHOGEN CHARACTERISTICS	
A.1	Current knowledge on the pathogen
A.2	Current species specificity of the disease-causing agent
A.3	Genetic variability of the infectious agent
A.4	Transmission of the pathogen in relation to the possible spread of the epidemic
A.5	Risk of showing no clinical signs and silent spread during infection and postinfection
A.6	Wild reservoir and potential spread from it
A.7	Existence of vectors (vertebrates and invertebrates, e.g. mosquitoes, bats, rodents, ticks, culicoid biting midges) and potential spread
A.8	Transmission of the pathogen
A.9	Environmental persistence
B. DISTANCE TO BELGIUM	
B.1	Current incidence (cases)/prevalence of the disease in the world
B.2	European geographic proximity of the pathogen/disease to Belgium
B.3	To your knowledge, when was the disease last reported in Europe
C. ABILITY TO MONITOR, TREAT AND CONTROL THE DISEASE	
C.1	Ability of preventive/control measures to stop the disease from entering the country or spreading (containment of the epidemic). Excluding treatment, vaccination and vector(s)/reservoir(s) control
C.2	Vaccine availability
C.3	Control of reservoir(s) and/or vector(s)
C.4	Availability and quality of diagnostic tool(s) in Belgium
C.5	Disease is currently under surveillance overseas (OIE, EU)
C.6	Eradication experience in other countries and/or Belgium
C.7	Detection of emergence, for example difficulties for the farmer/veterinarian to declare the disease or clinical signs not so evident
D. FARM/PRODUCTION SYSTEM CHARACTERISTICS	
D.1	Mono-species farms (one single farmed animal species, e.g. only cattle) or multispecies farms (more than one species, e.g. goats and cattle, are raised in the same farm/land/premises)
D.2	Farm demography/management: such as type of dairy or beef (cattle) production. For pigs—reproduction, fattening, finishing farm or both. Chickens—only laying eggs chickens or solely finishing broilers
D.3	Animal density of farms. Extensive (small holders with a few animals) v/s intensive farming
D.4	Feeding practices of farms
D.5	Human movements among premises—veterinarians or farm staff
D.6	Proximity of livestock farm to wildlife and wildlife reservoirs of disease, for example contact with wild or feral birds and animals, which have been scavenging on landfill sites that contain contaminated animal products
D.7	Changes of land use, for example field fragmentation, creation of barriers, landfill sites
E. CHANGES IN CLIMATIC CONDITIONS	
E.1	Influence of annual rainfall on the survival and transmission of the pathogen/disease
E.2	Influence of annual humidity on the survival and transmission of the pathogen/disease
E.3	Influence of annual temperature on the survival and transmission of the pathogen/disease
F. WILDLIFE INTERFACE	
F.1	Potential roles of zoo's in the (re)emergence of the pathogen
F.2	The rural(farm)–wildlife interface
F.3	Increase of indigenous wild mammals in Belgium and neighbouring countries
F.4	Increase in endemic/migrating populations of wild birds
F.5	Hunting activities: hunted animals can be brought back to where livestock is present
F.6	Transboundary movements of terrestrial wildlife from other countries

(Continues)

TABLE 1 (Continued)

G. HUMAN ACTIVITIES	
G.1	In- and out-people movements linked to tourism
G.2	Human immigration
G.3	Transport movements: more specifically commercial flights, commercial transport by ships, cars or military (excluding transport vehicles of live animals)
G.4	Transport vehicles of live animals
G.5	Bioterrorism potential
G.6	Inadvertent release of an exotic infectious agent from a containment facility, for example laboratory
H. ECONOMIC AND TRADE ACTIVITIES	
H.1	Decrease in resources allocated to the disease surveillance
H.2	Modification of the disease status (i.e. reportable disease becoming not reportable) or change in screening frequency due to a reduced national budget
H.3	Decrease in resources allocated to the implementation of biosecurity measures at border controls (e.g. harbours or airports)
H.4	Most likely influence of (il)legal movements of live animals (livestock, pets, horses, etc.) from neighbouring/MSs for the on the disease (re) emergence in Belgium
H.5	Influence of increased (il)legal imports of animal products such as skin, meat and edible products from MSs on the disease (re)emergence in Belgium
H.6	Most likely influence of increased (il)legal imports of non-animal products such as tires, wood, furniture from MSs on the disease (re)emergence in Belgium.
H.7	Most likely influence of (il) legal movements of live animals (livestock, pets, horses, etc.) from Third countries on the disease (re)emergence in Belgium.
H.8	Most likely influence of increased imports of animal products such as skin, meat and edible products from Third countries on the disease (re)emergence in Belgium
H.9	Most likely influence of increased (il)legal imports of NON-animal products such as tires, wood, furniture from Third countries on the disease (re)emergence in Belgium

Abbreviation: MS, European Union Member State.

species specificity of the disease-causing agent). Each spreadsheet included two columns. Experts had to fill both of them. The first one corresponding to the coefficient for the choice for the criterion, and the second one for weighting they gave to the criterion (intradomain weighting). Regarding the weighting system, a Las Vegas method was applied (Gore, 1987). The number of points to be distributed was proportional to the number of criteria per category multiplied by ten. Indeed, the criterion with the most points allocated is considered the one that weighs the most in the category. If, on the other hand, all the criteria have the same weight in the category, the distribution is equitable, with 10 points for each criterion. For example, 90 points were to be distributed between the 9 criteria of the 'pathogen characteristics' domain. Indeed, the criterion with the most points allocated is considered the one that weighs the most in the pathogen characteristics. Such process illustrated the experts' opinion on the relative importance of criteria within one domain.

The last spreadsheet was dedicated to the inter-domain weighting. Experts were asked to distribute a total of 80 points (N = 8 domains) among the domains to classify the domains according to their opinion.

2.1.3 | Expert elicitation

Two rounds of expert elicitation were implemented. The first round consisted in the questionnaire assessment; experts were asked to verify whether the questions were in relation with the drivers and whether the scoring systems were correctly defined and identified. The questionnaire and related instructions were sent to 14 experts (Appendix B) by e-mail. The experts were asked to complete questionnaire by scoring and additionally to assess and give comments on the criteria and coefficient definitions. The questionnaire was then refined according to experts' comments and suggestions.

For the second round, 62 experts were identified (Appendix C) via Internet searching and recommendations from the project partners and recruited participants. These experts were asked to answer the questionnaire in order to rank the diseases. Thus, they had to choose the defined coefficient for each criterion (i.e. criterion scoring), then distribute the points for within each domain (i.e. the intradomain weighting), and lastly distribute the points within the domains (i.e. inter-domain weighting).

They were invited to participate via a project summary e-mail and were sent the reviewed questionnaire via e-mail if they agreed to participate. Experts were recruited until a minimum of 4 experts per disease was obtained with a maximum of 5 experts. In some cases, one expert could answer several questionnaires (one per disease) if the diseases were within is area of expertise.

2.2 | Calculation of total scores for each disease

To obtain the overall score for the ranking, an aggregation method that combined the 2 types of weighting (i.e. the intra- and inter-domain) was used. First, the criterion score (coefficients attributed by experts) had to be standardized. Indeed, some criteria were allocated coefficients from 0 to 4 and others from 1 to 4. This standardized score was then multiplied by the intradomain weight as given by the expert. These results were summed to obtain a domain score.

$$DSj = \sum crit\,(SCj \times WdWj) \quad (1)$$

In this formula, DSj = domain score, crit = criterion, SCj = standardized score of the criterion and WdWj = intradomain weight for each criterion.

Each domain score was then multiplied by the inter-domain weight. These results were summed and an overall weighted score calculated, per expert and per disease.

$$OWS = \sum cat\,(DSj \times IdWj) \quad (2)$$

In this formula, OWS = overall weighting score of each expert for a specific disease, cat = category, DSj = domain score and IdWj = inter-domain weight.

Each disease had 4 or 5 OWS (since there were 4 or 5 experts per disease), and thus, for each disease, the final score was the average of all disease experts' OWS. The final score was then used to rank the diseases, based on drivers, from the highest score to the lowest. The highest score corresponded to the disease with the highest risk of (re-) emerging according to the drivers. In addition, the median and range among the scores of all the disease experts were also obtained. With the median, a ranking was done to observe whether there was any significant difference with the ranking obtained using the mean. The range was used to note which diseases had the highest and lowest level of variation/uncertainty among the final experts' average score.

2.3 | Ranking of the perceived drivers (domains)

In order to determine which driver(s) was/were considered as the most influential for the (re-) emergence of diseases, the domains were ranked. Domain ranking was performed using the inter-domain scores (weights). The sum of each domain weight (∑IdWj) per disease and per domain given by each expert was ranked from the high to the low, that is 1 to 8. Then, for each domain, the frequency of their rank was used to display in graph.

2.4 | Cluster analysis

A cluster analysis was implemented using regression tree analysis (Salford Predictive Modeler®, Version 8.2, Salford Systems, San Diego, California, USA). The normalized disease score is a continuous variable, and the aim was to obtain groups in qualitative categories of importance (e.g. very high, high, moderate and low) with minimal within-group variance.

2.5 | Sensitivity analysis

Two sensitivity analyses were assessed, that is on expert elicitation and influence of a domain. This was achieved by repeating the disease ranking with a 'reduced' version of the model and comparing the new ranking to the complete model.

The experts' sensitivity analysis consisted in dividing them into 4 groups. Scores were then re-calculated by deleting a group of experts. Each reduced ranking model was compared to the full complete model by using the Spearman's rank test to establish whether the ranking was correlated between the complete and the reduced models.

The sensitivity analysis on the domains was done by deleting one domain and re-calculating the mean scores to rank the diseases. This 'reduced' ranking was then compared with the complete model, and the Spearman's rank test was applied. If the ranking position changed to less than three places, then the final score was considered as robust. If it changed to more than two places, then it was considered as a domain of drivers influencing greatly disease (re-) emergence.

3 | RESULTS

3.1 | Disease selection

We compiled a list of 29 diseases (Table 2) after applying inclusion and exclusion criteria. Nearly all of them were viral with the exception of three bacterial diseases: contagious bovine pleuropneumonia (CBPP), contagious caprine pleuropneumonia (CCPP) and haemorrhagic septicaemia. Out of the 29 diseases, 13 were caused by arboviruses. Six diseases, that is eastern equine encephalitis (EEE), western equine encephalitis (WEE), Venezuelan equine encephalitis (VEE), Japanese encephalitis, West Nile fever and Nipah disease, were zoonotic.

3.2 | Questionnaire survey

All 14 experts contacted for the first phase (questionnaire assessment) answered positively (Appendix B). There was a general agreement on which criteria and coefficients were clear or not. Neither criterion nor coefficient were deleted but only amended according to experts' suggestions.

For the second phase of expert elicitation, a total of 62 experts agreed to participate and answered the questionnaires (Appendix C). The objective of minimum of 4 experts per disease was reached, and the maximum of 5 experts was reached for 8 diseases.

3.3 | Ranking of diseases

The final disease ranking based on the average final scores is shown in Figure 2. The higher the mean score, the higher the ranking, which means the disease is most likely to (re-)emerge in Belgium.

The top 5 diseases in decreasing order were porcine epidemic diarrhoea (PED), FMD, low pathogenic avian influenza (LPAI), African horse sickness (AHS) and HPAI (Table 3). On the other end, the diseases with the lowest mean scores were haemorrhagic septicaemia, Japanese encephalitis, WNF, *peste des petits ruminants* (PPR) and Nipah disease.

TABLE 2 List of 29 diseases selected for prioritization, including the family and genus it belongs to and species it affects

Name of disease	Family	Species affected
Eastern equine encephalitis	F: *Togaviridae* G: *Alphavirus*	Wild birds, horses, humans
Western equine encephalitis	F: *Togaviridae* G: *Alphavirus*	Wild birds, horses, humans
Venezuelan equine encephalitis	F: *Togaviridae* G: *Alphavirus*	Wild birds, horses, humans
Japanese Encephalitis	F: *Flaviviridae* G: *Flavivirus*	Equids, wild birds, humans, swine
West Nile fever	F: *Flaviviridae* G: *Flavivirus*	Wild birds, equids, humans
Aino disease	F: *Bunyaviridae* G: *Orthobunyavirus*	Bovines, cervids, sheep
Akabane disease	F: *Bunyaviridae* G: *Orthobunyavirus*	Bovines, goats, sheep
Schmallenberg disease	F: Bunyaviridae G: Orthobunyavirus	Bovines, sheep, goats
Rift Valley fever	F: *Bunyaviridae* G: *Phlebovirus*	Sheep, bovines and goats.
African horse sickness	F: *Reoviridae* G: *Orbivirus*	Equids
Bluetongue	F: *Reoviridae* G: *Orbivirus*	Bovines, sheep, goats and wild ruminants
Epizootic haemorrhagic disease	F: *Reoviridae* G: *Orbivirus*	Bovines and wild ruminants
African swine fever	F: *Asfivirus* G: *Asfivirus*	Pigs and wild boar
High pathogenic avian influenza	F: *Orthomyxoviridae* G: *Influenzavirus* A	Poultry, wild birds
Low pathogenic avian influenza	F: *Orthomyxoviridae* G: Influenzavirus A	Poultry, wild birds
Contagious bovine pleuropneumonia	*Mycoplasma Mycoides*	Bovines
Contagious caprine pleuropneumonia	*Mycoplasma capricolum*	Goats
Classic swine fever	F: *Flaviviridae* G: *Pestivirus*	Pigs and wild boar
Foot-and-mouth disease	F: *Picornaviridae* G: *Aphthovirus*	All cloven-hoofed animals
Haemorrhagic septicaemia	*Pasteurella multocida* (Serotypes 6:B, 6:E)	Bovines
Lumpy skin disease	F: *Poxviridae* G: *Capripoxvirus*	Cattle
Newcastle disease	F: *Paramyxoviridae* G: *Avulavirus*	Poultry
Nipah virus encephalitis	F: *Paramyxoviridae* G: *Henipavirus*	Pigs
Novel swine enteric coronavirus disease	F: *Coronaviridae* G: *Deltacorona Virus*	Pigs
Peste des petits ruminants	F; Paramyxoviridae G: *Morbillivirus*	Sheep and goats
Porcine epidemic diarrhoea	F: Coronavirus G: *Alphacoronavirus*	Pigs
Sheep and goat pox	F: *Poxviridae* G: *Capripoxvirus*	Sheep and goats
Swine vesicular disease	F: *Picornaviridae* G: *Enterovirus*	Pigs
Vesicular stomatitis	F: *Rhabdoviridae* G: *Vesiculovirus*	Equids, cattle and goats

(Continues)

Abbreviations: F, Family; G, Genus.

