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Market instruments, biosecurity and place-based understandings of animal disease

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ABSTRACT

Neoliberal approaches to managing animal disease use Market Instruments (MIs) to promote biosecurity citizenship amongst farmers. MIs create risk-based trading markets that make disease risks visible, and establish and reward appropriate farming practices. However, for other policies the use of MIs is often context dependent and related to farmers' existing values and practices. This paper considers how different spatial imaginations of disease and place attachment amongst farmers modifies the meaning of disease control MIs. Using the example of bovine Tuberculosis in New Zealand, the paper examines its Risk Based Trading scheme known as 'C status' designed to limit the movement of cattle. Drawing on qualitative interviews in a farming community in the West Coast, the paper shows how farmers accept the legitimacy of C status to create biosecurity citizenship. At the same time, farmers recognise different spaces of disease risk that vary according to landscape and climate, farming practices, and cattle genetics: factors not recognised within C status. These absences, together with farmers' attachment to place, and their adaptive plans to live with disease, can minimise the significance of MIs.

1. Introduction

This paper explores the role of Market Instruments (MIs) in creating and encouraging biosecurity citizenship amongst farmers to prevent the spread of animal disease. Market Instruments (MIs) – codes of practice, environmental management systems, environmental certification, and financial incentives – are commonly used to secure environmental benefits and encourage positive environmental behaviours amongst land owners and farmers (Dibden and Cocklin, 2005; Lemos and Agrawal, 2006). Increasingly, MIs are employed in the management of animal disease to create risk-based trading markets for cattle in which disease-free livestock can attract financial premiums. At the same time, MIs can help reduce the spread of disease by establishing and rewarding forms of 'good farming' and normative behaviours which act as forms of social control (cf. Burton, 2004).

Whilst studies have examined farmers' responses to MIs for a range of agricultural policies, there are no social science studies that examine their use in managing animal disease. More generally, Higgins et al. (2012) suggest that further research is required to understand how MIs are used in practice, how they are resisted or adapted, and how existing values, knowledges and practices interact with and reshape policies. This is also true for animal disease MIs: they articulate specific epidemiological understandings of animal disease articulated at different spatial scales (such as the farm, parish or region) yet farmers' disease management practices may be informed by understandings of disease that are rooted in place-based experiences (see for example: Enticott, 2008).

This paper therefore asks to what extent do place-based understandings of animal disease correspond with and support the aims of animal disease MIs? The paper focuses on the management of bovine Tuberculosis (bTB) in New Zealand where a system of MIs is used to limit the movements of potentially infected cattle. The paper begins by reviewing the role of MIs, linking them to Barker's (2010) concept of biosecurity citizenship. Drawing on interviews with farmers in the West Coast, New Zealand, the paper describes the role of place in shaping farmers' understandings of bTB, and how their spatial understandings of disease transmission support and conflict with the aims of MIs designed to prevent its spread.

2. Biosecurity and market instruments

Biosecurity – or measures taken to eliminate and prevent the spread of animal disease – is central to the neoliberal project of the

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free movement of agricultural animals and produce (Busch, 2010). The neoliberal governance of biosecurity relies on the creation of standards and technologies to patrol inter- and national borders (Higgins and Dibden, 2011). At the same time, the neoliberal governance of animal disease has sought to pass the costs, duties and responsibilities of biosecurity to farmers by creating new partnership governance structures. In countries like Australia and New Zealand, the agricultural industry takes the lead in funding and governing the eradication of specific animal diseases with the State representing a minority partner.

Biosecurity is also devolved to individual farmers through specific technologies of rule designed to individualise biosecurity responsibilities by creating new biosecurity subjectivities. Drawing on Rose's (2007) notion of 'biological citizenship' and ideas of 'ecological citizenship' (Dobson, 2003), Barker (2010) suggests that the creation of biosecure citizenship involves 'symbiotic individualisation' in which a variety of technologies of persuasion and enforcement are used to encourage citizens to think about and act upon their individual biosecurity responsibilities. Thus, technologies of rule identify appropriate practices that seek to create 'contractual obligations' for citizens to participate in the surveillance and reporting of unwanted biological presences.

