Lessons for New Zealand from Britain's Foot and Mouth Epidemic

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ABSTRACT

This paper explores some implications for New Zealand's rural community of Britain's foot and mouth epidemic in the light of growing international trade and travel, and changes in New Zealand's rural society.

The paper includes ecological mapping with a projected/likely spatial distribution of an epidemic in New Zealand, and an assessment of the possible institutional and social responses in the wake of a disease outbreak. It notes the course of the epidemic in Britain, and possible differences and similarities in institutional response frameworks between Britain and New Zealand.

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The British food and mouth epidemic (hereafter FMD) of February 2001 was one of the most devastating livestock disease epidemics ever experienced by that country.

Although New Zealand's economy, agricultural practices, and biosecurity controls are significantly different from Britain, there are some similarities in the institutional frameworks responsible for biosecurity control, and in aspects of rural society and change. These similarities (and differences) mean that the FMD epidemic in UK has potential lessons for New Zealand.

This paper reflects on possible lessons for New Zealand of Britain's experience. It briefly explains the biology of the disease and why a FMD epidemic is a matter of concern for New Zealand. It then summarises the UK experience and early analysis of its impacts on British rural society. Using Geographic Information Systems (GIS) techniques to simulate optimum ecological conditions for the disease, it presents an ecological map of the possible spatial distribution of an epidemic in New Zealand. In the light of the model, and of the UK experience, the paper then reflects on the possible impacts should the disease spread in New Zealand.

The map shows that ecologically optimum areas for the disease include communities that are significantly different in social and economic terms. These differences suggest that the consequences of an epidemic could vary substantially, depending on its source and the economic and social structure of the affected communities. The differences suggest that New Zealand's biosecurity emergency systems need to take account of the diverse nature of New Zealand's rural society and the rapid changes in agriculture and rural economy that are occurring.

The biology of FMD

FMD is a highly contagious viral disease of ungulates (cloven-hoofed animals). Cattle, pigs, sheep, goats and deer are susceptible, although horses are not affected (WHO, 1997). Although not very lethal in adult animals, it causes serious production losses and is a major constraint in international trade because of protective measures by importing countries.

Animals can become infected with FMD through inhalation of virus aerosols, ingestion and through

reproduction. Under the right conditions long distance spread (measured in kilometres) of FMD by wind-borne virus can occur. Movement of infected animals is probably the most important method of spread between herds. Other sources of infection include contaminated vehicles, equipment, people and products (Sanson, 1994).

The FMD virus can survive in frozen lymph nodes, bone marrow and viscera. The virus will also survive well in salted and cured meats, and in non-pasteurised dairy products. It has been shown experimentally that FMD can be transmitted through artificial insemination where the donor was infected. The highest risk of entry of FMD is through imports of susceptible live animals, and contaminated meat or dairy products from infected countries. The virus can survive for long periods in a range of fresh, partially cooked, cured and smoked meats, and in inadequately pasteurised dairy products. These could be brought in with passengers on aircraft and ships, through the mail or on fishing vessels or yachts (Kitching, 1998).

To eradicate the disease, both the UK and New Zealand have adopted a 'stamping out' policy. This involves quarantine, movement restrictions, and slaughter and disposal of all affected and in-contact livestock on affected premises followed by cleaning and disinfection.

Reasons for New Zealand concerns about FMD

The prime reason for New Zealand's concern about FMD stems from the extent of its dependence on export receipts from the pastoral industry, and tourism, and the changing nature of trading relationships between New Zealand and the rest of the world. While New Zealand has become increasingly open to both visitors and goods from other parts of the world, many of the countries to which New Zealand exports are ones which ban the importation of agricultural products form countries affected by FMD. These include USA, Canada, and members of the European Union.

Rural New Zealand contributes income through pastoral agriculture (meat, wool and dairy), horticulture, forestry, tourism, and a host of value-added industries based on rural resources. Each and all of these could be affected in the event of a severe FMD epidemic. In 1999, dairy products and meat and meat products contributed $7.7bn and comprised 25 percent of New Zealand's export income; 'Other food and beverages' contributed $2.4bn, and international visitors contributed $3.6bn (Statistics New Zealand, 2000). The Ministry of Agriculture and Forestry has estimated that if 100 New Zealand farms were affected by FMD, as many as 100,000 people could lose their jobs – 30,000 on farms and another 70,000 in industries that depend on farming. Meat plants and dairy factories could close, and many of the businesses supplying them could close. The value of the New Zealand dollar could fall and the cost of imported goods such as petrol could rise (MAF, 2001a).

Apart from the potential damage to the economy from an FMD epidemic, New Zealand faces increasing threat of an epidemic from the changing nature and scale of in-coming trade. In particular, the threat of FMD has increased with the enormous growth of trade with the countries of eastern Asia, and with a much greater diversification of trade.

