Multi-criteria decision analysis (MCDA) for control of transboundary livestock diseases using the example of the 2010/11 foot-and-mouth disease (FMD) outbreak in the Republic of Korea

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I hereby certify that the thesis has not been submitted for a higher degree at any University or Institution and work embodied in this thesis is my work unless noted otherwise in the acknowledgements.

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Abstract

Decisions regarding transboundary livestock disease control strategies differ from personal decisions, such as buying groceries, in important ways: the stakes are high and the outcome of a decision will affect people in different fields. Decision making for transboundary livestock disease control strategies requires consideration of a number of factors including the epidemiology of the disease, economic cost of control, and environmental and social impact. For example, when applying pre-emptive slaughtering as a control measure for FMD, decision makers need to consider the epidemiologic effectiveness of the control measure, financial loss to farmers, the operational cost of slaughtering, negative impacts on the environment due to burning or burial of culled animals, and the public's concerns for the welfare of slaughtered animals. Therefore, it can be challenging for decision makers to choose the best control strategy among alternative strategies. The study presented in the thesis describes the application of multi-criteria decision analysis (MCDA) process as a decision support tool for decision making about transboundary livestock disease control strategies using an example of a simulated FMD outbreak.

The first research chapter (**Chapter 3**) investigates the preferences of chief veterinary officers (CVOs) for the criteria of FMD-control strategies in the Asia-Oceania region, which comprises countries free from or having experienced FMD. Criteria were grouped into epidemiologic, economic, and social-environmental. The CVOs in the Asia-Oceania region considered the epidemiologic criterion more important than the economic or the social-environmental criterion. The importance of the economic criterion differed with FMD status of a country: specifically, those countries considered free of FMD ranked the economic criterion as more important than those without. Among the criteria comprising the epidemiologic criterion, the most important was the size of the FMD-infected area, defined as the geographical size of FMD outbreak area. Within the economic criterion, the operational cost of the FMD-control strategy was considered the most important, and within the social-environmental criterion, the mental health of FMD-affected farmers was the most important criterion.

Chapter 4 describes the construction of an epidemiologic model of the spread of the 2010/11 FMD outbreak in the city of Andong, Republic of Korea, to measure the epidemiologic effectiveness of FMD-control strategies. According to the simulation results, the model accurately represented the FMD outbreak in two ways: 1) the median number of simulated FMD-detected farms was the same as the number of detected farms during the actual FMD epidemic, and 2) the simulated epidemic curve was similar to the actual epidemic curve for the 2010/11 FMD epidemic. Thus, the constructed model could be used as a reference for evaluating the effectiveness of alternative FMD-control strategies.

The control strategy applied during the 2010/11 FMD epidemic consisted of a pre-emptive slaughter area with a radius of three kilometres, 100 day movement restriction, and vaccination of all FMD-susceptible animals in the country. This was used as a baseline strategy in the study. Alternative levels of these control measures for the FMD-control strategy were simulated to evaluate the effect of alternative strategies. Changes in control measures were: 1) pre-emptive slaughtering within a radius of 0.5, one, and five kilometres of FMD-infected farms; 2) movement restriction of 30 days and 60 days; 3) ring vaccination in a band three to five kilometres from FMD-infected farms. According to the simulation results, the five kilometres slaughtering strategy resulted in the fewest FMD-infected farms.

Cost-effectiveness (CE) analysis was applied to evaluate the economic effectiveness of FMD-control strategies using the results of epidemiologic simulation model (**Chapter 5**). This showed that ring vaccination in a band three to five kilometres from FMD-infected farms was the most cost efficient among alternative FMD-control strategies. The other FMD-control strategies, in decreasing order of economic efficiency, were five kilometre slaughtering, 30 day stop movement, and 60 day stop movement. The 0.5 kilometre and one kilometre slaughtering strategy were excluded in the analysis because these strategies did not control FMD spread during the simulations.

Chapter 6 describes the MCDA process for choosing the optimal FMD-control strategy based on the results from **Chapters 3**, **4** and **5**. The measurements of the criteria were merged with the weight of criteria to calculate the overall score of each FMD-control strategy. In the Asia-Oceania region, CVOs preferred ring vaccination over alternative FMD-control strategies, with 30 day stop movement being the least preferred of the FMD-control strategies.

The findings presented in each of these chapters have broadened our knowledge of the decision making process regarding FMD-control strategies. The processes were reliable, transparent, and reproducible and can be applied not only to FMD but also to other transboundary livestock diseases such as classical swine fever or highly pathogenic avian influenza.

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Nomenclature

AUD	Australian Dollar
BCA	Benefit-Cost Analysis
BDI	Beck Depression Inventory
CSF	Classical Swine Fever
CVO	Chief Veterinary Officer
EU	European Union
FMD	Foot and Mouth Disease
FRF	French Franc
GBP	Great Britain Pound
HPAI	Highly Pathogenic Avian Influenza
KOSTAT	Statistics Korea
MCDA	Multi-Criteria Decision Analysis
MOSPA	Ministry of Security and Public Administration
OIE	The World Organization of Animal Health
USD	United States Dollar

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