Thinking about biosecurity citizenship and the governance of the self therefore alerts us to the technologies and rationalities required to normalise pro-biosecurity practices. Market Instruments are a prime example. The growing use of MIs stems from a general dissatisfaction with old policy instruments, the rise of governance paradigms based in neoliberal institutionalism and the desire to regulate without challenging free-trade or subsidising production (Higgins et al., 2012). In practice, MIs are a diverse set of instruments, ranging from direct taxation, cap and trade schemes, certification and labelling, and payments for ecosystem services (Lemos and Agrawal, 2006). According to Lockie (2013), MIs will differ according to policy objectives and can take three forms: 'market friction' MIs seek to improve existing markets by providing information that allows product differentiation, such as certification schemes and standards; 'price-based' mechanisms set or modify prices to incorporate the cost of ecosystem services through auctions, tenders grants and taxes; and 'quantity based' MIs set targets to achieve or maintain environmental goals through cap and trade mechanisms.

In the regulation of animal disease, MIs are commonly associated with policies of Risk Based Trading (RBT). RBT seeks to regulate the movement of livestock between different places – defined by either institutional or epidemiological boundaries. RBT schemes can be either statutory or voluntary, and seek to shape farmers' livestock purchasing practices by providing accurate information on disease risks in order to "encourage farmers to consider the relative disease risk of animals that they are buying, empower them to make better informed cattle trading decisions, and take greater responsibility for managing the [disease] risk of their herd as part of wider efforts to stop the spread of [disease]" (Bovine TB Risk Based Trading Group, 2013). RBTs therefore act as a market friction MI, attempting to improve the efficiency of existing markets through the provision of information. Frequently, they take the form of certification schemes, herd classifications and disease ratings in order to make disease risks visible, and create a market for different levels of disease risk. In seeking to robustly define and measure animal disease risks, RBTs can be seen to be part of a 'metrological regime' (Barry, 2002) through which metrics are key components in the shaping of calculative economic behaviour (Çalışkan and Callon, 2010). Equally, the metrological systems inherent to RBTs contribute to Barker's concept of 'symbiotic individualisation'. Their focus is on rendering measurable and calculable aspects of farming practices in order to allow farmers to identify where their conduct can be optimised (Higgins et al., 2012). In this way, MIs that rely on standards and numerical inscriptions can be seen to 'provide an opportunity and obligation to demonstrate [a] 'duty of care'' (Lockie and Higgins, 2007, p. 7). MIs therefore contribute to constructing farmers as 'entrepreneurial and 'active' agents who improve their productivity without government interference' (Lockie and Higgins, 2007, p. 2).

The adoption and use of MIs is not without problems. Crucially, MIs demand that their users put community interests before their own. Tensions between existing values and attitudes, and the new practices encouraged by MIs may lead to their non-adoption or misuse. The use of MIs may ultimately be highly context-dependent, and relate to the significance of competing government policies (Higgins et al., 2012). Whilst MIs may seek to define and make new farming practices socially acceptable, Burton (2004) shows that farmers possess their own symbolic codes of recognising 'good farming' but which can also undermine government attempts to persuade them to adopt different practices through, for example, payments for ecosystem services. Studies of the adoption of new farming practices also emphasise the extent to which adoption is shaped by pre-existing values and attitudes, requiring specific trigger events to break path-dependent approaches to farming (Sutherland et al., 2012; Sutherland and Darnhofer, 2012).