While the majority of Europe, North and Central America, Pacific nations and the Caribbean are free of the disease, the disease remains endemic and at a high prevalence in many countries in Africa, the Middle East, Asia and South America. A number of the countries where it is endemic are ones which send visitors or export goods to New Zealand, or which receive visitors from New Zealand (for example, Japan, Korea, and Taiwan have all experienced recent outbreaks of the disease).

Table 1 shows that between 1989 and 1999, the value of imports into New Zealand grew 94 percent overall, but 171 percent with the countries of eastern Asia (excluding Japan) and 130 percent with "other countries". "Other countries" include Indonesia, Malaysia and Thailand as significant countries of origin. The UK epidemic was caused by Pan-Asian form of the virus, and is thought to have been introduced to Britain via illegal meat imports from East Asia (DEFRA, 2002b:45).

In practical terms, the volume of trade translates to a significant border control effort. New Zealand's Border Management section of the Biosecurity Authority (Alexander, 2001) reported that for the year to June 2001, there were:

400,000 containers in total, of which 250,000 were full (the reason for the empty containers is that NZ exports more than it imports);

82,000 containers inspected, including empties;

Table 1: Change in the value and origin of imported merchandise to New Zealand, 1989 - 1999

Countries or regions of origin of imports	1989 $million	1999 $million	% change
Australia	2,673	5,367	101
USA	2,067	4,283	107
Japan	2,338	3,056	31
Europe	1,710	2,672	56
Other Eastern Asia[1]	843	2,285	171
Other countries	2,860	6,585	130
Total	12,491	24,248	94

Source: Statistics New Zealand, 1990 and 2000 Yearbooks.

51,000 full containers inspected; and

1600 full containers decontaminated.

The increase and diversification of visitor numbers has been equally significant over the past decade. Table 2 shows a 75 percent net increase in international visitors over the decade but the number of visitors from the traditional sources (Australia, USA and Japan) has grown much less than the number from Asia.[2]

In terms of airport arrivals for the year to June 2001, the Border Control section reported (Mike Alexander, personal communication):

3.5 million passengers (50 percent of passengers are returning New Zealanders);

22,500 aircraft (Private aircraft; 268 Military aircraft);

508,000 items declared;

64,000 were not declared.

Modern forms of transport now mean that overseas visitors to New Zealand, or New Zealand holiday makers might travel through rural areas of East or South-East Asia, board a plane, and land in New Zealand within a few hours. It would certainly be possible for the FMD virus to survive in undeclared meat or animal products transported by visitors to New Zealand.

The FMD epidemic in the UK

The UK FMD epidemic of February 2001 spread widely and with great speed (Figure 1). The outbreak has been traced to contaminated pig swill fed to pigs on a farm in the northeast of England. The disease remained unreported until nearly a month later when it was identified and reported from infected sheep noticed at an abattoir in the southeast of England. Within days of the first reported cases, the number of infected cases had grown to dozens of farms, affecting thousands of animals. By the time of the last reported case, 4,082,000 animals had been slaughtered, including more than half a million cattle, and 3.3 million sheep (DEFRA, 6/2/02).

The spread peaked about two months after the first outbreak, and six months later the spread of FMD began to show a significant decline, as shown by the chart above. There were no new cases reported by the end of September 2001.

The spread of the disease was not uniform. It was heavily concentrated in the north and west of Britain, including the counties of Dumfries and Galloway in the southwest of Scotland, the Welsh border, and the north and west of England (Figure 2).

In England, the areas most particularly affected were Cumbria in the north (where nearly half of all cases were identified), Devon, North Yorkshire, Northumberland and parts of Gloucestershire. All the areas most heavily affected were typically sheep farming areas, and sheep were the main carriers of the disease. This is in contrast to the previous outbreak of FMD in UK in 1967, when cattle and sheep had been most affected. Analysis has shown that one reason for the prominence of sheep in the 2001 epidemic was farming practices which involve trading of sheep at stock sales and their widespread transportation to different parts of the country. The disease is difficult to detect in sheep and this meant that the disease spread widely in the month before it was finally identified.

Table 2: Change in the number and origin of international visitors to New Zealand, 1989 - 1999

Countries or regions of origin of visitors	1989	1999	% change
Australia	296,496	508,035	71
USA	116,901	165,980	42
Europe	122,756	295,275	140
Japan	95,457	149,561	57
China & Hong Kong	9,700	46,718	382
Other Asia	38,865	143,719	270
Total	**867,522**	**1,517,324**	**75**

Source: Statistics New Zealand, 1990 and 2000 Yearbooks

Once the disease was confirmed, a major eradication campaign began. Farms identified with the disease, as well as those within a 3km radium were quarantined. All animals from infected farms were slaughtered and there was a complete ban on the movement of stock around the country. Restrictions were placed on the use of footpaths and countryside access, to prevent spread of the disease by people.

FMD and its consequences affected the everyday lives of people throughout the UK. Farmers' experienced severe restriction on their movements, and disruption to their livelihoods; tourist industries had to shut their doors, as did many local industries. Community events were cancelled and everyday activities disrupted by movement and stock restrictions.