When comparing the ranking obtained using the average of the scores of the experts and the ranking obtained with the median of the experts' score, the Spearman's test, a Rho of 0.8044, was obtained (*p*-value .05), showing that there was a significant correlation in both rankings (Appendix D). However, important change in the ranking for 4 diseases (CBPP, CCPP, Bluetongue and Newcastle) was noted (Appendix D). The range obtained showed that the 4 highest range values (i.e. the diseases which experts had a high disagreement on their (re)emergence in Belgium) were CBPP, CCPP, vesicular stomatitis and Nipah virus (Figure 2). On the other end, the 5 smallest range values were novel swine enteric coronavirus disease, HPAI, haemorrhagic septicaemia, CSF and Schmallenberg virus (Figure 2).

3.4 | Cluster analysis

The regression tree analysis determined 4 clusters (Figure 2). The clusters distinguished five, eleven, nine and four diseases, and were classified, respectively, as of 'low importance', 'moderate importance', 'high importance' and 'very high importance' (i.e. highly influenced by drivers). The diseases belonging to the node 'highest importance' were PED, FMD, LPAI and AHS. The node of the lowest importance included haemorrhagic septicaemia, Japanese encephalitis, PPR, Nipah disease and WNF.

3.5 | Drivers influence

The relative importance of the 8 domains varied depending on the disease. However, when considering all domains for all 29 diseases, 'economy and trade activities' obtained the highest number of points, being ranked first 15 times and zero times last ranked (8th). The opposite can be said about 'characteristics of farm/production system', as it was never ranked 1st nor 2nd (Figure 3).

3.6 | Sensitivity analysis

The sensitivity analysis done on the groups of experts showed that the ranking of diseases was not affected in the reduced models. Indeed, the Spearman's rank-order correlation indicated a strong positive association of ranks when using different groups of experts for different reduced models, showing that there was a consistency among the scoring of the experts.

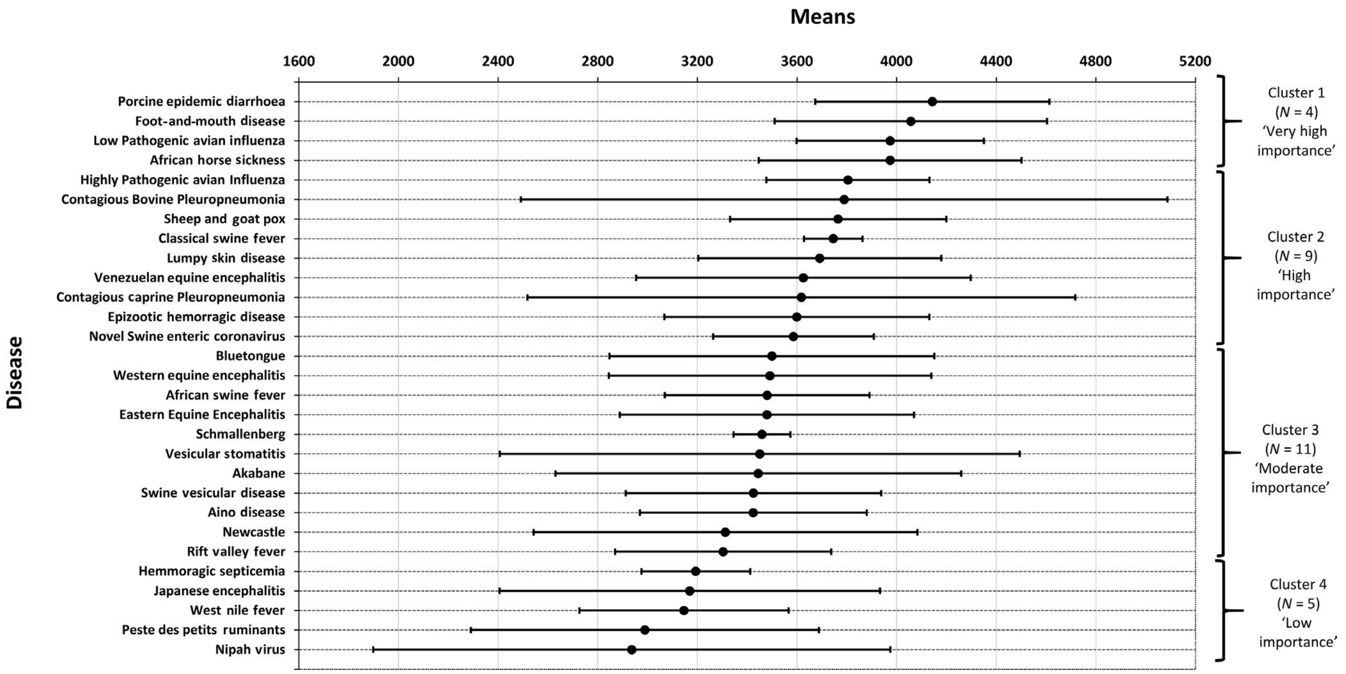

FIGURE 2 (Re-)emerging livestock diseases prioritized. Mean scores and standard deviations are mentioned. Four clusters were identified by regression tree analysis marked by brackets

As for the domain sensitivity analysis, Table 3 displays the mean scores and ranking of the diseases without the scores. The domain that showed the strongest influence on the ranking of a disease (changing the ranking of a disease for more than 3 spots) was 'economic and trade activity'. When discarding that domain, 22 diseases moved three places up or down in the ranking. The Spearman rank correlation test for comparing the base model with the reduced model without the 'economic and trade activity' showed a 0.42-Rho ($p < .05$).

Figure 4 illustrates the movements of the top 5 diseases after performing the sensitivity analysis. When discarding the domain (A) (pathogen characteristics), FMD moved from the 2nd to the 6th place in the ranking, thus highlighting the strong influence of the domain (A) on that specific disease. The ranking of AHS changed notoriously without 'economy and trade activities' (domain H), moving from the 4th to the 25th place. Low pathogenic avian influenza was also strongly influenced, lowering from the 4th to the 23rd place, in the model without the wildlife interface domain.

4 | DISCUSSION

The MCDA approach allowed the selection of 29 livestock diseases exotic to Belgium and their prioritization based on drivers. Whilst such an approach was used in previous disease prioritization exercises, this is one of the first to consider livestock epidemic diseases only and to use criteria related to drivers of (re-)emergence. Only diseases exotic to Belgium were prioritized.

The diseases that fitted the eligibility criteria were all of viral origin, except haemorrhagic septicaemia (*Pasteurella multocida*, serotypes 6:B, 6:E), CCPP and CBPP. Few zoonoses were included in the list (n = 6) as the prioritization exercise focused on livestock epidemic diseases. Therefore, several zoonoses included in other prioritization processes were excluded.

Regarding prioritization, PED ranked top of the list. Although currently not reportable neither in the EU (except in the UK) nor to the OIE, it ranked high in all models (high mean score), possibly due to its highly transmissible character and the difficulty to control it; furthermore, the disease mainly concerns intensive production. Cases have already been reported in EU Member States: for example in May 2014, an outbreak of diarrhoea occurred in fattening pigs on German farms. An outbreak of diarrhoea occurred on a Belgian fattening pig farm at the end of January 2015; this was the first confirmed PED case in Belgium in decades (Theuns et al., 2015). When the list of diseases was compiled, the outbreak had not occurred yet, but when the experts answered the questionnaire it had, and therefore, this was most likely the reason why it ranked at the top of the prioritized list.

Low pathogenic avian influenza ranked slightly higher than HPAI in this multicriteria analysis on the risk of (re)-emergence (LPAI ranked 3rd whilst HPAI ranked 5th). However, by the time this paper was written, no cases of LPAI were registered on the OIE WAHIS interface for Belgium (World Organisation for Animal Health, 2018), whereas HPAI was detected in Hungary in October 2016 and later in 19 other Member States: Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, France, Germany, Greece, Hungary, Italy, Luxembourg, the Netherlands, Poland, Slovakia, Spain, Sweden, Romania and the United Kingdom (European Commission, 2018). Low pathogenic avian influenza shows less signs and symptoms than the HPAI, and the vast majority of LPAI viruses are maintained in

TABLE 3 Ranking and mean scores grouped by regression tree analysis of the 29 diseases according to the base model and the other 'reduced' models

		Deleted domain								
		0^b	Disease pathogen characteristics	Distance to Belgium	Monitoring, treatment and control of the disease	Production system characteristics	Changes in climatic conditions	Wildlife interface	Human activities	Economy and trade activities
	Regression	(Rank)	(Rank)	(Rank)	(Rank)	(Rank)	(Rank)	(Rank)	(Rank)	(Rank)
Disease	tree cluster[a]	Mean Score	Mean Score	Mean Score	Mean Score	Mean Score	Mean Score	Mean Score	Mean Score	Mean Score
Porcine epidemic diarrhoea	1	(1) 4,143.38	(1) 3,454.63	(3) 3,839.38	(3) 3,572.13	(8)* 3,461.81	(1) 4,124.63	(1) 4,129.94	(3) 3,599	(5)* 2,822.13
Foot-and-mouth disease	1	(2) 4,057.36	(12)* 2,938.61	(2) 3,841.11	(1) 3,731.11	(2) 3,773.01	(2) 4,007.26	(2) 3,954	(6)* 3,390.86	(8)* 2,765.56
Low pathogenic avian influenza	1	(3) 3,974.13	(8)* 3,019.5	(1) 3,881.13	(5) 3,386.88	(6)* 3,467.88	(3) 3,851.938	(23)* 3,017.06	(2) 3,609.438	(1) 3,585.06
African horse sickness	1	(4) 3,974.1	(2) 3,370.8	(4) 3,797.35	(2) 3,578.85	(1)* 3,882.1	(10)* 3,501.1	(3) 3,837.8	(1)* 3,639.1	(25)* 2,211.6
Highly pathogenic avian influenza	2	(5) 3,804.5	(6) 3,053.86	(9)* 3,507.75	(6) 3,357.63	(10)* 3,377.94	(6) 3,684.19	(17)* 3,153.31	(7) 3,381.375	(2)* 3,115.44
Contagious bovine pleuropneumonia	2	(6) 3,789.35	(5) 3,071.25	(5) 3,650.54	(23)* 2,824.66	(3)* 3,615.98	(4) 3,761.23	(6) 3,614.66	(8) 3,350.6	(11)* 2,636.54
Sheep and goat pox	2	(7) 3,765.06	(7) 3,045.89	(8) 3,514.49	(9) 3,186.19	(4)* 3,485.31	(7) 3,678.81	(4)* 3,736.06	(17)* 3,211.94	(16)* 2,496.75
Classical swine fever	2	(8) 3,745.33	(3)* 3,280.125	(11)* 3,402.83	(4)* 3,550.01	(15)* 3,235.01	(5)* 3,732.2	(20)* 3,045.83	(19)* 3,174.39	(6) 2,796.89
Lumpy skin disease	2	(9) 3,691.29	(11) 2,946.05	(14)* 3,347.29	(8) 3,193.24	(9) 3,455.41	(9) 3,523.79	(5)* 3,627.79	(11) 3,326.79	(19)* 2,418.66
Venezuelan equine encephalitis	2	(10) 3,625.75	(4)* 3,168.5	(6)* 3,582.5	(7)* 3,353.25	(7)* 3,465.75	(20)* 3,093.25	(13)* 3,271.75	(20)* 3,119.5	(24)* 2,325.75
Contagious caprine pleuropneumonia	2	(11) 3,617.45	(10) 2,952.3	(7)* 3,516.6	(19)* 2,920.45	(13) 3,275.7	(8)* 3,587.45	(19)* 3,049.5	(10) 3,328.7	(10) 2,691.45
Epizootic haemorrhagic disease	2	(12) 3,599.63	(15)* 2,880.52	(13) 3,360.03	(14) 3,056.33	(5)* 3,484.88	(14) 3,319.63	(12) 3,273.96	(4)* 3,429.13	(20)* 2,392.93
New swine enteric coronavirus disease	2	(13) 3,586	(22)* 2,639.25	(18)* 3,263.88	(15) 3,056.31	(27)* 2,870.69	(11) 3,499.13	(7)* 3,532.625	(5)* 3,391.625	(4)* 2,848.5
Bluetongue	3	(14) 3,499.22	(14) 2,885.64	(22)* 3,112.02	(16) 3,028.04	(11)* 3,368.72	(16) 3,255.22	(14) 3,260.21	(15) 3,223.97	(23)* 2,360.72

(Continued)

TABLE 3 (Continued)