Whilst there are no studies of how MIs have been used to help regulate animal disease and create norms of biosecurity citizenship, there is no reason to suspect that the fate of biosecurity MIs would be any different to those policy areas where they have been used. Recent biosecurity research suggests that the adoption of new disease prevention practices is related to factors such as trust in government (Enticott et al., 2014; Heffernan et al., 2008a) and is dependent on existing cultural beliefs about disease (Heffernan et al., 2008b; Maye et al., 2014). Farmers may resist the introduction of Government-led MIs, fearing disruption to the operation of existing markets or the creation of 'two-tier markets' (Bovine TB Risk Based Trading Group, 2013). Indeed, the establishment of metrological systems – such as those contained within RBTs – is well known for provoking debate and contestation due to the precise difficulties of measurement, definition and commensuration (Cooper, 2015). As Espeland and Stevens (1998) show, metrological systems rely on aggregating different attributes, yet these acts of commensuration depend on the extent to which people accept these metrics legitimately express value, or the extent to which disparate factors can be legitimately combined. Indeed, farmers' own understanding of disease can be shaped by their own place-based experiences of disease. The sharing of stories between farmers about disease outbreaks, can contribute to the creation of 'lay epidemiologies' (Enticott, 2008) in which farmers make sense of animal disease and draw up their own rules of good biosecure farming. Farmers' lay epidemiologies can undermine government attempts to persuade farmers to adopt new disease procedures by highlighting how scientific understandings of disease fail to take into account the local peculiarities of risk, landscape and place. Whilst knowledge of these understandings of animal disease is important, the extent to which they also shape the use of MIs in the management of animal disease is not known. The remainder of this paper therefore turns to an examination of farmers' reactions to a MI used in New Zealand to limit the spread of animal disease, and the extent to which place-based understandings of disease contribute to its use.

3. Methodology

Bovine tuberculosis (bTB) is a zoonotic infection found in cattle, wildlife (e.g. possums and badgers) and humans. The disease is endemic in many countries and is 'notifiable' requiring any suspicion of its presence to be reported to government authorities. For the purposes of controlling the international spread of bTB, the World Organisation for Animal Health establishes the conditions under which a country can declare itself bTB-free, and specifies disease surveillance practices that should be followed.

In New Zealand, bTB is managed by Operational Solutions for Primary Industries (OSPRI), formerly known as the Animal Health Board (AHB). The AHB was established as an incorporated society in 1998, following the passing of New Zealand's 1993 Biosecurity Act. The AHB takes the role of a Pest Management Agency, responsible for writing and delivering the National Pest Management Strategy for bTB (Hutchings et al., 2013). It was created as a partnership between the farming industry and the national government, but in which the agricultural industry has the majority stake due to its larger financial contribution. In this sense, the AHB represents a classic organisational form resulting from so-called “roll-back” neoliberalism (Peck and Tickell, 2002) common to agricultural reforms in New Zealand from the mid 1980s (Haggerty et al., 2009).

Since 1998, concerted disease control efforts by the AHB have resulted in a steep decline in the national prevalence of bTB in cattle herds which now stands at 0.21% (OSPRI, 2014). However, pockets of persistent infection remain in some areas of the country particularly in the West Coast region. One aspect of the disease control programme has been the use of a RBT scheme designed to limit the movements of cattle between infected and clean areas of New Zealand. Statutory RBTs were part of the successful bTB eradication scheme in Australia in which inter-state cattle movements and farm to farm cattle sales were tightly regulated (More et al., 2015).

By contrast, a voluntary RBT scheme was developed in New Zealand, which reflected the involvement of farmers in its creation and the governance of bTB. The system itself has changed over time, but its origins can be traced to 1991 when the East Coast Regional Animal Health Advisory Committee began insisting that any cattle on sale in their saleyards would have to display information on the herds' bTB status. The Board, led by Ross Bramwell, a local auctioneer, together with other local farmers, had become concerned about the number of cattle from regions of high bTB incidence, such as the Wairarapa, being sold in Hawke's Bay and translocating the disease. In these saleyards, farmers selling stock were required to complete an Animal Status Declaration (ASD) card which was displayed to farmers. Farmers from areas with high levels of bTB were initially shocked by the requirements. However, support from Hawke's Bay farmers ensured the scheme was a success, and gradually the scheme was implemented in other regions of New Zealand. As farmers' became increasingly involved in the management of bTB through the establishment of the AHB, so the scheme evolved into a nationwide RBT. The ASDs were replaced by a metrological system in which every herd was given a risk score which classified farms according to the number of years they have been clear of bTB (e.g. C1, C2 through to C10[1]) or infected (e.g. I1, I2 etc.). Status is conferred on high-ranking herds (e.g. C10) and penalises farmers purchasing cattle from herds with inferior bTB status: were a C10 farm to buy cattle from a C5 herd, it would adopt the lower status classification. ‘C Status’ therefore operates as a market friction MI, applying a risk metrics to the existing cattle trading market through which premiums for disease-free cattle are created, rewarding farmers who stay clear of disease, and incentivising disease control measures by creating a visible rating of a farmers' performance. Importantly, as the RBT was developed with farmers – alternative risk scores based on epidemiological calculations were rejected by farmers – the system also had the potential to overcome farmer scepticism and problems of commensuration common to other metrological systems.