Social factors militated against the efficient management of the epidemic as people became disease vectors. Unexpected human behaviour furthered the spread of the disease more widely than ecological factors alone. Examples of such

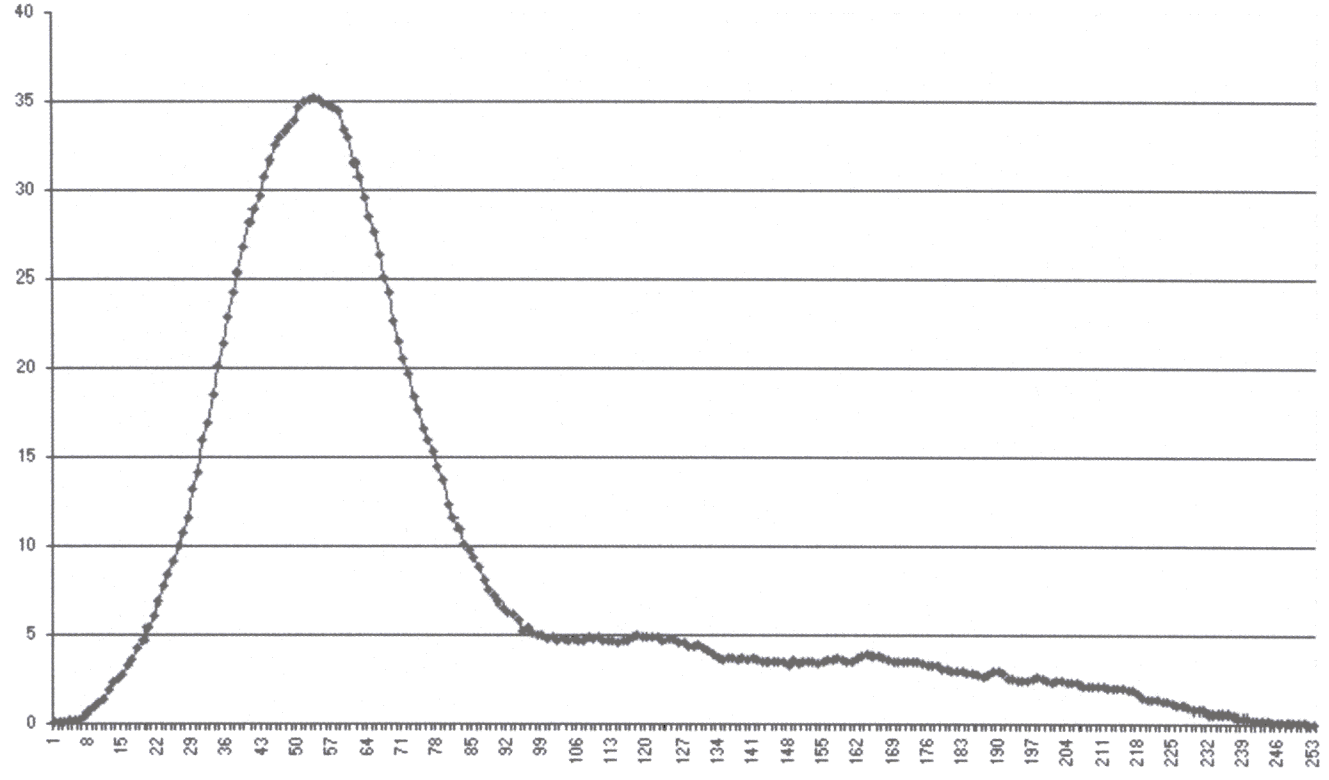

Figure 1: Number of reported cases of foot and mouth disease in the UK from February 2001 to the end of the epidemic (days)