Disease	Regression tree cluster[a]	Deleted domain: 0[b] (Rank) Mean Score	Disease pathogen characteristics (Rank) Mean Score	Distance to Belgium (Rank) Mean Score	Monitoring, treatment and control of the disease (Rank) Mean Score	Production system characteristics (Rank) Mean Score	Changes in climatic conditions (Rank) Mean Score	Wildlife interface (Rank) Mean Score	Human activities (Rank) Mean Score	Economy and trade activities (Rank) Mean Score
Western equine encephalitis	3	(15) 3,491.81	(13) 2,909.38	(10)* 3,404.31	(10)* 3,110.25	(12)* 3,276.19	(18)* 3,241.81	(25)* 2,892.13	(16) 3,223.06	(21)* 2,385.56
African swine fever	3	(16) 3,479.96	(9)* 2,963.81	(19)* 3,181.34	(11)* 3,072.46	(20)* 3,090.59	(12)* 3,456.71	(24)* 2,933.65	(22)* 3,079.03	(12)* 2,582.15
Eastern equine encephalitis	3	(17) 3,479.38	(23)* 2,600	(12)* 3,391.88	(13)* 3,056.88	(14)* 3,263.75	(19) 3,152.81	(18) 3,075.313	(13)* 3,280.94	(15) 2,534.06
Schmallenberg disease	3	(18) 3,459.19	(26)* 2,532.94	(23)* 3,108.56	(24)* 2,788.44	(16) 3,231.38	(21)* 3,071.06	(11)* 3,279	(9)* 3,336.06	(3)* 2,866.88
Vesicular stomatitis	3	(19) 3,450.4	(21) 2,667.5	(15)* 3,342.9	(18) 2,953.4	(17) 3,127.9	(15)* 3,297.4	(10)* 3,310.4	(12)* 3,287.9	(26)* 2,165.4
Akabane disease	3	(20) 3,444.55	(20) 2,681.93	(16)* 3,332.05	(17)* 3,013.19	(18) 3,108.94	(22) 2,978.61	(15)* 3,244.55	(18) 3,211.175	(14)* 2,541.43
Swine vesicular disease	3	(21) 3,425.25	(18)* 2,704.94	(21) 3,131.56	(20) 2,896.5	(26)* 2,906.5	(13)* 3,400.88	(8)* 3,360.875	(21) 3,100.25	(17)* 2,475.25
Aino disease	3	(22) 3,424.75	(16)* 2,784.18	(17)* 3,306.94	(21) 2,853.26	(19)* 3,107.19	(23) 2,965.38	(9)* 3,313.25	(14)* 3,266.81	(22) 2,376.25
NewCastle	3	(23) 3,312.75	(17)* 2,722.88	(24) 3,107.06	(12)* 3,059	(25) 2,934	(17)* 3,242.13	(21) 3,028.063	(29)* 2,647.75	(18)* 2,448.38
Rift valley fever	3	(24) 3,303.6	(28)* 2,483.38	(20)* 3,134.79	(22) 2,851.79	(23) 3,005.85	(24) 2,954.23	(16)* 3,211.1	(25) 2,925.48	(13)* 2,558.6
Haemorrhagic septicaemia	4	(25) 3,193.44	(19)* 2,683.75	(26) 2,973.44	(25) 2,759.69	(21)* 3,052.81	(27) 2,859.06	(22)* 3,019.688	(23) 2,993.44	(28)* 2,012.19
Japanese encephalitis	4	(26) 3,169.56	(29)* 2,480.31	(25) 3,069.56	(29)* 2,344.56	(22)* 3,010.19	(28) 2,847.69	(27) 2,828.313	(26) 2,860.19	(9)* 2,746.13
West Nile fever	4	(27) 3,146.47	(25) 2,577.93	(29) 2,756.78	(26) 2,640.74	(24)* 2,941.07	(29) 2,738.17	(28) 2,631.66	(24)* 2,954.97	(7)* 2,783.97
Peste des Petits Ruminants	4	(28) 2,989.31	(24)* 2,585	(27) 2,812.75	(27) 2,523.06	(28) 2,684	(25)* 2,953.38	(26) 2,883.688	(28) 2,748.38	(29) 1,734.94

(Continued)

TABLE 3 (Continued)

Disease	Regression tree cluster[a]	Deleted domain: 0[b]		Disease pathogen characteristics		Distance to Belgium		Monitoring, treatment and control of the disease		Production system characteristics		Changes in climatic conditions		Wildlife interface		Human activities		Economy and trade activities	
		(Rank)	Mean Score	(Rank)	Mean Score	(Rank)	Mean Score	(Rank)	Mean Score	(Rank)	Mean Score	(Rank)	Mean Score	(Rank)	Mean Score	(Rank)	Mean Score	(Rank)	Mean Score
Nipah Virus	4	(29)	2,936.56	(27)	2,486.19	(28)	2,795.31	(28)	2,498.94	(29)	2,514.69	(26)*	2,919.69	(29)	2,500.813	(27)	2,796.88	(27)	2,043.44

Note: Highlighted numbers represent an up or down movement of more than 3 steps in the ranking.
[a]Regression tree analysis clusters group: 1 = very high importance; 2 = high importance; 3 = moderate importance; and 4 = low importance.
[b]Base model of the ranking.
*Denotes more than three changes in the ranking.

asymptomatic wild birds (Center for Food Security & Public Health, 2015); thus, an incursion of LPAI in an area free of the virus is more likely to happen and go undetected. Additionally, the HPAI viruses can evolve directly from low pathogenic (LPAI) virus precursors following introduction into domestic poultry (Monne et al., 2014). Hence, these characteristics of the virus give in this prioritization LPAI a higher score than HPAI, but HPAI is more likely to be detected and notified.

African horse sickness surprisingly ranked 4th, although its last know incursion in Europe (Portugal and Spain) was in 1987 and its eradication dates back to 1990. Such high position in the ranking could be related to its vector-borne transmission, that is by *Culicoides* biting midges. These vectors are often highly abundant, across most of Africa, the Middle East, Europe and southern Asia (Carpenter, Mellor, Fall, Garros, & Venter, 2017). Additionally, the recent changes in the epidemiology of bluetongue and its latest epidemic in Europe and the emergence of Schmallenberg disease (Afonso et al., 2014; Anonimous, 2013; Carpenter et al., 2009; Wilson & Mellor, 2009) highlight the uncertainty about the variables controlling the spread and persistence of *Culicoides*-borne arboviruses. These different factors have raised concerns that AHS may also amount similar incursions, hence explaining such high mean final score in the prioritization process.

In this prioritization, most of the diseases were in clusters 2 (high importance, N = 9) and 3 (moderate importance, N = 11). Cluster 2 of high importance includes the diseases HPAI, CSF, LSD, sheep and goat pox and CBPP, all of which have been well described in the past, have had epidemics and still have important outbreaks worldwide. The new swine enteric coronavirus disease, which was added on interest basis, also belongs to this cluster. The three diseases that were added to the prioritization although not present in any of the official list of notifiable diseases, Aino, Akabane and Schmallenberg, were categorized in cluster 3, even though only Schmallenberg has had outbreaks in Europe. It is therefore considered that the Simbu serogroup could be of moderate importance in (re-)emerging.

From the complete list of the livestock diseases prioritized, it is important to highlight ASF. In this prioritization, ASF did not obtain the highest ranking score at 16th place and placed in the group of moderate importance of the regression tree analysis. However, ASF has become more prevalent in the Caucasus regions since its spread from eastern Africa to Georgia in 2007 and the virus reached the European Union member states of Estonia, Latvia, Lithuania and Poland; in 2016, Moldova; in 2017, the Czech Republic and Romania (Chenais, Ståhl, Guberti, & Depner, 2018); and in 2018, the Hungary and Bulgaria. It emerged in Belgium in September of 2018 when authorities in Belgium reported that ASF had been confirmed in 2 wild boars (Linden et al., 2019). The detection of ASF in Belgium was unexpected as ASF appears to have jumped a considerable distance from previously affected countries: ~500 km from the border with the Czech Republic, 800 km from Hungary and 1,200 km from the border with Romania (Garigliany et al., 2019) and how it was introduced in the wild boar population until the writing this article is unknown (presumably related to illegal human activities) (Saegerman,

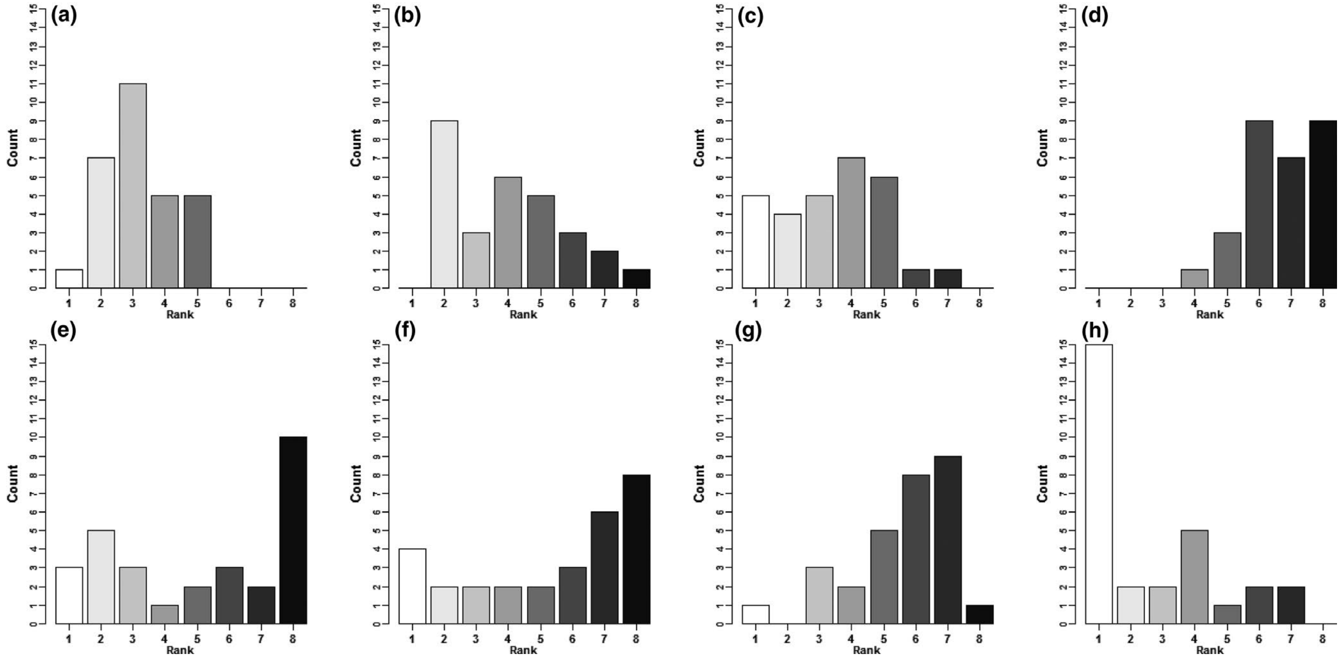

FIGURE 3 Frequency of rank (from 1 to 8) for each domain. (a) Disease/pathogen characteristics; (b) distance to Belgium; (c) ability to monitor, treat and control the disease; (d) farm/production system characteristics; (e) changes in climatic conditions; (f) wildlife interface; (g) human activity; and (h) economic and trade activity. Colour of each bar: white (ranked 1st) until black (ranked 8th)

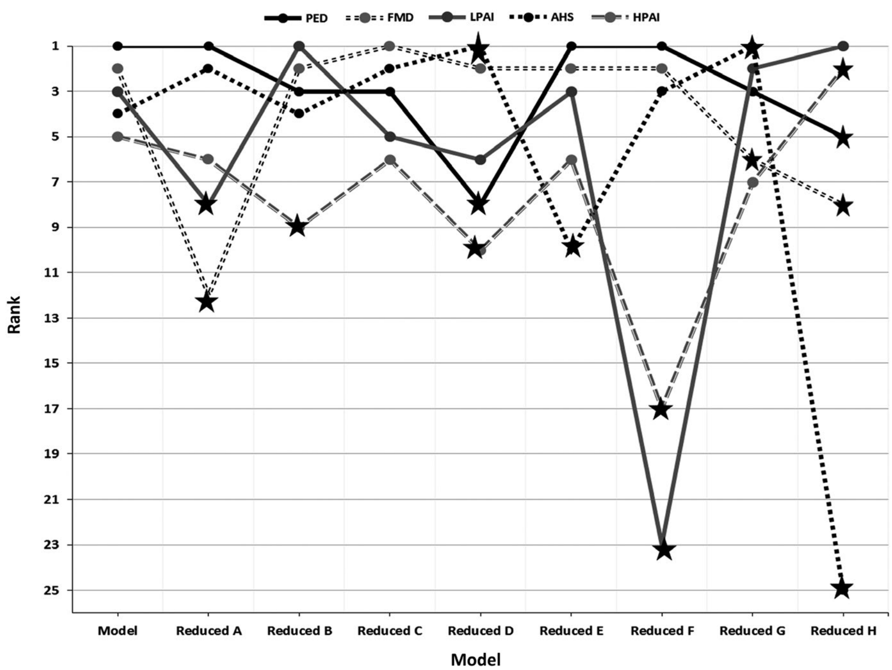

FIGURE 4 Sensitivity analysis for the five diseases with highest mean scores; the graph illustrates their up or down movements in the ranking. *Ranking changed by more than 3 positions. (A) Disease/pathogen characteristics; (B) distance from Belgium; (C) ability to monitor, treat and control the disease; (D) farm/production system characteristics; (E) changes in climate change; (F) wildlife interface; (G) human activity; and (H) economic and trade activity. AHS, African horse sickness; FMD, foot-and-mouth disease; HPAI, high pathogenic avian influenza; LPAI, low pathogenic avian influenza; PED, porcine epidemic diarrhoea

2018). The ASF score (ranked 16th place and was in group of moderate importance of the regression tree analysis) may be explained that although there was an awareness of the risk of ASF spreading to EU member states, when the questionnaire was answered by the experts (year 2016) the risk that ASF would become endemic in domestic pigs in Ukraine and Belarus was considered to be moderate and the risk to further spread into unaffected areas was also considerate moderate (European Food Safety Authority, 2014; 2014). Furthermore, the score reflected the geographical position of where ASF had been reported and it was unexpected that ASF skipped neighbouring countries and directly entered Belgium (Garigliany et al., 2019). In addition, any ranking cannot include unforeseen circumstances such as the human factors; the vigilance should be always implemented for new introduction.