To investigate how C Status informs farmers' disease management practices, farmers in Karamea – a small farming community in the West Coast region of New Zealand – were interviewed. The West Coast has the highest prevalence of bTB in New Zealand: approximately two-thirds of the cases in New Zealand are found here (Animal Health Board, 2012). Karamea lies at the northern tip of the West Coast, 100 kms north of the nearest town – Westport – and accessible by one road. At the time of the research, the area contained 56 farms, 38 of which were dairy and the remainder beef. Farms in Karamea have a long history of bTB and it has been recognised as a bTB problem area since the 1960s. The area is surrounded by the Kahurangi National Park which provides the ideal habitat for possums, known to spread bTB to cattle (Davidson, 1991) (see Map 1 for locations). At the time of the research, 11 farms were infected with bTB and three were rated C10.

Karamea was therefore chosen as a unique case because of its high levels of bTB and which allows the impact of MIs upon farmers to be assessed. In total, 20 qualitative interviews were conducted with farmers in Karamea. Because beef cattle are slaughtered at a young age, beef producing farms are restricted to C2 status. To account for the impact of the full range of C values, research therefore focussed on dairy farms. All farmers interviewed had experienced a bTB breakdown, and nine herds were infected at the time of the interviews. The C status of farms without bTB ranged from C1 to C5. Herd sizes ranged from 150 to 370. Three farmers had recently retired from dairying but still maintained and rented out land in Karamea for agricultural use. All but one of the active farmers owned the farm with the remainder being a lower order sharemilker.

Access was initially arranged through the West Coast bTB Eradication Board with help from Animal Health Board officials, and snowball sampling was used to make contact with other Karamea farmers. For additional context, a further 5 farmers were interviewed on the West Coast, along with 10 interviews with vets and officials dealing with bTB on the West Coast. Interviews were conducted in August and November 2012, and lasted between 40 min and 2 h. Interviews covered the history of bTB on each farmers' farm and in Karamea, their understanding of the way the disease spreads, and the role and meaning of C status. Interviews were conducted on the farm. In nine cases, the interview consisted of a farming couple (husband and wife or mother and son). The remaining interviews were with male farmers. All interviews were recorded and transcribed and coded in NVivo. Interviews were conducted on the basis of strict confidentiality and quotes used in the analysis have been anonymised.