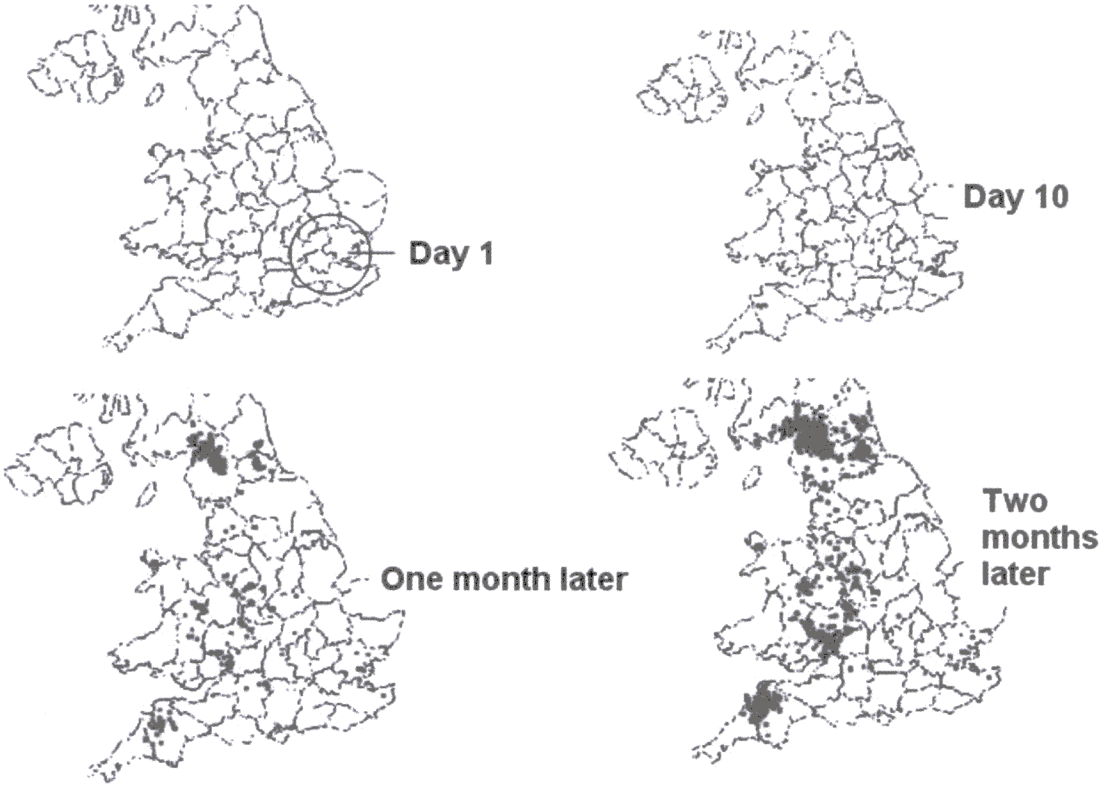

Figure 2: Reported spread of foot and mouth disease over time from initial identification of the disease at an abattoir in the south of England. (Day 1 case is enlarged to improve visibility).

behaviour have been the subject of speculation in the British press, including checking the age of sheep and cattle at livestock markets by examining their teeth, unregulated sale of livestock outside saleyards (making it difficult for authorities to trace the movement of stock), the exchange of infected animals to seek compensation (as the markets for stock from affected areas were closed and farmers were unable to sell healthy stock), and unauthorised preparation of meat and dairy products for local consumption in infected areas.

There has been widespread criticism in the UK that the British government pursued a policy driven mainly by political considerations, and that it may have chosen the right strategy but did not pursue it wholeheartedly. The government's approach from the start was to treat the outbreak as an economic problem affecting only farmers. This approach ignored the much greater economic crisis which quickly engulfed tourism and other countryside (and urban) businesses. While the direct taxpayer cost of control operations and compensation to farmers has been placed at £2bn, an estimate of the loss for tourism has been £3bn (Hetherington, 2001). Rural businesses have suffered additional cost as a flow-on consequence of the losses suffered by farming and tourism. There was widespread belief that government agencies, the veterinary community and farmers failed to respond adequately to the epidemic[3] and some have argued that the army should have been called in much earlier to assist with logistical matters.

A credible assessment of the handling of the FMD crisis in the UK is probably that presented by the veterinary community in the UK, in a report to the National Audit Office by the Pig Veterinary Society (PVS, 2001):

- The Department for Environment Food and Rural Affairs were slow to realise the magnitude of the epidemic because they did not appreciate the extent of sheep movement throughout the country.

- The logistical approach to the handling of the crisis was appalling, and it is difficult to understand why the Army were not drafted in to assist with slaughter and carcass disposal as soon as the magnitude of the epidemic had been realised.

- The veterinary community was concerned that internal conflicts of opinion on scientific matters such as vaccination, epidemiological predictions and so on were emerging in public. Confusion in the public domain about the merits or otherwise of vaccination was a result of poor and divided communication.

- The development and application of the licensing procedures for animal movements became unnecessarily tedious.

- In the early stages of the epidemic most abattoirs demanded on-farm ante-mortem inspection of animals, especially pigs, at the expense of the producer.

The Anderson Report, *Foot and Mouth Disease 2001: Lessons to be Learned Inquiry* (DEFRA, 2002b: 8-10), concluded that the government's first responses were not fast enough; knowledge of farming practices within government was inadequate (in particular the nature and extent of sheep movements); the impact of the epidemic on the wider rural community was not recognised early enough and the epidemic was too narrowly perceived to be a farming problem rather than a problem for the entire rural community; the Ministry of Agriculture Food and Fibre (later to become the Department for Environment, Food and Rural Affairs, or DEFRA) was under -resourced to cope with the outbreak; the quality of communication was mixed and often inadequate; and, until the armed forces were brought in, leadership, management and logistical skills were inadequate to the task.