This score can only be compared with the prioritization work done by Humblet and collaborators (Humblet et al., 2012) as other prioritization works using the MCDA method, such as those by Cardoen et al. (2009), and Havelaar et al. (2010), only included zoonoses. Indeed, in regression tree analysis of prioritized diseases of food-producing animals and zoonoses, ASF also fell in the 3th group of importance out of the 4th group (Humblet et al., 2012), just like in this prioritization work. Another study, which may be used for comparison as it used MCDA approach and had swine diseases, done by Brookes, Hernandez-Jover, Cowled, Holyoake, and Ward (2014), ASF ranked higher, but in this study only exotic diseases for the pig industry in Australia were ranked using criteria related to impact and the experts were pig producers, which changes the importance in the scores, giving ASF a higher ranking.

The livestock diseases at the bottom of the list were Nipah disease, PPR, WNF, Japanese encephalitis and haemorrhagic septicaemia. In other prioritization exercises, Nipah, Japanese encephalitis and WNF were ranked in a higher category (Cox et al., 2013; Havelaar et al., 2010; Humblet et al., 2012). The prioritization model presented here was based on criteria reflecting only drivers; no criteria linked to societal or economic impacts were considered, which affects the weights given to the different domains. Therefore, diseases that otherwise would have scored high in the ranking were in the lower end ('low importance' group in the regression tree analysis). Moreover, until recently only WNF had been reported in Europe (Sambria et al., 2013). However, when writing the results of this article, in June 2018, Bulgaria reported the first outbreak in the European Union of PPR, in farms close to the border with Turkey (Altan, Parida, Mahapatra, Turan, & Yilmaz, 2018). Thus, although PPR here is in the low importance group, this unexpected introduction would make this disease become suddenly a priority.

Drivers are a complex set of factors, and their convergence can cause the (re-)emergence of a disease. Several drivers have a stronger impact on diseases compared to others, as shown in the results section. Porcine epidemic diarrhoea ranked at the top in all models, except in the reduced models of production system characteristics. Porcine epidemic diarrhoea affects mainly intensive production systems; thus, the driver category 'production system characteristics' logically influences a lot. When using the reduced model, the mean score decreases and the disease moved from the 1st place to the 8th place. In comparison, FMD ranked high in the prioritization process (2nd), but lowered to the 12th place in the reduced model, which excluded disease pathogen characteristics. For FMD, the strongest driver was the 'pathogens characteristics'. The virus is highly contagious, spreads via airborne and direct contact and affects different livestock species, giving this driver category a strong weight.

All experts considered that 'economy and trade activities' was the most important driver (high weight). It was ranked first more often than others. In the reduced model (without the 'economy and trade activities' domain), all diseases with the exception of 7 moved up or down in the ranking by more than 3 places. This is of no surprise, as economic and trade activity has priority in the age of globalization; increased movement of live animals and animal products crossing oceans and international boundaries increase the risk of spread for animal and zoonotic diseases (Domenech, Lubroth, Eddi, Martin, & Roger, 2006). On the other side of the scale, the domain defined as 'characteristics of farm/production system' was given the least weight, therefore with the least influence. Although this true for many diseases within the EU Member States, it is important to consider that for some other diseases in certain cases this domain could be a strong influence. One example is farms, which may have backyard pigs, with no biosecurity set in place and not always under the full control of veterinary services. This type of farming could well explain the dissemination of diseases such as ASF, thus making characteristics of farm/production an importance driver.

As only diseases exotic to Belgium were considered, the results presented here are specific to the country. Nevertheless, a similar prioritization exercise could be applied to other countries, in particular EU Member States, because their animal sanitary status, regulations and controls are similar. Indeed, the focus of the questionnaire was to prioritize diseases according to their drivers and not to the impact on the country nor other criteria country-specific. Furthermore, the sensitivity analysis of experts also showed a high correlation among the ranking of models, which confirms that experts were in agreement in regards to the scores.

Overall, the importance of validating each generated model is highlighted. Two types of validations can be used. This involves testing the internal validity of the model (e.g. by performing a sensitivity analysis on the domains of criteria and/or testing the effect of deleting groups of experts on the results) and the external validity of the model (e.g. comparing results of each model with other driver-based prioritization exercises if they exist).

The tool provided here clearly defines each criterion and its coefficients in order to ensure standardization of answers. Although this study cannot account for the complexity of drivers in the (re-) emergence of a disease, it can provide, through a quick assessment, a general picture of what drivers can influence the (re-)emergence of a disease. Furthermore, this MCDA tool, which could be made available to third parties upon request to the main authors, can be used with a subset of criteria and/or impact criteria or public health aspects can be easily added, and it could be applied to a broader set of diseases. The resulting scores could be translated into practical recommendations tailored to the needs of a specific country's national public or governmental agencies.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

ETHICAL APPROVAL

Ethical statement is not applicable to this study as the data were gathered through questionnaire survey without any animal experimentation.

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APPENDIX A Domains which each defined criterion and their respective defined coefficients (scores)

DOMAIN A. DISEASE/PATHOGEN CHARACTERISTICS		
A1	Current knowledge of the pathogen	
	Score 0	
	Score 1	Very high: deep scientific knowledge on the pathogen, extensive scientific literature available on its biology (transmission mode, knowledge on vector(s), infectivity, etc.)
	Score 2	High: detailed scientific knowledge on the pathogen but conflicting scientific results; some elements of the pathogen's biology are still not elucidated
	Score 3	Moderate: limited scientific knowledge on the pathogen agent because it is still under characterization; pathogen recently discovered/isolated but belonging to a well-known and studied family of pathogens; the pathogen is characterized by multiple variants not characterized yet
	Score 4	Low: lack of scientific knowledge on the pathogen (multiplication, infectivity, incubation period, transmission mode, etc.); pathogen agent recently discovered and emerging
A2	The current species specificity of the causing agent of the disease	
	Score 0	
	Score 1	Low. Only one host is involved belonging to the same family, for example only bovines, only equines, only avian, only porcines
	Score 2	Medium: two species involved
	Score 3	High: three species involved
	Score 4	Very high: affects more than 3 types of families
A3	Genetic variability of the infectious agent	
	Score 0	Negligible. The infectious agent is genetically stable
	Score 1	Low. The genetic variability is low; therefore, it has a low effect in the (re)emergence of the pathogen
	Score 2	Medium The pathogen can be considered with a medium genetic variability.
	Score 3	High. The pathogen is considered with a high genetic variability
	Score 4	Very high. Very high genetic instability (e.g. high mutation rate, re-assortment and recombination). Potentially, the three phenomena can characterize the pathogen's evolution
A4	Transmission of the agent in relation of the possible spread of the epidemic (i.e. ease/speed of spread)	
	Score 0	
	Score 1	Low: Low and slow transmission within farms. Between farms only if an infected animal is introduced, close contact
	Score 2	Medium: Medium ease/speed transmission within the farm. Between farms medium
	Score 3	High. Fast transmission within a farm. In a short period of time, all animals of the farm are infected. Adjacent farms become infected fast
	Score 4	Very High. Very fast and high transmission within the farms and between farms. A complete area is infected in a very short period of time.
A5	Risk of showing no clinical signs and silent spread during infection and post infection	
	Score 0	Null: Silent spread is not part of the pathogen's characteristics
	Score 1	Low: Very short incubation period and signs of infections easily detected/recognized.
	Score 2	Moderate: Very short incubation period and signs of infection are NOT easily detected/recognized
	Score 3	Medium: Long incubation period, clinical signs are not characteristics and therefore specific diagnosis is necessary to detect infection.
	Score 4	Very high. Long incubation period. Disease/infection shows not clinical symptoms during the infectious period. Chronic shedder
A6	Wildlife reservoir and potential spread from it	
	Score 0	Null: No known wildlife reservoir. Disease has never been reported in wildlife species
	Score 1	Low: Few clinical cases have been reported in wildlife and no transmission to livestock has ever been documented.
	Score 2	Moderate: Wildlife is a reservoir of the disease but only accidental spill overs to livestock have been reported.
	Score 3	High: Wildlife is a reservoir for the pathogen/disease but certain environmental conditions (e.g. floods, farms crossing the farmland-bush division) have to occur for the pathogen/disease to (re)emerge in livestock.
	Score 4	Very high: Disease establishes itself in wildlife as a reservoir and very hard to eradicate it from wildlife. Livestock easily gets infected with the contact with wildlife.

(Continued)

APPENDIX A (Continued)

A7	Existence of vectors (vertebrate and invertebrate, for example mosquitoes, bats, rodents, ticks, midges, culicoids) and potential spread.	
	Score 0	Null: No known vector
	Score 1	Low: Only one type of vector is present in the country but it's role in the transmission is presumed low (has not been assessed to date).
	Score 2	Moderate: Only one type of vector exists in the country and has only been suspected as source and spread of disease
	Score 3	High: Only one competent vector is present and can carry and spread the disease
	Score 4	Very high: More than one type of vector can carry and spread the disease and are found spread in most of the territory
A8	Transmission of the pathogen.	
	Score 0	
	Score 1	Low: Animals only get infected by direct close contact with other infected animals and vertical transmission.
	Score 2	Moderate: Transmission by direct and indirect contact only (e.g. through vehicles, clothes, instruments) or non flying vector (e.g. ticks).
	Score 3	High: Exclusively vector transmission by flying vectors (e.g. culicoides, mosquitoes)
	Score 4	Very high: More than three modes of transmission and/or airborne transmission
A9	Environmental persistence	
	Score 0	Null: Pathogen does not survive in the environment
	Score 1	Low: Only anecdotal isolation of the pathogen from the environment has been recorded
	Score 2	Moderate: The survival of the agent in the environment is limited (only temporary) and it's dependent on certain environmental conditions such as humidity, temperature and rainfall.
	Score 3	High: The survival of the agent in the environment is limited (only temporary)and NOT dependent on certain environmental conditions such as humidity, temperature and rainfall
	Score 4	Very high: Agent naturally surviving in the environment (soil, water) and organic materials were it has a long-term survival.

Number of Criteria = 9, hence 90 points to be distributed within this domain for the intra-domain weighing.

DOMAIN B. DISTANCE TO BELGIUM

B1	Current incidence (cases)/prevalence of the disease in the world	
	Score 0	
	Score 1	Pathogen has been reported only in the countries of the Australasia (Australia, New Zealand, New Guinea and Neighbouring Pacific Islands) region
	Score 2	Disease was reported in countries of the Americas, Caribbean and Asia (excluding the Russian Federation)
	Score 3	Disease was reported/present in the African continent
	Score 4	Disease was reported in countries of the Mediterranean Basin, Middle East and the Russian Federation
B2	European geographic proximity of the pathogen/disease to Belgium	
	Score 0	
	Score 1	Disease has never been present in Europe
	Score 2	Disease has been reported in Europe in the past but is currently exotic.
	Score 3	Disease is currently present in at least one European country which is NOT bordering Belgium
	Score 4	Diseases is currently present in at least one of the countries bordering Belgium
B3	To your knowledge when was the disease last reported in Europe	
	Score 0	More than 20 years ago
	Score 1	More than 10 years ago
	Score 2	More than 5 years ago
	Score 3	More than 1 year ago
	Score 4	Currently present in Europe

Number of Criteria = 3, hence 30 points to be distributed within this domain for the intra-domain weighing.

DOMAIN C. ABILITY TO MONITOR, TREAT AND CONTROL THE DISEASE

(Continued)

APPENDIX A (Continued)

C1	Ability of preventive/control measures to stop the disease from entering the country or spreading (containment of the epidemic), EXCLUDING treatment, vaccination and vector(s)/reservoir(s) control	
	Score 0	
	Score 1	Very High Sanitary certificate; effective traceability of animals and by-products; effective disinfection measures; no contact between domestic and wild animals; effective biosecurity measures
	Score 2	High No sanitary certificate; effective traceability of animals and by-products; effective disinfection measures; limited or incomplete possibilities to restrict contacts between domestic and wild animals; effective biosecurity measures
	Score 3	Low No sanitary certificate; incomplete traceability of animals and by-products; ineffective disinfection measures; incomplete restriction of contacts between domestic and wild animals; ineffective biosecurity measures
	Score 4	Very low No sanitary certificate; no traceability of animals and by-products; ineffective disinfection measures; impossibility to restrict contact between farms or between domestic and wild animals; biosecurity measures totally ineffective
C2	Vaccine availability	
	Score 0	
	Score 1	Very high Commercialized vaccine available on a global scale (worldwide)
	Score 2	High Local/mono-species vaccine available at a regional/national scale and/or for a targeted species (not systematically available for a global fight plan)
	Score 3	Low Experimental vaccine, not commercialized to date; severe adverse reaction when applied; limited protector effect
	Score 4	Very low Absence; no vaccine available on the market for a use in the species considered in the study, no experimental vaccine either
C3	Control of reservoir(s) and/or vector(s)	
	Score 0	Null No vector-borne transmission and/or no reservoir(s) known to date
	Score 1	Very high Effective. Limited reservoir(s) with limited geographical repartition, easy-to-identify; high scientific knowledge on vector(s)/reservoir(s); effective fighting measures
	Score 2	High Limited reservoir(s)/vector(s) with limited geographical repartition; easy-to-identify, high scientific knowledge on vector(s)/reservoir(s); effective fighting measures but NOT applicable at a large scale; limited fighting measures
	Score 3	Low Numerous reservoirs vectors identified with limited geographical repartition; hard to identify. Lack of scientific knowledge on vector(s)/reservoir(s).Fighting measures are poorly effective - resistances and/or negative impact on environment;
	Score 4	Very low Numerous Vector(s)/reservoir(s)identified with wide geographic distribution; hard to identify, absence of scientific knowledge on vector(s)/reservoir(s); NO effective fighting measure against vector(s) (no active molecule, resistance to measures applied)
C4	Availability and quality of diagnostic tools in Belgium	
	Score 0	
	Score 1	Very High Field test(s) available and easy to use, with highly discriminating sensitivity and specificity
	Score 2	High Tests used in local/regional laboratories by not in the field
	Score 3	Low tests only used in *specialized* laboratories/national reference laboratory
	Score 4	Very Low no diagnostic tools available to date
C5	Disease is currently under surveillance overseas (OIE, EU)	
	Score 0	
	Score 1	Very high: Generalized surveillance implemented by ALL EU Member States and worldwide surveillance (i.e. OIE reported)
	Score 2	High Surveillance of the pathogen only EU member states
	Score 3	Low Surveillance only in some EU member states (because they had cases of the disease) and only in some NON-EU countries (not a disease reported in any international organizations)
	Score 4	Very low Absence of surveillance of the pathogen in ALL EU member countries AND world wide
C6	Eradication experience in other countries and/or Belgium	
	Score 0	
	Score 1	Very high Previous experience on eradication has been applied, fast and successfully
	Score 2	High Previous experience on eradicating the disease but with some setbacks in the process
	Score 3	Low Knowledge on eradication procedures but have never had to implement an eradication program in Belgium
	Score 4	Very low It is a novel disease, first time countries are faced with a new disease to eradicate