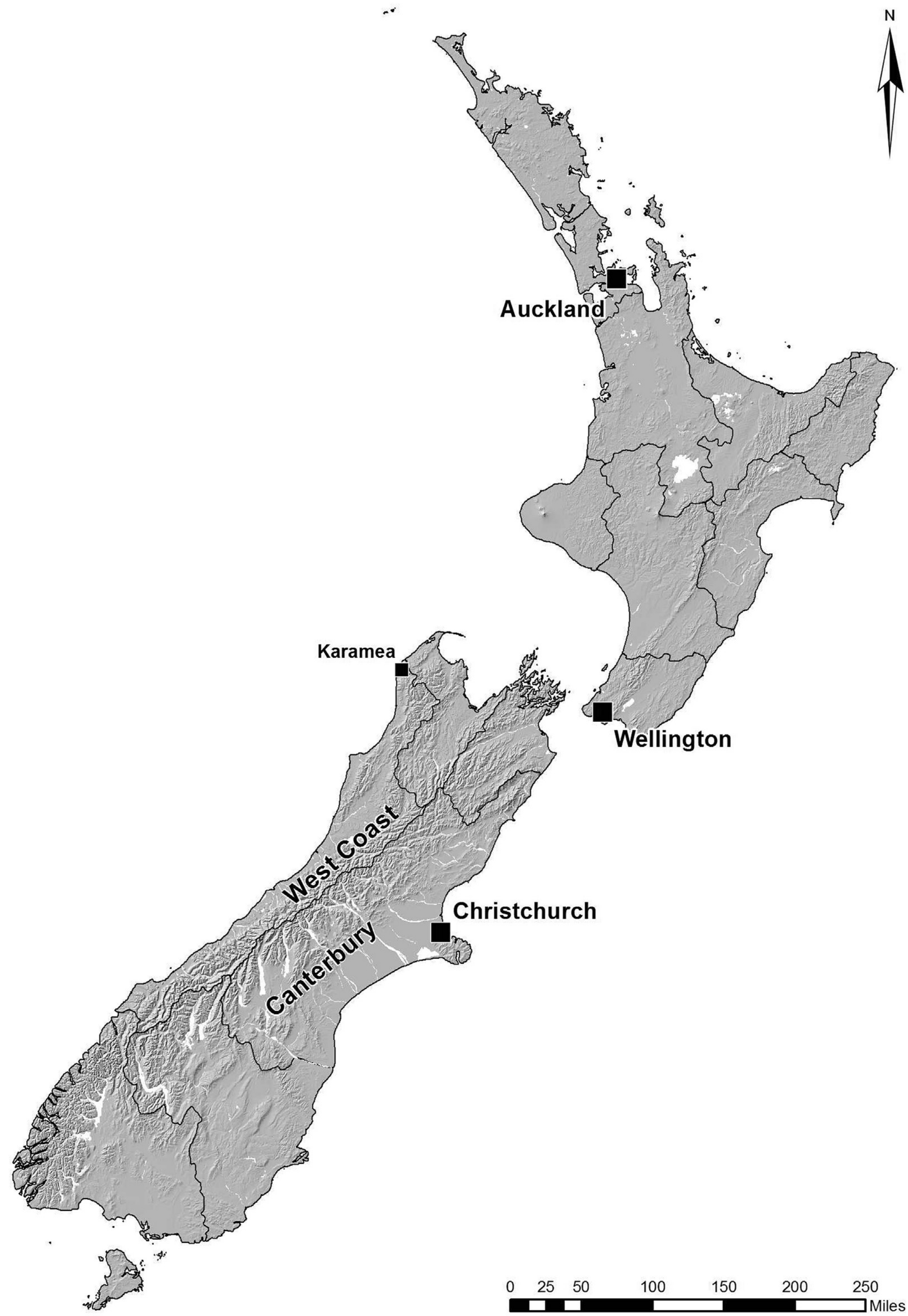
4. Analysis

The following sections provide an analysis of the impact of MIs upon farmers' disease management practices. It begins by considering how MIs shape biosecurity citizenship by limiting the movement of cattle from Karamea, before analysing how farmers' place-based understandings of disease modify the meaning of C status.

4.1. C status and the production of biosecurity citizenship

Farmers in Karamea readily defined themselves using the C classification. Unprompted, they would describe their herd using the C nomenclature and clearly understood that the higher the C number, the better it was. Farmers recognised that it was rewarding

[1] Officially, the highest status a herd can achieve is C10, however farmers will often refer to herds having a higher C status, reflecting the importance of high status, as well as the simplicity of the metrological system.



Map 1. Locations of the West Coast and Karamea in New Zealand.

to have a high status, not least because it allowed them to trade stock and move stock between different parcels of land. C status was also useful in helping farmers make sense of the disease situation on their farm. A common narrative of bTB in Karamea was of a constant cycle of infection followed by a clear period, before lapsing back into infection:

"We'll have a cow with TB and then you'll get your two clear tests cos generally we get 2 clear tests after that and then we're off for another 5 years. So its just something … yeah, it seems to be a 5 year cycle so we'll be due to go back on [laughs]" (KF5, bTB status: C4, 180 cows)

Moreover, C status became a central part of this narrative of infection and cleanliness, providing a way of describing the timeline of this cycle. For example, the chair of the West Coast bTB Eradication Board described the situation like this:

> *"We just ended up in a cycle for a while of pure frustration — they'd find a reactor or a cull at the works and nothing, nothing, nothing. You'd do your testing and get to C1 or 2 or maybe 3 or 4 and then boom you'd fall over again, it just seemed to be quite a bunch of us up here that would do this cycle: you're off, you're on, you're off, you're on"*