The last outbreak of FMD in Britain before February 2001 was in 1967. The 1967 FMD outbreak was smaller in scale, less widely distributed, and caused less disruption to rural society. From a comparison of the 1967 and 2001 epidemics, the British Department of Food, Environment and Rural Affairs (DEFRA, 2001a) tentatively concluded that reasons for differences in the two epidemics include changes in Britain's disease preparedness as well as changes in farming practices (specifically, the sheep industry). It is also clear, however, that social and economic changes in Britain's rural society and economy since 1967 brought on a wider range of repercussions, and that these changes were not recognised by government officials.

Since 1967, the British countryside in general has become socially and economically more differentiated (Ilbery, 1998). Robinson (1990) has pointed out that, with the urbanisation of rural communities, the distinction between rural and urban has become increasingly unclear in Europe, North America, Australia and New Zealand. Within the countryside, there is differentiation within and between rural populations, as areas within commuting distance of cities experience a greater mix of farmers, rural workers, urban workers (who commute to the city), and retired urban and rural residents; while peripheral areas may be more homogeneously rural, although not necessarily less differentiated in terms of income and social class. Ilbery makes the point that

> Agriculture is being restructured and farmers are having to adjust to national and international processes of change which are reducing the importance of the previously dominant productivist ethos. This adjustment often takes the form of generating new sources of income from non-agricultural activities either on or off the farm (Ilbery, 1998:4).

Farming has become more diversified (into interdependent forms of specialist production), and non-farm activities have increased. Enterprises such as tourism and life-style development have become important in many parts of the British countryside. As shown by Ilbery and Bowler (1998: 57-84), agriculture in Europe and the USA over the past three decades has become at the same time more productivist and post-productivist. Productivism involves an increasing intensification, concentration and specialisation of agricultural production while post-productivism moves in

the opposite direction towards extensification, dispersion and diversification. Pathways to post-productivism can include redeployment of farm resources into new agricultural products or services on or off-farm, redeployment of human capital into off-farm occupation, reduced intensification of traditional production (low-input/low-output farming), and hobby or part-time farming. This diversification and development of non-farm activities means that there are many who can be severely affected by the restrictions placed as a result of the outbreak, while not members of the farming community.

The role of GIS

Maps can be a valuable tool to help identify and predict spatial patterns of disease. By combining spatial information from different sources, Geographical information systems and spatial analysis can be used to predict and map patterns of disease spread. Observations are made in the real world and converted to a series of representative objects, or data abstractions, using GIS techniques to create mathematical representations of landscape features. Once the spatial components have been assembled, visualisation tools, data analysis methods, and model building techniques are applied to predict spatial patterns. GIS was used as a tool by the Ministry of Agriculture, Fisheries and Food for epidemiological mapping of the UK FMD epidemic, and has been well recognised by the United Nations' Food and Agriculture Organisation (FAO) with its *Manual on Livestock Disease Surveillance and Information Systems* (FAO, 2000).

The fact that FMD is an airborne disease makes predictions of spread very difficult to compute and test (Donaldson et al., 1982). Airborne diseases are not only affected by wind direction, but will also be sensitive to atmospheric moisture and temperature levels, terrain, livestock movements (deliberate, or in the course of breeding and sale arrangements), bird migration, and so on.

Notwithstanding this difficulty, we have produced a model for the possible pattern of FMD spread for New Zealand. Based on ecological conditions alone it has not been possible to establish a robust predictive model because human behaviour can cause unexpected links in the chain of cause and effect. However, based on simulating the physical conditions associated with the disease in the UK in 2001 (moist, cool, moor-like type environments), a model has been built for New Zealand, and the following 'snapshot' is taken from this predictive model (Figure 3).

Lessons for New Zealand

New Zealand's response framework to a FMD outbreak is part of a biosecurity system. The biosecurity system comprises:

i) pre-border measures (e.g. agreements with other countries to report disease outbreaks, checks of imported goods in countries of origin);

ii) a border control system that is responsible for preventing the entry of unwanted organisms into the country;

iii) a system of emergency response to disease incursion, the 'the introduced pest and disease response' system;

iv) a surveillance system responsible for detecting unwanted organisms that have entered the country; and,

v) a system of regional and national pest management for pests and diseases that have become established or naturalised in New Zealand.

The Ministry of Agriculture and Forestry (MAF) is responsible for border control (MAF Quarantine), exotic disease response (Exotic Disease Response Centre), and coordination of biosecurity (Biosecurity Authority). In the event of a FMD outbreak, the immediate response would be through MAF, coordinated by the Exotic Disease Response Centre. The Exotic Disease Response Centre is a relatively modest organisation that coordinates a network of contracts with different agencies intended to provide the emergency operations and services needed to respond effectively in the event of an outbreak. For example, the National Centre for Disease Investigation, Alpha Scientific, and AgriQuality provide diagnostic laboratory services, Asure NZ provides slaughterhouse surveillance, and various firms provide education and information services.