(Continued)

APPENDIX A (Continued)

C7	Detection of emergence—for example difficulties for the farmer/veterinarian to declare the disease or clinical signs not so evident.	
	Score 0	
	Score 1	Very high Disease is easily detected with clinically signs and farmers are aware of the disease and willing to notify it as soon as possible it
	Score 2	High Disease is easily detected by the clinical signs but farmers don't have sufficient knowledge/awareness nor interest to notify it
	Score 3	Moderate Disease is not as easily detect by the clinical signs and farmers don't have sufficient knowledge/awareness nor interest to notify.
	Score 4	Low The infected animal does not show any pathognomonic clinical sign(s); farmer is reluctant to declare/notify any abnormality.
Number of Criteria = 7, hence 70 points to be distributed within this domain for the intra-domain weighing.		
DOMAIN D. FARM/PRODUCTION SYSTEM CHARACTERISTICS		
D1	Mono species farms—One single farmed animal (e.g. only bovines) or multi species farms (farms with more than one species, for example goats and bovines in the same farm/land/premises).	
	Score 0	
	Score 1	Negligible: the type of farm does not influence in any form (re)emergence of the disease among the livestock population.
	Score 2	Low: mono or multi species farm has a low effect on the risk of disease to emerge or re-emerge.
	Score 3	Moderate: the type or types of farmed animals has a moderate effect on the emergence of the disease in Belgium.
	Score 4	High: the type of farmed animals has a high influence for the disease to emerge and spread in Belgium.
D2	Farm demography/management: such as type of dairy or beef (cattle) production. For pigs—reproduction, fattening, finishing farm or both. Chickens—only laying eggs chickens or solely finishing broilers	
	Score 0	
	Score 1	Negligible: population demography does not influence in any form the (re)emergence of the disease among the livestock population.
	Score 2	Low: the demographic population of the farm is a low influencing factor for disease (re)emergence. For example, disease only clinically affects only one age strata (i.e.) newborns, therefore adults are immune to it.
	Score 3	Moderate: the demographic of the population has a moderate effect on the (re)emergence of the disease, as it can (re)emerge in more than one type of demography but other conditioning factors have to occur in conjunction.
	Score 4	High: the type of demographic of the farm has a high effect on the (re)emergence of the disease as it can (re)emerge in different types of farmed animals and all types of age groups
D3	Animal density of farms. Extensive (small holders with a few animals) v/s intensive farming	
	Score 0	
	Score 1	Negligible: animal farm density is not a risk factor for the disease to emerge in Belgium
	Score 2	Low: farm density (extensive or intensive) of animals has a low effect on the pathogen's/disease (re)emergence
	Score 3	Moderate: farm density of animals in the farm (extensive v/s intensive) has a moderate effect on the emergence of pathogen/disease
	Score 4	High: farm density of animals has a high effect on the (re)emergence of pathogen/disease.
D4	Feeding practices of farms	
	Score 0	
	Score 1	Negligible: Feeding practices have a negligible effect on the (re)emergence of the pathogen/disease
	Score 2	Low: Feeding practices have a low effect on the (re)emergence of the pathogen/disease
	Score 3	Moderate: Feeding practices have a moderate effect on the (re)emergence of the pathogen/disease
	Score 4	High: Feeding practices have a high effect on the (re)emergence of the pathogen/disease
D5	Human movements among premises - Veterinarians or farm staff.	
	Score 0	
	Score 1	Negligible: Disease is spread by other means
	Score 2	Low: Movement of human staff has a low effect on the introduction or spread of the disease
	Score 3	Moderate: Movement of human staff has a moderate effect on the introduction or spread of the disease
	Score 4	High: Movement of human staff has a high effect on the introduction or spread of the disease

(Continued)

APPENDIX A (Continued)

D6	Proximity of livestock farm to wildlife and wildlife reservoirs of disease, for example contact with wild or feral birds and animals which have been scavenging on landfill sites that contain contaminated animal products	
	Score 0	
	Score 1	Negligible: Disease (re)emergence from wildlife and wildlife reservoir never reported.
	Score 2	Low: Disease (re)emergence from wildlife and wildlife reservoir rarely reported.
	Score 3	Moderate: Disease (re)emergence from wildlife and wildlife reservoir is documented regularly.
	Score 4	High: wildlife is a reservoir for the disease and the main source of infection for livestock.
D7	Changes of land use, for example field fragmentation, creation of barriers, landfill sites.	
	Score 0	
	Score 1	Negligible: Changes in land use have a negligible effect on the (re)emergence of pathogen/disease.
	Score 2	Low: changes in land use have a low effect on the (re)emergence of the disease/pathogen but need other factors (e.g. land use changes combined with higher winter temperatures)
	Score 3	Moderate: land use changes increases the availability of vectors or increases the pathogen's survival. Also empty land can create a suitable environment for certain wildlife carrying the disease (e.g. migratory birds)
	Score 4	High: land use changes are one of the main drivers for pathogen or its vectors
Number of Criteria = 7, hence 70 points to be distributed within this domain for the intra-domain weighing.		
DOMAIN E. CHANGES IN CLIMATIC CONDITIONS		
E1	Influence of annual rainfall in the survival and transmission of the pathogen/disease	
	Score 0	
	Score 1	Negligible: Pathogen survival and mode of transmission of the disease are not influenced by increased rainfall
	Score 2	Low: pathogen survival and mode of transmission of the disease are slightly influenced by increased rainfall
	Score 3	Moderate: pathogen survival and mode of transmission of the disease are moderately influenced by increased rainfall
	Score 4	High: pathogen survival and mode of transmission of the disease are highly influenced by increased rainfall
E2	Influence of annual humidity in the survival and transmission of the pathogen/disease	
	Score 0	
	Score 1	Negligible: Pathogen survival and mode of transmission of the disease are not influenced by increased humidity
	Score 2	Low: pathogen survival and mode of transmission of the disease are slightly influenced by increased humidity
	Score 3	Moderate: pathogen survival and mode of transmission of the disease are moderately influenced by increased humidity
	Score 4	High: pathogen survival and mode of transmission of the disease are highly influenced by increased humidity
E3	Influence of annual temperature in the survival and transmission of the pathogen/disease	
	Score 0	
	Score 1	Negligible: Pathogen survival and mode of transmission of the disease are not influenced by increased temperature
	Score 2	Low: pathogen survival and mode of transmission of the disease are slightly influenced by increased temperature
	Score 3	Moderate: pathogen survival and mode of transmission of the disease are moderately influenced by increased temperature
	Score 4	High: pathogen survival and mode of transmission of the disease are highly influenced by increased temperature
Number of Criteria = 3, hence 30 points to be distributed within this domain for the intra-domain weighing.		
DOMAIN F. WILDLIFE INTERFACE		
F1	Potential roles of zoo's in the (re)emergence of the pathogen	
	Score 0	
	Score 1	Negligible: The disease can be present in zoo animals but it is not known to have been transmitted from zoo animals to livestock.
	Score 2	Low: The disease can enter a zoo (e.g. with introduction of an infected exotic animal) but only accidental transmissions of the disease from zoo animals to livestock have been reported. Hence, zoos have a low effect on the (re)emergence of the disease in Belgium's livestock
	Score 3	Moderate: The disease can enter a zoo and be present in zoo animals but it needs a vector (biological/mechanical) for its transmission into livestock. Therefore, zoos have a moderate effect on the (re)emergence of the disease in Belgium.
	Score 4	High: Disease can be introduced to a zoo via an infected imported animal, zoo animals can carry the disease that can easily jump to livestock animals

(Continued)

APPENDIX A (Continued)

F2	The rural(farm)-wildlife interface	
	Score 0	
	Score 1	Negligible: The disease has never (re)emerged from the narrowing of the farm-wild interface
	Score 2	Low: The disease has a low probability to (re)emerge via the livestock farm-forest interface. The disease has been known to (re)emerge from the wild bush but very rarely
	Score 3	Moderate: The disease has a moderate probability of (re)emergence via the farm/wildlife interface. Barriers (natural or artificial) are needed to keep the disease/pathogen (re)emerging in livestock
	Score 4	High: there is a high probability for the disease to (re)emerge via the farm/forest interface. Barriers (natural or artificial) separating farms from natural forests are ineffective
F3	Increase of autochthons (indigenous animal) wild mammals in Belgium and neighbouring countries	
	Score 0	Null: Disease has not been reported in wildlife
	Score 1	Negligible: The increase the autochthonous mammals population does not affect the risk of the diseases to (re)emergence
	Score 2	Low: The slight increase of autochthonous mammals can slightly increase the probably of the disease emerging
	Score 3	Moderate: The increase of wild mammals has been associated with the re-emergence of the disease
	Score 4	High: The increase of wild mammals IS the only factor associated with outbreaks of the disease in livestock
F4	Increase in endemic/migrating populations of wild birds.	
	Score 0	Null: Wild/migrating birds are not a reservoir of the disease
	Score 1	Negligible: there is a negligible probability of disease (re)emerging in livestock because of an increase in populations of endemic/migrating wild birds.
	Score 2	Low: there is a low probability of the disease (re)emerging and spreading through increased populations of endemic/migrating wild birds. Disease has spread from the endemic/migrating wild birds but only accidentally or under exceptional circumstances
	Score 3	Moderate: there is a moderate probability of disease being introduced and spread through increased populations of endemic/migrating wild birds. They are hosts and in close contact with domestic livestock (i.e. poultry farms) may spread the disease
	Score 4	High: there is a high probability for a disease to (re)emerge through increased populations of wild/migrating birds. These are hosts or reservoirs of the disease
F5	Hunting Activities: hunted animals can be brought back to where livestock is present	
	Score 0	
	Score 1	Negligible: The risk of the disease/pathogen of (re)emerging in livestock due to hunting activities is practically null
	Score 2	Low: Disease is present in hunted wildlife and birds and only accidental cases have been reported in livestock that have (re)emerged because of hunting. The risk of the disease/pathogen of (re)emerging in livestock due to hunting activities is practically null
	Score 3	Moderate: Disease is present in hunted wildlife and birds but a certain control is established by the hunter
	Score 4	High: Disease is present in hunted wildlife and birds and hunting is one of the main modes of transmission of the disease to livestock
F6	Transboundary movements of terrestrial wildlife from other countries	
	Score 0	Null: Disease is not carried by terrestrial wildlife
	Score 1	Negligible: (re)emergence of the disease by terrestrial movements of wildlife has only been suspected but never confirmed.
	Score 2	Low: There is a low probability for the disease to (re)emerge and spread through transboundary movements of terrestrial wildlife
	Score 3	Moderate: There is a moderate probability for the disease to (re)emerge and spread through transboundary movements of terrestrial wildlife
	Score 4	High: There is a high probability for the disease to (re)emerge and spread through transboundary movements of terrestrial wildlife. These are host and may spread/carry the disease along.
Number of Criteria = 6, hence 60 points to be distributed within this domain for the intra-domain weighing.		
DOMAIN G. HUMAN ACTIVITIES		

(Continued)

APPENDIX A (Continued)