Farmers described how C status can play an important role in guiding cattle purchasing decisions. They recounted how their C status meant that farmers from outside Karamea were reluctant to buy their cattle. Low C status invited questions from potential purchases about the reasons why, or meant that business opportunities were abandoned or significantly lost value:

> *"I have had questions asked about our situation — how come you are only C3 that was a question I've got asked last year when I sold some animals — how come you are only C3?" (KF6, bTB status: C3)*

For farmers in Karamea, the of role C status to inspire biosecure citizenship was entirely appropriate. They did not begrudge other farmers use of C status as a way of informing their decisions and suggested that they would do the same in their position. Moreover, as well as limiting cattle movements, C status also had the effect of encouraging other forms of biosecurity in an attempt to preserve C status. Examples included ensuring that boundary fences were secure to prevent stock from mingling with neighbours' that might be infected:

> *"people that have managed to get their herds to C10 are jealously guarding that …. It's a bit like having a neighbour with weeds you know, you really, you really have got to watch that guy so I think that people would be quite careful about having neighbours like that and keeping their stock away from them" (KF15, bTB status: infected, 340 cows)*

Another farmer recounted a similar tale of attempts to protect his C10 herd by erecting a shelter-belt to prevent his herd from coming into contact with infected cattle on a neighbouring farm. Interestingly, this farmer went on to describe how his C10 status was regarded by other farmers in the area: whilst he argued that C10 *"didn't have to be important"*, he recalled how other farmers had sought out his advice to enhance their C status simply because he was C10:

> *"they would always come to you and say well what are you doing sort of thing, I'm infected at the moment and I don't know what I'm going to do and you seem to be able to keep clear — usually it was because they had stock away grazing or they might have bought in a cow from somewhere else, it's just wee things, things the farmer doesn't actually think about" (KF16, bTB status: infected, 220 cows)*

Whilst farmers' accepted the logic of C Status, they also sought to adapt it to fit their own understandings of disease. Specifically, farmers applied different temporal lenses to disease freedom in which they set different levels of risk rather than the 1–10 scale provided by C status. Rather than seeing a graduated scale of safety, farmers in Karamea set two or three zones: C1 to C3 as being least safe, followed by C3 to C10, with some setting another cut off at C5. For farmers in Karamea that bought cattle, these cut offs were applied when using C status as a guide to assess which cattle to buy. For example:

> *"The higher the status the better it would be for me buying animals on the coast, I definitely wouldn't buy anything below a C5 or a C6 over here, yeah, definitely looking for that higher status, even if they were a good animal and they were only a C2 C3 sort of thing I wouldn't buy them, I wouldn't even look at them. Well, you are running a risk of catching TB in your own herd" (KF16, bTB status: infected, 220 cows)*

The thresholds that farmers apply to C status show that farmers remake MIs to suit their own understandings of disease. Interestingly, the thresholds suggested are similar to those suggested by veterinary experts when C status was first introduced. Originally, vets argued that there was no epidemiological reason for having anything greater than C2. However, farmers pressed for a graduated scale up to C10. Whilst these interviews suggest that the cut off for farmers may be higher than C2, they nevertheless suggest that farmers apply their own limits of safety to MIs.

In defining and making disease risks visible to farmers, C status therefore appears to contribute to the creation of biosecurity citizenship amongst farmers in Karamea. At the very least, it provides farmers with a way of making sense of disease on their farm and in their local area. C status also appears to contribute to the goal of preventing cattle movements that could translocate bTB. Farmers frequently refer to C status to make judgements about the safety of other herds and give status to those farmers who have been free from disease for many years. In this sense, C status has potential to allow farmers to reflect on the 'right' farming practices in relation to bTB and guide their farming behaviour.

4.2. The limits to C status

The potential for C status to create biosecurity citizenship is nevertheless mediated by farmers' own understandings of disease that are linked to their place-based experiences of disease, and their social attachments to Karamea. In particular, thematic analysis reveals four key ways in which farmers' spatial understandings of disease modify the meaning and utility of C status.