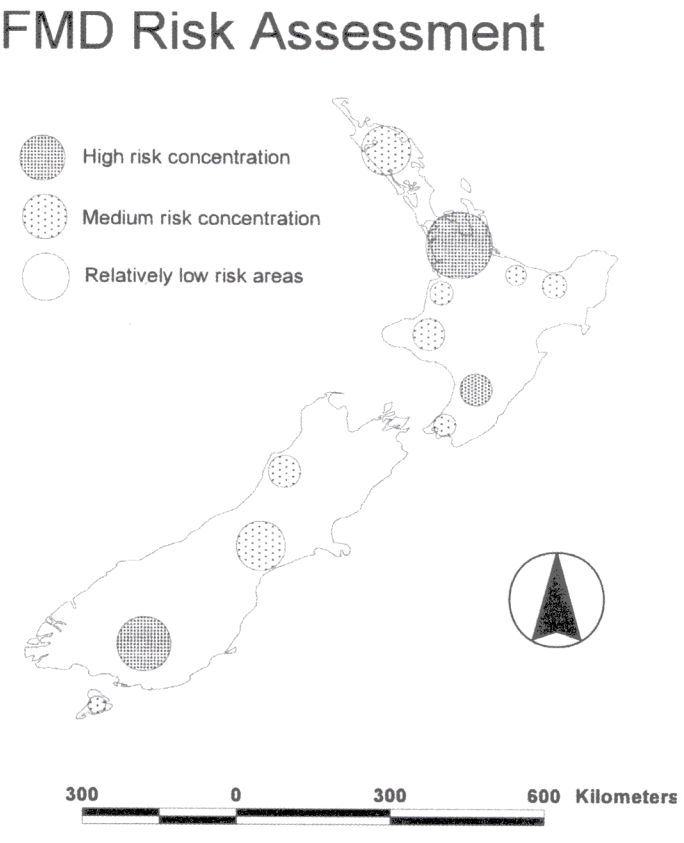

Figure 3: A 'snapshot' of the possible spread of a foot and mouth epidemic in New Zealand, based on the preferred environmental conditions of the disease

The New Zealand biosecurity system is highly attuned to the danger of a FMD outbreak. The Biosecurity Authority maintains a well developed contingency plan (MAF, 1998), with clear lines of responsibility in the event of a disease outbreak, and detailed guidelines for agencies responsible for responding to an outbreak. Regular simulation exercises have been conducted with relevant agencies, and there are regular training exercises. In addition, the Biosecurity Authority works with industry groups to encourage safe practices and exotic disease response contingency plans such as the one prepared by the New Zealand Pork Industry Board (NZ Pork Industry,2001).

As a consequence of the FMD outbreak in the UK, New Zealand boosted its biosecurity system with 100 new biosecurity staff, 11 new teams of detector dogs (in addition to 10 existing teams), and 9 new x-ray machines (MAF, 15/11/01).

Nevertheless, the course of the FMD epidemic in Britain has provided New Zealand with an important opportunity to assess its own procedures and learn from the British experience. These lessons have implications for New Zealand's institutional response framework.

Lesson One

Perhaps the first lesson from the FMD epidemic in Britain is that, "the geography of the disease is not the same as the geography of its impacts" (Countryside Agency, 2001). This means that the response framework for FMD needs to recognise the wider rural and national interests at stake in the event of an epidemic.

While the geography of the disease depends on the location and spread of the disease among livestock and feral animals, the geography of the impacts includes the effects on the social and economic fabric of rural society and the nation at large.

Because the economic importance of New Zealand's pastoral sector is so great, it is easy to forget the economic and social effects of an outbreak on other parts of the rural (and urban) community. However, a number of studies have shown that New Zealand's rural society, like that of Britain, has diversified and become much more heterogeneous in the past few decades (Joseph,1999; Liepins, 1997; Press and Newell, 1994; Scott, Park and Cocklin, 2000).

According to Moran (1997), many parts of the country have experienced rapid and considerable decreases in average farm size. Changes in farm size have been significantly related to changes in farm type, and to changes from farming to other land uses (e.g. changes from pastoral use to life-style use in peri-urban areas, or to forestry in other parts of the country). Demand for horticultural holdings and subsequent substantial regional diversification into horticulture have altered the rural social and economic structure of many parts of the country. Subdivision for horticultural units in specific regions has resulted in increasing rural population densities in some counties and a growth in centres servicing them.

Furthermore, others studies have shown that pastoral farming itself has diversified and changed. Among sheep and beef farmers, especially, there has been on-farm and off-farm diversification. Off-farm diversification has included small rural processing industries and working in nearby settlements; on-farm diversification has included farm home-stays and other tourism enterprises, grazing (of heifers and dairy cows), deer, and forestry (Johnsen, 1999).

In many parts of the country, the distinction between urban and rural is increasingly less obvious, as farm workers and contractors commute from the city to the farms, and 'lifestylers' commute from the countryside into the city.