G1	In- and out-people movements linked to tourism	
	Score 0	
	Score 1	Negligible: The movement of tourism is a negligible driver on the emergence or re-emergence of the disease
	Score 2	Low: Tourism increase has a low driver of the (re)emergence of the disease.
	Score 3	Moderate: Tourism increase has a moderate driver for the (re)emergence of the disease. Biosecurity measures are enough to stop the entering of the pathogen.
	Score 4	High: Tourist movement is a high driver on the (re)emergence of a disease. Tourists are highly likely to bring the disease into Belgium in their belongings and biosecurity measures are insufficient to stop the pathogen
G2	Human Immigration	
	Score 0	
	Score 1	Negligible: The immigration movements are a negligible driver of the disease (re)emergence in Belgium
	Score 2	Low: The immigration movements are a low driver of the disease (re)emergence in Belgium
	Score 3	Moderate: The disease is currently present in countries where more immigrants come from and pathogen highly likely to enter through, clothes, shoes and or possession, but the current biosecurity measures in place are able to prevent the emergence of the disease in Belgium
	Score 4	High: the immigration movement has a high effect as a driver on the emergence or re-emergence of disease in Belgium. Disease is highly likely to emerge using this route as biosecurity measures are not enough to avoid emergence of the disease
G3	Transport movements: more specifically commercial flights, commercial transport by ships, cars or military (EXCLUDING TRANSPORT VEHICLES OF LIVE ANIMALS).	
	Score 0	
	Score 1	Negligible: the role of commercial movements as a driver on the (re)emergence of the disease in Belgium is negligible.
	Score 2	Low: the role of commercial movements as a driver on the (re)emergence of the disease in Belgium is low. It is easily preventable by implementing biosecurity measures
	Score 3	Moderate: the role of commercial movements as a driver on the (re)emergence of a disease in Belgium is moderate. Disease can be prevented if biosecurity measures are tightened.
	Score 4	High: the role of commercial movements as a driver on the (re)emergence of a disease in Belgium is high. Disease is hard to control via the current biosecurity measures.
G4	Transport vehicles of live animals	
	Score 0	
	Score 1	Negligible: the role of transport vehicles of live animals as a driver for the (re)emergence of the disease in Belgium is negligible
	Score 2	Low: the role of transport vehicles of live animals as a driver for the (re)emergence of the disease in Belgium is low.
	Score 3	Moderate: the role of transport vehicles of live animals as a driver for (re)emergence of the disease in Belgium is moderate.
	Score 4	High: the role of transport vehicles of live animals as a driver for (re)emergence of the disease in Belgium is high
G5	Bioterrorism potential	
	Score 0	
	Score 1	Negligible: the role of bioterrorism as a driver for a disease to (re)emerge is negligible: agent is available but difficult to handle or has a low potential of spread or generates few economic consequences
	Score 2	Low: the role of bioterrorism as a driver for a disease to (re)emerge is low: agent is available and easy to handle by professionals and labs but has a low spread
	Score 3	Moderate: the role of bioterrorism as a driver for a disease to (re)emerge is moderate: agent available and easy to handle by professionals and labs and rapidly spreads
	Score 4	High: the role of bioterrorism as a driver for a disease to (re)emerge is high: Agent is available and easy to handle by individuals and rapidly spreads
G6	Inadvertent release of an exotic infectious agent from a containment facility, for example Laboratory	
	Score 0	
	Score 1	Negligible: the pathogen is not currently present in any laboratory
	Score 2	Low: the pathogen is present in a containment facility but its release is very unlikely as it is very easily contained
	Score 3	Moderate: the pathogen is present in a containment facility and its release can occur as not easily contained
	Score 4	High: pathogen is handled in a risk 3 or 4 laboratory (BSL3 or BSL4) in the country. It can leave the facility if the correct biosecurity measures are not implemented correctly and easily spread to livestock

Number of Criteria = 6, hence 60 points to be distributed within this domain for the intra-domain weighing.

(Continued)

APPENDIX A (Continued)

DOMAIN H. ECONOMIC AND TRADE ACTIVITIES		
H1	Decrease of resources allocated to the disease surveillance	
	Score 0	
	Score 1	Negligible: resources allocated to the disease surveillance have no effect on the (re)emergence of the disease in Belgium. Disease has never been under surveillance
	Score 2	Low: resources allocated to the disease surveillance have a low effect on the (re)emergence of the disease in Belgium. Disease has been under surveillance in the past and no change has happened after surveillance has been stopped.
	Score 3	Medium: resources allocated to the disease surveillance have a moderate effect on the (re)emergence of the disease in Belgium. Disease is under passive surveillance (reported only when observed) but with no need to further increase its surveillance
	Score 4	High: resources allocated to the disease surveillance have a high effect on the (re)emergence of the disease in Belgium. Disease needs to be under active and passive surveillance as its (re)emergence can easily occur, therefore if its surveillance decreases it's highly likely to (re)emerge
H2	Modification of the disease status (i.e. reportable disease becoming <u>not</u> reportable) or change in screening frequency due to a reduced national budget.	
	Score 0	
	Score 1	Negligible: modification of the disease status due to a reduced national budget has a negligible effect on the (re) emergence of the disease in Belgium
	Score 2	Low: modification of the disease status due to a reduced national budget has a low effect on the (re) emergence of the disease in Belgium
	Score 3	Moderate: modification of the disease status due to a reduced national budget has a moderate effect on the (re) emergence of the disease in Belgium
	Score 4	High: modification of the disease status due to a reduced national budget has a high effect on the (re) emergence of the disease in Belgium
H3	Decrease of resources allocated to the implementation of biosecurity measures at border controls (e.g. harbours or airports).	
	Score 0	
	Score 1	Negligible: decreasing the resources allocated to the implementation of biosecurity measures has a negligible effect on the (re)emergence of the disease in Belgium. Disease has never been detected in the past in a harbour or airport
	Score 2	Low: decreasing the resources allocated to the implementation of biosecurity measures has a low effect on the (re)emergence of the disease in Belgium. The disease has been suspected to have entered other countries because of deficient biosecurity at border controls.
	Score 3	Medium: decreasing the resources allocated to the implementation of biosecurity measures has a moderate effect on the (re) emergence of the disease in Belgium. The disease has been introduced in other countries because of deficient biosecurity at border controls
	Score 4	High: decreasing the resources allocated to the implementation of biosecurity measures highly increases the risk of (re)emergence of the disease in Belgium. In the past, the disease has been introduced in other countries <u>AND</u> in Belgium because of deficient biosecurity at border controls
H4	Most likely influence of (il)legal movements of live animals (livestock, pets, horses, etc.) <u>from neighbouring/European Union member states (MS)</u> for the disease to (re)emerge in Belgium.	
	Score 0	
	Score 1	Negligible: (il)legal movements of live animals (livestock, pets, horses, etc.) from neighbouring/European Union MS have a <u>negligible influence</u> on the pathogen/disease (re)emergence in Belgium.
	Score 2	Low: (il)legal movements (livestock, pets, horses, etc.) from neighbouring/European Union MS have a <u>low influence</u> on the pathogen/disease (re)emergence in Belgium.
	Score 3	Moderate: (il)legal movements (livestock, pets, horses, etc.) from neighbouring/European Union MS have a <u>moderate influence</u> on the pathogen/disease (re)emergence in Belgium.
	Score 4	High: (il)legal movements (livestock, pets, horses, etc.) from neighbouring/European Union MS have a <u>high influence</u> on the pathogen/disease (re)emergence in Belgium.

(Continued)

APPENDIX A (Continued)

H5	Influence of increased (il)legal imports of animal subproducts such as skin, meat and edible products from EU member states for the disease/pathogen to (re)emerge in Belgium	
	Score 0	
	Score 1	Negligible: increased (il)legal imports of animal subproducts such as skin, meat and edible products from EU member states have a negligible influence on the pathogen/disease (re)emergence in Belgium.
	Score 2	Low: increased (il)legal imports of animal subproducts such as skin, meat and edible products from EU member states have a low influence on the pathogen/disease (re)emergence in Belgium.
	Score 3	Moderate: increased (il)legal imports of animal subproducts such as skin, meat and edible products from EU member states have a moderate influence on the pathogen/disease (re)emergence in Belgium.
	Score 4	High: increased (il)legal imports of animal subproducts such as skin, meat and edible products from EU member states have a high influence on the pathogen/disease (re)emergence in Belgium.
H6	Most likely influence of increased (il)legal imports of NON-animal products such as tires, wood, furniture from EU member states for the disease/pathogen to (re)emerge in Belgium.	
	Score 0	
	Score 1	Negligible: increased (il)legal imports of NON-animal products such as tires, wood, furniture from EU member states have a negligible influence on the pathogen/disease (re)emergence in Belgium.
	Score 2	Low: increased (il)legal imports of NON-animal products such as tires, wood, furniture from EU member states have a low influence on the pathogen/disease (re)emergence in Belgium.
	Score 3	Moderate: increased (il)legal imports of NON-animal products such as tires, wood, furniture from EU member states have a moderate influence on the pathogen/disease (re)emergence in Belgium.
	Score 4	High: increased (il)legal imports of NON-animal products such as tires, wood, furniture from EU member states have a high influence on the pathogen/disease (re)emergence in Belgium.
H7	Most likely influence of (il)legal movements of live animals (livestock, pets, horses, etc.) from Third countries for the disease to (re)emerge in Belgium.	
	Score 0	
	Score 1	Negligible:(il)legal movements of live animals (livestock, pets, horses, etc.) from Third countries have a negligible influence on the pathogen/disease (re)emergence in Belgium.
	Score 2	Low: (il)legal movements of live animals (livestock, pets, horses, etc.) from Third countries have a low influence on the pathogen/disease (re)emergence in Belgium.
	Score 3	Moderate: (il)legal movements of live animals (livestock, pets, horses, etc.) from Third countries have a moderate influence on the pathogen/disease (re)emergence in Belgium.
	Score 4	High: (il)legal movements of live animals (livestock, pets, horses, etc.) from Third countries have a high influence on the pathogen/disease (re)emergence in Belgium.
H8	Most likely influence of increased imports of animal subproducts such as skin, meat and edible products from Third countries, for the disease to (re)emerge in Belgium.	
	Score 0	
	Score 1	Negligible: Increased imports of animal subproducts such as skin, meat and edible products from Third countries have a negligible influence on the pathogen/disease (re)emergence in Belgium.
	Score 2	Low: Increased imports of animal subproducts such as skin, meat and edible products from Third countries have a low influence on the pathogen/disease (re)emergence in Belgium.
	Score 3	Moderate: Increased imports of animal subproducts such as skin, meat and edible products from Third countries have a moderate influence on the pathogen/disease (re)emergence in Belgium.
	Score 4	High: Increased imports of animal subproducts such as skin, meat and edible products from Third countries have a high influence on the pathogen/disease (re)emergence in Belgium.

(Continued)

APPENDIX A (Continued)

H9	Most likely influence of increased (il)legal imports of NON-animal products such as tires, wood, furniture from Third countries, for the disease to (re)emerge in Belgium.	
	Score 0	
	Score 1	Negligible: increased (il)legal imports of NON-animal products such as tires, wood, furniture from Third countries have a negligible influence on the pathogen/disease (re)emergence in Belgium.
	Score 2	Low: increased (il)legal imports of NON-animal products such as tires, wood, furniture from Third countries have a low influence on the pathogen/disease (re)emergence in Belgium.
	Score 3	Moderate: increased (il)legal imports of NON-animal products such as tires, wood, furniture from Third countries have a moderate influence on the pathogen/disease (re)emergence in Belgium.
	Score 4	High: increased (il)legal imports of NON-animal products such as tires, wood, furniture from Third countries have a high influence on the pathogen/disease (re)emergence in Belgium.

Number of Criteria = 9, hence 90 points to be distributed within this domain for the intra-domain weighing.

APPENDIX B List of experts enrolled (*N* = 14) in the phase I (questionnaire assessment) with their gender, affiliation, country and field of expertise

Expert	Gender	Institution	Background	Country	Field of expertise	Keywords
Kris de Clercq	M	Sciensano	DVM, MSc, PhD, Head of Unit, Sciensano	Belgium	Exotic viruses and transmissible spongiform encephalopathies	Exotic diseases
Philippe Leonard	M	University Hospital Center	Medical doctor	Belgium	Infectious diseases	Travel medicine
Dirk Berkvens	M	University	Ir, PhD, Institute of Tropical Medicine, Antwerp	Belgium	Epidemiology and quantitative risk analysis	Veterinary epidemiology
Etienne Thiry	M	University	DVM, PhD, Dipl. ECVPH, Professor, Liege University	Belgium	Virology and viral diseases	Veterinary virology
Nathalie Kirschvink	F	University	DVM, PhD. Professor, University of Namur	Belgium	Animal physiology	Arboviruses
Thierry van den Berg	M	Sciensano	DVM, MSc, PhD, Operational Director Viral diseases at Sciensano	Belgium	Viral diseases, Avian influenza, Newcastle, Schmallenberg	Avian viruses, viral diseases
Christian Gortazar Schmidt	M	University	DVM, PhD, Professor at the University of Castilla-La Mancha, Spain. Head of SaBio (Sanidad y Biotechnologia) of IREC	Spain	Diseases and ecology of wild fauna	Population dynamics, Epidemiology, Ecology, animal health
Hendriks Pascal	M	Anses	DVM, PhD, Scientific director of epidemiology and surveillance	France	Animal health, surveillance, veterinary epidemiology	Surveillance systems
Fabiana Dal Pozzo	F	AMCRA	DVM, MSc, PhD, Scientific Coordinator at AMCRA	Belgium	Viral diseases, Bluetongue, laboratory diagnostics, Q fever	Viral diseases, arboviruses, Antibiotic resistance
Morgane Dominguez	F	OIE	DMV, PhD, OIE project officer	France	Epidemiology, Risk analysis in veterinary sciences	Veterinary epidemiology, biosecurity
Boelaert Frank	M	EFSA	DVM, MSc, PhD, Dipl. ECVPH, Senior Scientific Office at the Biological hazards and contaminants Unit of EFSA	Italy	Zoonoses, public health, surveillance of zoonoses and food-borne outbreaks	Surveillance, EU surveillance
Vanholme Luc	M	FASFC	DVM, Federal agency for the Safety of the Food Chain, General Direction of Control policy	Belgium	Veterinary medicine, Animal diseases, Control policy	Animal diseases

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APPENDIX B (Continued)

Expert	Gender	Institution	Background	Country	Field of expertise	Keywords
Laetitia Lempereur	F	University	DVM, PhD, Dipl. EVPC, Assistant Professor of parasitology, Liege University	Belgium	Parasitology, Vector-borne diseases	Tick-borne animal diseases
Depoorter Pieter	M	FASFC	DMV, Federal Agency for the Safety of the Food Chain, General Direction of Control Policy, Risk Direction	Belgium	Veterinary medicine, Animal diseases, Control policy	Animal diseases