4.2.1. Stress, disease and 'going over the hill'

Firstly, when judging stock, farmers make assessments of their disease resistance based on their regional provenance. Farmers commonly referred to West Coast cattle as being much hardier than cattle from 'over the hill' in the neighbouring region of Canterbury. As one farmer explained, life for cattle on the West Coast is hard: if they go 'over the hill'[2] they thrive and are incredibly productive. This meant that farmers in Canterbury would often take a commercial attitude towards lower status cattle on the West Coast: their disease status was off-set against the productivity gains once they had moved over the hill. Farmers on the West Coast recognised that this might cause them a problem if those cattle disclosed bTB infection at a test after they had moved. Indeed many recounted tales of how cattle from C10 herds that had moved to Canterbury subsequently became infected. Some farmers said this prospect worried them, but others suggested that it was down to the way the disease worked. Specifically, the role of stress in cattle setting off bTB which would occur as a result of the long journey to the Cantabrian plains. For example:

[2] In fact, farmers were referring to two hill ranges: the Karamea Bluff which separates Karamea from the rest of the West Coast, and the Southern Alps which separates the West Coast from Canterbury.

"Quite often I've heard of people taking animals from Karamea to Christchurch and they've been C14 and they show up with TB whether the movement causes some sort of stress and it breaks out …" (KF9, bTB status: infected, 150 cows)

At the same time, buying cattle in from low risk areas like Canterbury was seen to be a risk by farmers not just because of the stress of the movement, but also because of their naivety to bTB and/or the stage of their lifecycle. For example, stress at particular times in a cows' lifecycle was a factor in cattle reacting to the bTB test:

"Its generally the 2 year olds not your rising 2s, it's the R3s. they are in milk, its not generally the younger ones that have it, it's the two year olds that have the heifer reaction. And that could be stress that sets it off" (KF5, bTB status: C4, 180 cows)

Elsewhere, these lay understandings of disease have been found to affect the extent to which farmers engage in biosecurity practices (Enticott, 2008). In Karamea, a similar trend was noticeable: beliefs in stress and naivety also impacted upon the perception of C status – the best cattle to buy were not always those that were highest rated, but those that could fit the conditions. On the one hand, cattle from 'over the hill' were ill-prepared for the conditions on the West Coast. The wetter climate and harsher conditions meant that, even though those cattle were often rated as C10, their production would not be as good as local cows. As a result, farmers believed that they would quickly be infected with bTB because of the stress they would be under. These lay epidemiologies therefore modified perceptions of disease risks within the C score. For example:

"We'd buy in local stock – always local but we did buy from Christchurch occasionally, we bought cows but it seemed to be that East coast cows never did very well on the West coast in the harsher conditions – West Coast cows would do well over in Canterbury, but the other way it just didn't really work. We bought some very good cows from Canterbury and they only ended up being average cows. They don't like the weather" (KF12, bTB status: C3)

These assessments reveal how broader spatial judgements are made about the safety of cattle, beyond the herd-level assessment provided by C Status. In these assessments of stress and disease, farmers refer to much broader infected and safe geographical areas in which some cows are able to thrive and whilst others decline. In part, these spatial assessments are built on the prevalence of disease and the extent of C10 farms. But they also reflect how farmers view disease as embedded within a set of heterogeneous relations, combining landscape, climate, farming systems and genetics. The spread of disease was therefore understood in terms of disruptions to these relations that came to construct these different disease spaces, rather than simply reducing disease to a metric.

4.2.2. Luck

The fate of cattle moving and succumbing to bTB despite good C status highlights a second reason how C status can fail to inspire biosecurity citizenship. Many farmers concluded that contracting bTB was a matter of luck rather than anything related to their own actions and practices. Farmers viewed themselves as lucky if they avoided the disease and unlucky if they tested positive. Frequently, they suggested that '*there was no rhyme or reason*' to why they had got bTB and others not. Farmers sought to detect spatial patterns in the distribution of the disease or observe how the distribution of the disease matched those suggested by vets but efforts to develop disease rules were usually confounded. All farmers accepted that wildlife (in this case possums) could spread bTB and that vectors should be eradicated. However, the pattern of bTB reactions did not appear to match the distribution of farms closest to the bush (possum habitat). Farmers commented that whilst the disease may have been confined to certain areas in the past, the idea of 'clean' and 'dirty' areas was no longer true. Farms in areas previously considered safe – because of their distance from the bush – such as the beach, were now home to several infected farms, whilst those close to and in the bush were clear of bTB.