This diversification and differentiation means that not only farmers would be affected by an outbreak of FMD, but rural contractors, lifestylers, tourism operators, recreation providers, cottage industries, and others. Non-agricultural enterprises on and off farms could be seriously affected by quarantine restrictions surrounding affected farms.

Lesson Two

Rapid social, political, economic and agricultural changes in the rural sector affect emergency response measures based on traditional models of the rural economy. In Britain, officials and policy makers found that widespread social, economic and agricultural changes in the rural sector over the past three decades meant that experience from the 1967-68 epidemic did not adequately prepare them for the spread and extent of the 2001 epidemic. In particular, as a consequence of EU agricultural policies, British sheep farmers had developed stock management practices that involve widespread movement of stock between farms and saleyards. Officials were not prepared for the spread and extent of stock sales, and for the complexities of tracing the ownership, origins and movements of sheep stock.

Although New Zealand pastoral agriculture is different in important ways from that of the UK, it has experienced equally far reaching changes. Taking the dairy industry as an example, while dairying has expanded, the number of dairy farms has decreased, the size of farms has increased, as has the size of dairy herds, and there is growing specialisation of farms. In the Waikato region as an example, there has been a trend to concentrate dairy cows on specialised milking farms, and to rear calves and dairy heifers on calf-rearing farms and grazing farms. Yet other farms may cultivate dairy fodder crops such as maize. Increasingly, dairy farmers maintain a milking herd on one farm, graze replacement stock elsewhere, and grow, or buy-in, additional feed to supply the diary herd at times of low grass growth on the milking farm. In short, individual farms in the Waikato are managed less and less as independent production units and more and more as parts of an increasingly integrated regional system of dairy-related farms and farm services.

A consequence of this intra-regional specialisation is that farms are interdependent, and transport (of livestock, fodder, farm service providers) between farms is greatly increased. Restrictions on transport due to an FMD epidemic could create major upheavals to all the farms within and across regions.

Lesson Three

Human factors are critical in the epidemiology of the disease; this means that the spread of the disease cannot be predicted solely from its ecology, and emergency response procedures need to be prepared for the unexpected. In Britain, human factors were critical in spreading the disease, and in the failure of institutional systems to identify the disease rapidly at the outset. For example, a month elapsed between the time the disease was introduced and the time that emergency response measures were implemented. The time lag before notification involved a chain of delays due to human causes, including (in the early days) lack of knowledge and ability on the part of farmers to recognise the symptoms in their own stock.

Human factors are equally likely to cause complications in New Zealand. These factors could include lack of knowledge about the disease among some farmers (e.g. lifestyle farmers); fear of the consequences of reporting the disease (especially if the importation is due to illegal activity); slack procedures in the case of stock handling and record keeping at saleyards and freezing works; illegal movement of animals or feed if transportation restrictions make for feed shortages on some farms.

Lesson Four

Place matters; the consequences of an epidemic are likely to vary depending on local and regional differences of circumstance. Local variations such as climate, topography, types of farming and land use, and the nature of the local and regional economies are all important factors that can affect the spread and impacts of the disease. This means that emergency response procedures and control operations need to work with local and regional authorities for more effective implementation at local and regional levels.

British experience showed that Cumbria and Devon suffered particularly from the effects of the outbreak. The reasons related not only to the fact that the ecological conditions of these areas suit the disease, but both areas depend heavily on tourism as source of income.

The snapshot map of ideal ecological conditions for the disease includes areas of New Zealand that are very different in social, economic and agricultural terms. If an FMD outbreak occurred within the peri-urban fringe of Auckland or Christchurch, for example, it could have immense effects on the movement of people and goods in and out of the city.

The exact consequences of the disease would depend on the mix of economic activities, and the interdependencies of economic and social activities in a particular area. They include factors such as type of farming, roading infrastructure, opportunities for disposal of carcasses, and even the prevalence of feral animal vectors such as wild pigs or deer. Even if we compare rural areas with similar types of farming, the likely consequences of an outbreak in Southland or Canterbury could vary quite substantially from an outbreak in the Waikato or Northland. In Canterbury and Southland the scale of pastoral holdings and the regional community of farms is different from that of Waikato or Northland. The average size of dairy herd in Waimate, South Canterbury, for example, is 615 cows, compared with the Northland average of 197 (LIC, 2000). The logistics of disposing of a herd of 615 cows are very different from those of a herd of 197. Equally important, farms sit within rural communities that are economically and socially different. Thus the consequences of a disease outbreak in a community that relies heavily on tourism as part of its regional income is likely to be greater than those for a community which depends more on forestry or urban commuters.

Effects of control operations could have unexpected impacts on members of the rural community not directly affected by the disease. For example, in some poorer parts of New Zealand (such as much of Northland), some members of the rural community depend significantly on hunting of feral animals such as pigs and deer. Deer, pigs, and feral goats are all ungulates which could become vectors of the disease. They could be instrumental in spreading an FMD epidemic outside farm quarantine procedures. Efforts to stamp out such wild or feral populations could have serious impacts on members of the rural community who look to contributions from hunting to feed their families.