APPENDIX C List of experts enrolled (N = 62) in phase II (disease prioritization) with their gender, affiliation, country, field of expertise and disease they answered for

Expert	Gender	Institution	Background	Country	Field of expertise	Keywords	Disease expert answered
Agnes Waret	F	University	DVM, MSc, PhD, Assistant Lecturer, Swine production and pathology, University of Toulouse, France	France	Epidemiology of animal infectious diseases in southern countries, animal health economy	Animal health	Peste des petits Ruminants
Alexandre Caron	M	CIRAD	DVM, PhD, CIRAD-UPR AGIRs	France	Disease ecology at the wildlife/domestic interface in border conservation areas, thinking sustainable and resilient socio-ecosystems in borders of conservation areas	Disease ecology	Peste des petits Ruminants
Ana Alba Casals	F	CReSA	DVM, PhD, Epidemiology Unit, CReSA	Spain	Data Mining and knowledge discovery	West Nile Fever	West Nile Fever
Ana de la Grandière	F	University	DMV, PhD, Department of infectious and parasitic diseases, Liege University	Portugal	Virology and viral diseases	African horse sickness	African horse sickness
Ana Sofia Ramirez	F	University	DMV, MSC, Heidelberg University, Germany	Germany	Infectious Diseases, Epidemiology, Ventilation, Tuberculosis, Airway obstruction	Infectious diseases	Contagious Bovine Pleuropneumonia Contagious Caprine pleuropneumonia
Andrea Apolloni	M	CIRAD	M.A., Physics, PhD, Researcher at CIRAD	France	Modelling of infectious diseases	Computational epidemiology	Contagious Bovine Pleuropneumonia Contagious Caprine pleuropneumonia
Anette Botner	F	DTU VET	DMV, PhD, Division of Diagnostics & Scientific Advice - Virology, National Veterinary Institute	Denmark	Veterinary virology	Viral diseases	Porcine Epidemic Diarrhoea
Ann Brigitte Cay	F	Sciensano	Bio Engineer, PhD, Head of Unit Enzootic and Re-emerging viral diseases, Sciensano	Belgium	Molecular Biology, Molecular Cloning, Cell Biology, Infection	Horse diseases	West Nile fever

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APPENDIX C (Continued)

Expert	Gender	Institution	Background	Country	Field of expertise	Keywords	Disease expert answered
Annelise Tran	F	CIRAD	PhD, Animal et Gestion Intégrée des Risques (AGIRS), CIRAD	France	Spatial Analysis, Remote Sensing, Geographic Information System, Environmental science	Arboviruses	Rift Valley fever
Axel Mauroy	M	University	DVM, PhD, Assistant Professor of Veterinary Virology at the University of Liege	Belgium	Virology, Viral diseases	Arboviruses	Aino, akabane, Low pathogenic avian influenza, High pathogenic avian influenza, Porcine epidemic diarrhoea, Schmallenberg, Vesicular stomatitis
Bart Pardon	M	Ghent University, Assistant	DVM, PhD, Dip ECBHM, Ghent University, Doctor Assistant of internal medicine of large animals at Ghent University.	Belgium	Internal Medicine, Infectious Diseases	Respiratory Diseases, Internal Medicine, Infectious Diseases	Haemorrhagic Septicaemia
Bénédicte Lambrecht	M	Sciensano	DVM, PhD, Head of Scientific Service Avian virology and immunology, Sciensano	Belgium	Avian virology and immunology	Newcastle disease	Newcastle disease
Benoît Durand	M	ANSES	DVM, MSc, PhD, Epidemiology unit, ANSES	France	Epidemiology unit	Animal diseases, modelling	Western Equine Encephalitis, Eastern Equine Encephalitis, Venezuelan Equine Encephalitis, Foot-and-mouth disease
Benoit Muylkens	M	University	DVM, PhD, Professor at the University of Namur	Belgium	Virology (herpes virus, vaccination) control of viral genetics expression	Arboviruses	Akabane
Cecile Beck	F	ANSES	DVM, PhD, Laboratory of animal health, ANSES	France	Virology	Antibodies, ELISA, Virus, Vaccination	Venezuelan equine encephalitis
Chris Oura	M	University	DVM, PhD, Senior lecturer in Veterinary Virology, University of the West Indies, Trinidad and Tobago	Trinidad and Tobago	Virology, One-Health, Zoonotic and animal pathogens, Emerging infectious diseases	Exotic diseases	African Swine fever
Christelle Fablet	F	ANSES	DEA, Biology and production animals, PhD, Epidemiologist at ANSES	France	Epidemiologist, Animal Productions, Respiratory Diseases, Swine	Epidemiology, One health initiative.	Novel swine enteric coronavirus
Dirk Berkvens	M	University	Ig., MSc, PhD, Institute of Tropical Medicine, Antwerp	Belgium	Epidemiology and quantitative risk analysis	Epidemiology, modelling	Bluetongue, Rift Valley fever
Ducatez Mariette	F	University	DVM, PhD, Host-pathogen interaction, University of Toulouse	France	PCR, Genotyping, Emerging Infectious Diseases, Viral infection	Influenza viruses	Low pathogenic avian influenza, High pathogenic avian influenza

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APPENDIX C (Continued)

Expert	Gender	Institution	Background	Country	Field of expertise	Keywords	Disease expert answered
Ethienne Thiry	M	University	DVM, PhD, University Professor, Unit of Virology and Viral Diseases, University of Liège	Belgium	Virology	Virus, Animal, emerging diseases, genetics	Aino, Akabane, Vesicular stomatitis
Emmanuel Bread	M	ANSES	DMV, PhD, Laboratory for Animal Health, ANSES	France	PCR, Cell culture, Infection, Immunology of infectious diseases	Arboviruses	Bluetongue, Epizootic haemorrhagic disease, Schmallenberg
Fabiana Dal Pozzo	F	AMCRA	DVM, MSc, PhD, Scientific Coordinator at AMCRA	Belgium	Viral diseases, bacterial diseases	Viral diseases, poxviruses, arboviruses, antibiotics resistance	African horse sickness, Bluetongue, Epizootic haemorrhagic diseases, Sheep and goat pox
Francois Roger	M	CIRAD	DVM, MSc, PhD, Animals, Health, Territories, Risks and Ecosystems Unit, CIRAD	France	Epidemiology, Infectious diseases, Biostatistics	One Health	*Peste des petits Ruminant*
Francois Thiaucourt	M	CIRAD	DVM, PhD, Researcher at CIRAD	France	Animal Science, Cattle, Vaccine Development	Animal Science, Cattle, Diagnostics, Molecular Biological Techniques	Contagious Bovine Pleuropneumonia, Contagious Caprine pleuropneumonia
Frank Koenen	M	Sciensano	DVM, PhD, One Health Unit, Sciensano	Belgium	Surveillance, Swine diseases	Classical Swine Fever, African Swine Fever	African Swine Fever, Classical swine fever
Gaby Van Galen	F	University	DVM, MSc, PhD, DES, Dipl. ECEIM, Dipl ECVECC, Associate Professor, University of Sidney	Australia	Equine medicine	Internal Medicine and Surgery	African horse sickness, Eastern equine encephalitis, Western equine encephalitis, Japanese encephalitis
Gilles Meyer	M	University	DMV, PhD, ECBHM, University of Toulouse, Professor	France	Veterinary Virology, Viral, Ruminant Pathology	Veterinary virology, vector-borne diseases	Aino, Schmallenberg
Grasland Beatrice	F	ANSES	PhD, ANSES	France	Swine virology and diseases	Virology, Nomenclature, Swine Diseases, PRRS	Novel swine enteric coronavirus
Guy Czaplicki	M	ARSIA	DVM, MSc, Head of a veterinary diagnostic laboratory	Belgium	Laboratory diagnosis	Animal serology, bovine pathology, swine pathology, epidemiology, animal infectiology	Foot-and-mouth disease, swine vesicular diseases, vesicular stomatitis
Guy-Pierre Martineau	M	University	DVM, PhD, Diplomate of ECPHM, Professor at the National Veterinary School of Toulouse	France	Medicine and porcine production	Pig production	Novel swine enteric coronavirus, Swine vesicular disease
Ignacio Garcia Bocanegra	M	University	DVM, PhD, Dip. ECZM, Professor of animal Health at the University of Cordoba, Spain	Spain	Animal health, wildlife population health	Wildlife population health	West Nile Fever

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APPENDIX C (Continued)

Expert	Gender	Institution	Background	Country	Field of expertise	Keywords	Disease expert answered
James Wood	M	University	DVM, MSc, PhD, Dipl. ECVPH, Professor, Department of Veterinary Medicine, University of Cambridge	United Kingdom	Epidemiology, infection dynamic, control of diseases in Africa and globally	Horse diseases, Bat ecology	African horse Sickness, Nipah virus
Jaques Mainil	M	University	DVM, PhD, Professor, Bacteriology and Bacteriologic Diseases, University of Liège	Belgium	Bacteriology	Bacteriology, pathogeny, genetics (prokaryotes), molecular epidemiology, plasmidology	Haemorrhagic Septicaemia
Jean Guillotin	M	Departmental laboratory	DMV, Departmental laboratory	France	Diagnosis of animal diseases	Swine diseases	Classical swine fever
Jean Pierre Ganière	M	University	DMV, PhD, Oniris	France	Mandatory diseases	Animal diseases	Peste des petits Ruminants
Jean-Pierre Vaillancourt	M	University	DVM, MSc, PhD, Professor titulaire, University of Montreal	Canada	Epidemiology of zoonosis and public health, Infectious diseases of swine and poultry	Public health, biosecurity	Newcastle disease
Jordi Casal	M	University	DVM, University Professor, Universidad Autonoma de Barcelona	Spain	Animal Health	Animal epidemiology, zoonoses, biosecurity	Foot-and-mouth disease, lumpy skin disease, Rift valley fever, vesicular stomatitis
Joseph Hooyberghs	M	FASFC	DVM, MSc, Federal agency for the safety of the food chain, General Direction of Control Policy	Belgium	Animal diseases, virology	Epidemic diseases	African swine fever, classical swine fever, porcine epidemic diarrhoea
Julien Cappelle	M	CIRAD	DVM, PhD, Health Ecologist, CIRAD	France	Wildlife ecology	Ecology, epidemiology, Wildlife	Nipah virus
Kris De Clercq	M	Sciensano	DVM, MSc, EU Reference Laboratory for FMD viruses, Sciensano	Belgium	Exotic viruses and transmissible spongiform encephalopathies	Exotic diseases	Foot-and-mouth disease, lumpy skin disease, sheep and goat pox
Labib Bakkali Kassimi	M	ANSES	DVM, PhD, Head of FAO reference centre and OIE reference laboratory for FMD at ANSES	France	Virology, immunology, molecular biology	Laboratory, Foot-and-mouth disease	Foot-and-mouth disease
Lecoq Laureline	F	University	DVM, DES, MSc, Dipl. ACVIM	Belgium	Equine medicine	Horse diseases	Japanese encephalitis
Louis Lignereux	M	University	DMV, MSc, Liege University	Australia	Management of wildlife diseases, Animal diseases	Animal diseases	Contagious caprine Pleuropneumonia
Ludovic Martinelle	M	University	DVM, MSc, PhD, Head of the Experimental Station (CARE-FePex) at Liege University	Belgium	Epidemiology, pathogenesis of Bluetongue and Shmallenberg	Pathogenesis, Bluetongue, Schmallenberg	Aino, Akabane, Epizootic haemorrhagic disease
Marie-France Humblet	F	University	DVM, MSC, PhD, Department of Occupational Protection and Hygiene, Biosafety and Biosecurity section, Liege University	Belgium	Biosecurity, epidemiology	Biosecurity, Hygiene, Epidemiology	Japanese encephalitis, Newcastle disease, Venezuelan equine encephalitis, West Nile fever

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APPENDIX C (Continued)

Expert	Gender	Institution	Background	Country	Field of expertise	Keywords	Disease expert answered
Marilena Filippitzi	F	Sciensano	DVM, PhD, Dipl. ECVPH, Veterinary epidemiology, Sciensano	Belgium	Veterinary epidemiology, Risk assessment, Antimicrobial resistance, Biosecurity	Disease surveillance, Antimicrobial resistance	Rift Valley fever
Marius Gilbert	M	University	Applied Biological Sciences, PhD, Head of spatial epidemiology Lab, FNRS Research Associate at the Universite Libre de Bruxelles.	Belgium	Spatial epidemiology of animal diseases	Ecology, population biology,	Low pathogenic avian influenza, High pathogenic avian influenza
Marylene Tignon	F	Sciensano	Lic., MSc, PhD, Virology Department, Sciensano	Belgium	Veterinary virology, Porcine, bovine and horse viral diseases	Diagnosis	African horse sickness
Mutien-Marie Garigliany	M	University	DVM, PhD, Dipl. ECVP, General pathology, Liege University	Belgium	Pathologist of infectious disease, avian influenza	Influenza, Pathology	Bluetongue, Epizootic haemorrhagic disease, Schmallenberg
Nick De Regge	M	Sciensano	DMV, PhD, Virology Department, Sciensano	Belgium	Infectious animal diseases, Enzootic and vector-borne diseases.	Vector-borne diseases, Arthropod vectors	Western Equine Encephalitis, Eastern Equine Encephalitis, Venezuelan Equine Encephalitis, Swine vesicular diseases, vesicular stomatitis
Nicolas Rose	M	ANSES	DVM, PhD, Swine Epidemiology and Welfare Unit, ANSES	France	Swine epidemiology	Epidemiology, Animal welfare	African swine fever, Classical swine fever, Novel swine enteric coronavirus, Porcine epidemic diarrhoea
Patrick Butaye	M	University	DVM, PhD, School of Veterinary Medicine, Ross University	Belgium	Microbiology	Microbiology, Antimicrobial resistance	Haemorrhagic septicaemia
Paul Kitching	M	The Pirbright Institute	DMV, PhD, The Pirbright Institute	United Kingdom	Virology	Poxviruses	Lumpy skin disease, sheep and goat pox
Philippe Caufour	M	CIRAD	DVM, PhD, Department BIOS, CIRAD	France	Virology, Immune response	Poxviruses	Lumpy skin disease, sheep and goat pox
Ruben Rosales	M	University	DMV, PhD, Universidad de Las Palmas de Gran Canaria	Spain	Veterinary science, Veterinary diagnostics, Veterinary infectious diseases, Veterinary epidemiology	Infectious diseases	Contagious Bovine Pleuropneumonia, Contagious Caprine pleuropneumonia
Stephan Zientara	M	Anses	DVM, MSc, PhD, Head of Virology and of the National Reference Laboratory for Foot-and-Mouth Disease, Bluetongue, West Nile and African Horse Sickness	France	Virology	Foot-and mouth disease, Bluetongue West Nile Fever, Equine viral diseases	Bluetongue, Epizootic haemorrhagic disease
Steven Van Gutch	M	Sciensano	DVM, MSC, PhD, Head of Viral Diseases, Sciensano	Belgium	Virology	Bat diseases	Nipah virus

