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# **Application of a global sensitivity analysis technique to the New Zealand Standard Model of foot-and-mouth disease**

A dissertation presented  
in partial fulfilment of the requirements  
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at Massey University

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*“I have been, and remain, entirely committed to the idea that modeling is the essence of science  
and the habitat of all epistemology.”*

- Robert Rosen, Essays on Life Itself

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## Abstract

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*“All models are wrong, but some are useful”* George Edward Pelham Box (Box, 1987)

Unfortunately, often people don't realise that models are wrong, or alternatively do not appreciate that they are not supposed to be 'right'. A model, whether a map, a regression model or a stochastic model that creates data, is merely a representation of reality. It is a tool and is bound by assumptions, the quality of the data used to create it as well as the code itself. This dissertation attempts to provide a simple guide to help non-modellers to understand what a model is and the uncertainties that exist in the modelling process, the methods available for sensitivity analysis and describes the role of this analysis in corroborating a model.

In New Zealand we are fortunate not to have had an outbreak of foot-and-mouth disease (FMD), but recognise the devastating consequences of an outbreak and the need to develop appropriate controls for eradication of the virus. Given the complexity of the interactions over time and space between the virus, the unique environment of New Zealand, its livestock industries and the controls available, it is unlikely that these issues could be explored adequately and with sufficient rigour without the use of modelling.

This thesis is divided into three main sections. In the first section a review of the literature related to simulation modelling and sensitivity analysis is provided. In New Zealand we are fortunate to have a well corroborated platform for disease modelling – InterSpread Plus. This has allowed development of a model scenario for exploring FMD spread within a set of InterSpread Plus parameters termed the New Zealand Standard model (NZSM). The NZSM is a complex epidemiological model and has been, at the time of writing, under-utilised. An element of the under-utility is due to the complexity and computational demands that are inherent to an epidemiological model. The second section of this thesis provides a description of the New Zealand standard model in an attempt to explain its logical framework.

In the third section a sensitivity analysis of the NZSM is carried out in an effort to identify those settings in the model that had the greatest influence on the predicted number of infected premises in a simulated outbreak of FMD in New Zealand.

The outcomes of the sensitivity analysis have increased the understanding of the NZSM model itself and have provided initial insight into ways the model may be improved and refined. If heeded, this can result in an increased ability to interpret and communicate model outputs. This, in turn, will increase confidence that the NZSM parameter set provides an appropriate indication of the way FMD might spread if it were introduced into the farm animal population in New Zealand, and therefore better preparation for any future FMD outbreak.

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