Lesson Five

Co-operation between central and regional levels of government are crucial to effective community responses. As reported earlier, there is widespread belief in Britain that government agencies failed to respond adequately to the epidemic. The Anderson report (DEFRA, 2002b:9) noted that the course of the epidemic was less severe in Scotland than England, despite initially high levels of seeding by disease vectors. They conclude that

> . . . in Scotland, with a different management structure and closer relationships between central government, local government and the farming industry, the outbreak was better managed. Contingency planning had been more systematic and the disease did not spread so far. Key problems were identified early and dealt with quickly.

Within New Zealand, a potential weakness in an FMD response is the relationship between central and regional government. Although both central and regional government have biosecurity responsibilities, they are reinforced by separate funding systems (taxpayer funded for central government and ratepayer funded for regional) and by legislative systems of financial accountability that constrain the extent to which they can work together. Cooperation is restricted by provisions of the Biosecurity Act which require

very strict accountability for funding operations by biosecurity agents.

Lesson Six

Past biosecurity system failures in New Zealand suggest that despite the preparedness of the Biosecurity Authority and Exotic Disease Response Centre, there is no cause for complacency in the way New Zealand might respond to an FMD outbreak. The New Zealand contingency plans are similar in important respects to those of the UK (AVIS, 10/06/01). Despite a skilled and motivated network of individuals, the institutional framework for New Zealand's biosecurity has been unable to prevent a number of serious pest invasions in recent years. These include the varroa bee mite, the clover root weevil, Argentinean ant, rabbit haemorrhagic disease (RHD), and the painted apple moth (*Teia anatroides*).

The structure and funding of the emergency response system means that central government officials have the responsibility to coordinate the national response to an epidemic, but not necessarily the contact with local and regional government officials that will allow them to respond effectively to local and regional differences in the impacts of the disease.

The case of the painted apple moth illustrates some of the problems that central government could face in the event of a FMD epidemic that impinged on a peri-urban area such as south Auckland. The painted apple moth is a threat to forestry and horticulture and possibly to native vegetation. It has been identified in the suburbs of west Auckland (Henderson, Te Atatu, Glen Eden, New Lynn, and Point Chevalier). The Ministry of Agriculture and Forestry initially sought to control the pest by ground operations, but after finding this was not effective, decided that aerial spraying was necessary. However, it has faced enormous opposition from local residents who are concerned about possible effects on health and on other species. Critics of the programme have argued that the Ministry has adopted a "bullying and hectoring approach" (Beston, 10/9/2002), and that, at the outset, it did not tackle the problem the way it should have (NZH, 10/01/2002). The debate is an example of the difficulty of applying a large-scale control operation in a heterogeneous urban population that does not necessarily agree with the aim or the methods of the operation.

Conclusion

Similarities in British and New Zealand institutional frameworks for foot and mouth disease response, and parallels in rural social and economic change, have provided New Zealand with an important opportunity to learn from the FMD outbreak in UK. The British experience demonstrated forcefully how an epidemic such as FMD can affect not only the farmers directly involved, but a wide network of people who live or work or travel in, and to, the countryside.

The past several decades have seen growing diversification and differentiation in rural society both in Britain and New Zealand. This means that pastoral agriculture is much less dominant (and less powerful) in contemporary rural society. Other significant interest groups, such as tourism, urban commuters, agricultural contractors and agricultural industries have emerged as politically influential and important. In addition, transportation changes have made stock movements easier and more widespread, posing greater risks of wide distribution of the disease. Furthermore, specialisation of farms within farming systems has meant that travel between farms (e.g. for movements of stock, and stock feed, or services by specialised contractors) is increasing. This again increases the risk that an outbreak will become widespread. Rural to urban commuting by life-stylers, and urban to rural commuting by farm service contractors mean that travel between town and country has increased, so that disruptions due to quarantine restrictions could cause widespread inconvenience and resentment.

Given the differentiation of rural society, New Zealand's pest and disease response system needs to recognise that a wide range of people and interest groups would be affected by a FMD epidemic; it can no longer be considered a disease that affects only the agricultural sectors of the community. Equally, New Zealand's heavy economic dependence on pastoral production and tourism means that its biosecurity system remains a critical buffer against threats from increasing world travel and trade. It is important to the nation's social and economic welfare that the emergency response system remains properly resourced and prepared.

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Notes

[1] Including China, Korea and Taiwan

[2] The 1989 figure for China and Hong Kong is an underestimate because the number of visitors from China in 1989 was too low to be included. The lack of exact comparability, however, does not contradict the fact that there was a very large percentage increase of visitors to New Zealand from East and South-east Asia during the 1990s.

[3] It should be noted that the Anderson Report (DEFRA, 2002b) goes to great lengths to explain the very difficult circumstances of the State Veterinary Service immediately before the outbreak. The State Veterinary Service was under-resourced and overstretched according to this report.

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