(Continued)

APPENDIX C (Continued)

Expert	Gender	Institution	Background	Country	Field of expertise	Keywords	Disease expert answered
Sylvie Lecollinet	F	ANSES	DVM, PhD, Laboratory for Animal health, ANSES	France	PCR, Infection, ELISA, Viral Infection	Viruses, Equine Medicine	Western equine encephalitis, Eastern equine encephalitis, Japanese encephalitis, Venezuelan equine encephalitis, West Nile fever
Thierry van den Berg	M	Sciensano	DMV, PhD, MSc, Operational Director Viral diseases at Sciensano	Belgium	Viral diseases, Avian influenza, Newcastle	Avian viruses, viral disease	Low pathogenic avian influenza, High pathogenic avian influenza, Newcastle
Thomas Hagennarts	M	University	DMV, PhD, Bacteriology and Epidemiology, University of Wageningen	The Netherlands	Biology, Ecology, Epidemiology, Mathematics, Veterinary science	Swine diseases	Swine vesicular disease
Pierre Wattiau	M	Sciensano	Bachelor Degree in Industrial Chemistry, MSc, PhD, Veterinary bacteriology Department, Sciensano	Belgium	Laboratory techniques, Bacterial isolation and identification, Antibiotic susceptibility testing, Molecular detection	Laboratory Microbiology	Haemorrhagic septicaemia
Weerapong Thanapongtharm	M	Ministry	DVM, PhD, Senior Veterinary Office at Ministry of Agriculture and Cooperatives, Thailand	Thailand	Animal Health, livestock development	Spatial analysis	Nipah virus

APPENDIX D Table D1 Means, Standard deviation, Median and Range of the scores of the diseases. Ranking of the diseases according to the mean score and to the median score are also shown

Disease	Mean (*SD*[a])	Rank Mean[b]	Median	Rank Median[c]	Range[d]
Porcine epidemic diarrhoea	4,143.38 (469.88)	1	4,090	2	1,111
Foot and mouth disease	4,057.36 (546.83)	2	4,053.75	3	1,428.75
Low pathogenic avian influenza	3,974.13 (376.09)	3	4,114.5	1	830
African horse sickness	3,974.1 (527.52)	4	3,940.75	4	1,411
Highly pathogenic avian influenza	3,804.5 (327.9)	5	3,787.375	7	616.75
Contagious bovine pleuropneumonia	3,789.35 (1,297.83)	6	3,164	25	2,640.6
Sheep and goat pox	3,765.06(434.19)	7	3,702.125	10	972
Classical swine fever	3,745.33 (117.13)	8	3,758.15	8	275
Lumpy skin disease	3,691.29 (488.16)	9	3,586.75	13	1,135.85
Venezuelan equine encephalitis	3,625.75 (671.92)	10	3,853.75	5	1,441.25
Contagious caprine pleuropneumonia	3,617.45 (1,099.65)	11	3,247.25	21	2,681.75
Epizootic haemorrhagic disease	3,599.63 (532.13)	12	3,723.75	9	1,165.65
Novel swine enteric coronavirus disease	3,586 (322.33)	13	3,542.125	14	760.25
Bluetongue	3,499.22 (652.21)	14	3,837.5	6	1,465
Western equine encephalitis	3,491.81 (647.42)	15	3,591.875	12	1,411
African swine fever	3,479.96 (411.22)	16	3,464.375	16	872.6
Eastern equine encephalitis	3,479.38 (590.71)	17	3,608.125	11	1,248.75

(Continued)

APPENDIX D (Continued)

Disease	Mean (*SD*[a])	Rank Mean[b]	Median	Rank Median[c]	Range[d]
Schmallenberg	3,459.19 (113.93)	18	3,442.125	17	267.5
Vesicular stomatitis	3,450.4 (1,043.85)	19	3,011.25	26	2,574.25
Akabane disease	3,444.55 (814.42)	20	3,437.6	18	1,623
Swine vesicular disease	3,425.25 (512.82)	21	3,333	19	1,195
Aino disease	3,424.75 (455.24)	22	3,330.375	20	996.75
NewCastle	3,312.75 (770.34)	23	3,504	15	1,783
Rift valley fever	3,303.6 (433.98)	24	3,192	24	1,011.6
Haemorrhagic septicaemia	3,193.44 (218.2)	25	3,230	22	513.75
Japanese encephalitis	3,169.56 (763.67)	26	3,005	27	1,811.75
West Nile fever	3,146.47 (419.96)	27	3,206.25	23	1,132.5
Peste des Petits Ruminants	2,989.31 (698.7)	28	2,841.25	29	1,602.75
Nipah virus	2,936.56 (1,038.14)	29	2,937.125	28	2,369

[a]*SD* = Standard Deviation.

[b]Rank Mean = The ranking of the disease obtained with the mean scores.

[c]Rank Median = The ranking of the disease obtained with the median.

[d]Range = The range of the scores obtained from the expert's scores.

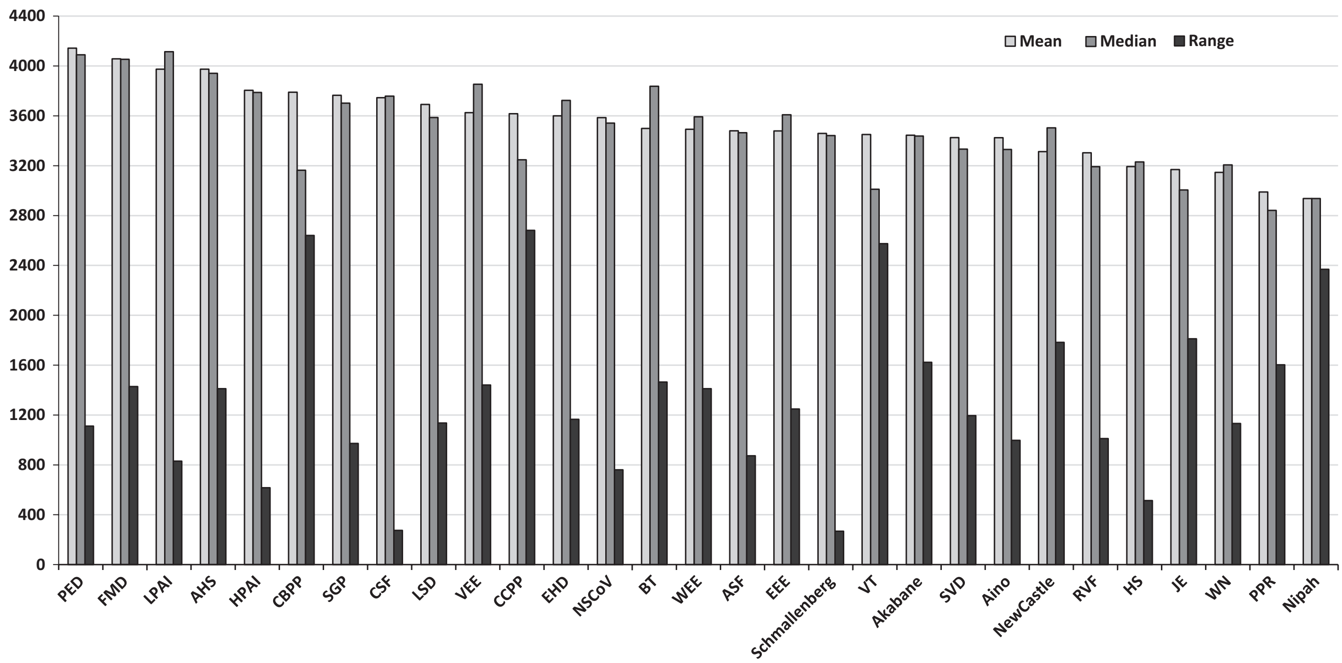

FIGURE D1 Graph showing the mean, median scores and the range of the scores among the experts per disease. AHS, African Horse Sickness; ASF, African Swine Fever; BT, Bluetongue; CBPP, Contagious Bovine Pleuropneumonia; CCPP, Contagious Caprine Pleuropneumonia; CSF, Classical Swine Fever; EEE, Eastern Equine Encephalitis; EHS, Epizootic Haemorrhagic Disease; FMD, Foot and Mouth Disease; HPAI, Highly Pathogenic Avian Influenza; HS, Haemorrhagic Septicaemia; JE, Japanese Encephalitis; LPAI, Low Pathogenic Avian Influenza; LSD, Lumpy Skin Disease; NSCoV, Novel Swine Enteric Coronavirus Disease; PED, Porcine Epidemic Diarrhoea; PPR, *Peste des Petits Ruminants*; RVF, Rift Valley Fever; SGP, Sheep and Goat Pox; SVD, Swine Vesicular Disease; VEE, Venezuelan Equine Encephalitis; VT, Vesicular Stomatitis; WEE, Western Equine Encephalitis; WN, West Nile Fever

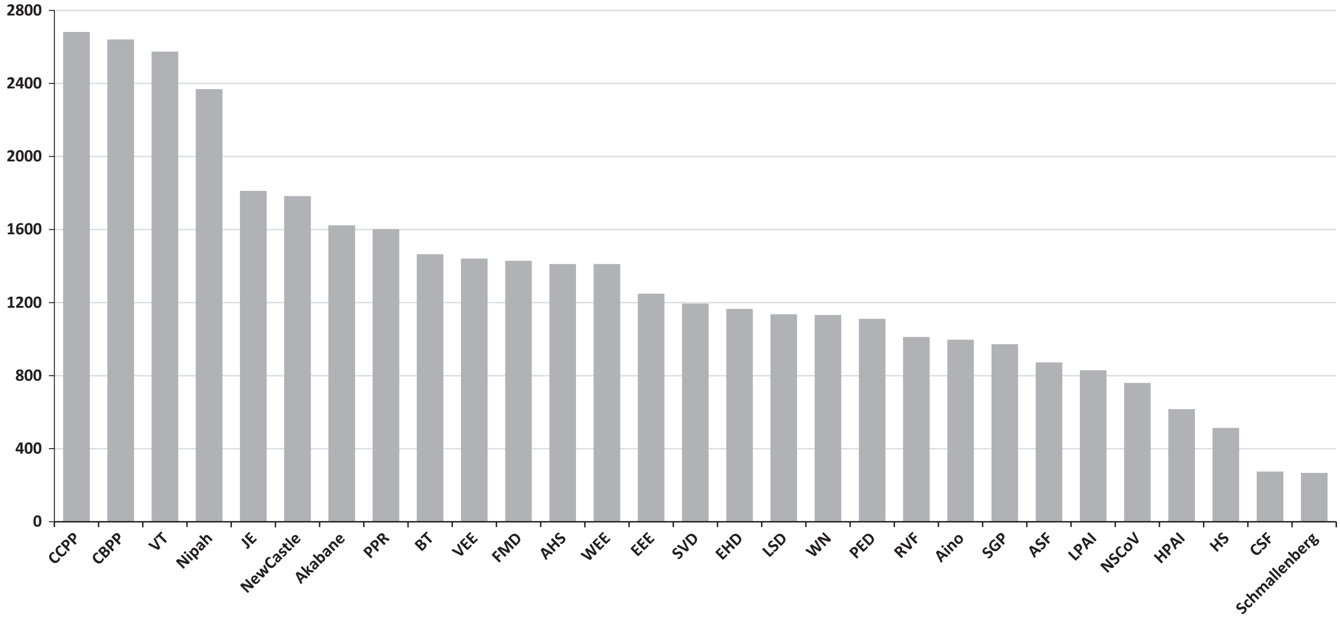

Figure D2 Graph showing the range of the scores among the experts per disease. AHS, African Horse Sickness; ASF, African Swine Fever; BT, Bluetongue; CBPP, Contagious Bovine Pleuropneumonia; CCPP, Contagious Caprine Pleuropneumonia; CSF, Classical Swine Fever; EEE, Eastern Equine Encephalitis; EHD, Epizootic Haemorrhagic Disease; FMD, Foot and Mouth Disease; HPAI, Highly Pathogenic Avian Influenza; HS, Haemorrhagic Septicaemia; JE, Japanese Encephalitis; LPAI, Low Pathogenic Avian Influenza; LSD, Lumpy Skin Disease; Nipah, Nipah virus; NSCoV, Novel Swine Enteric Coronavirus Disease; PED, Porcine Epidemic Diarrhoea; PPR, *Peste des Petits Ruminants*; RVF, Rift Valley Fever; SGP, Sheep and Goat Pox; SVD, Swine Vesicular Disease; VEE, Venezuelan Equine Encephalitis; VT, Vesicular Stomatitis; WEE, Western Equine Encephalitis; WN, West Nile Fever