This confounding pattern appeared to confirm farmers' beliefs about their lack of control over bTB and the role of luck. If bTB infection wasn't down to farming practices or location, then there was little farmers could do about it. Some farmers pointed out that cattle bought from C10 herds had come down with bTB once they had moved. Others invested in additional controls, paid for pest control and changed their management practices but still had bTB. Whatever, they all felt they were unable to control the disease:

"Oh [we have no control] whatsoever. We've tried – like we are a closed herd, and we've fenced a buffer zone with the cows next door if they have TB, the possum guys come around here and do it, but I've never seen a possum on this place and I don't think there's any control over it" (KF14, bTB status: infected, 230 cows)

Instead, many farmers attributed their lack of control to the bTB test failing to find reactors hidden in the herd and which would only react at certain points in their life. Farmers were well acquainted with the inadequacies of the bTB test: cattle in Karamea appear to suffer disproportionately from a nonspecific reaction to the test. Young animals aged 2–3 years would react to the bTB test, but a subsequent blood test would usually clear them and they would be allowed to remain in the herd. Accordingly, farmers generally believed these cattle to be free of disease. Older cattle that reacted would be slaughtered as soon as possible because they were believed to be more likely to have had the disease and may have been hiding it for several years. Some farmers believed that cattle in Karamea had developed immunity to the testing which allowed them to keep spreading the disease. The level of the disease combined with the unpredictability of the test meant that many farmers believed they were always '*one test away from being infected*'. For example:

"you are only one test away from being nothing aren't you? I think you just don't set your hopes on it too high you don't go round saying I'm C10 or whatever, but you are only one test away from not being and in Karamea it's quite likely you are going to get it. [C10 is] nothing to get excited by" (KF14, bTB status: infected, 230 cows)

In this context of disease unpredictability, C status lost its value to Karamea farmers. The inability to control the disease, combined with the problems associated with diagnostics, meant that C status was not a reflection on a farmers' ability, their commitment to biosecurity, or of the disease status of their cattle. Indeed, many farmers suggested that the amount of testing conducted in Karamea was more of an indication of the safety of the cattle than from other parts of the country. For these farmers then, there were minimal differences between herds rated C1, C5 or C10. As one farmer stated: *"There's nothing. Well it's only a number, yeah. I mean clear is clear as far as I'm concerned"*. As another farmer said, C status could provide no guarantees or guide to the problem of bTB:

"I'd say that if you are C10 now then it's probably down to more good luck than good management because it's become more of an issue over the last 10 years … and if people have managed to get

into that position, I'd say it's down to the area they are farming in more than anything and they should count themselves lucky really that they didn't get it" (KF15, bTB status: infected, 340 cows)

4.2.3. Local embeddedness

A third reason why C status failed to matter to farmers was that many had already adapted their business to deal with the consequences of an unexpected bTB breakdown. Given the history of bTB in Karamea, many farmers had long since adapted their businesses in order to live with disease and the problems it brought. Farming systems that involved breeding replacements rather than buying cattle, deliberately overstocking to cope with wastage from bTB tests, and not selling animals to other areas were established practices amongst the long-standing farmers in the area. However, farmers that had recently moved to Karamea did not always employ these tactics. Indeed, farmers' personal attachment to Karamea played an important role in creating these tactics and diminishing the meaning of C status. Most of the farms in Karamea are family owned and have been in the same family's hands for generations. Few, if any, of these farmers have plans to sell up and move away: the community is based on continuity rather than change. Moreover, the isolation of Karamea helps to keep farmers in the community. Farmers spoke of '*being here for the long haul*', whilst the isolation meant that farming had its own unique culture of self-sufficiency. Most farmers had all the machinery they needed and the distance from Canterbury meant that farmers adopted a '*make do and mend*' policy rather than wait several days for supplies to fix any problems.

In this social and geographical context, the importance of C status declined. The importance of place attachment and the practices adopted to cope with the loss of C status reinforced the effect of luck and chance and the lack of incentive to improve one's C status, as it said nothing of a farmer's ability or contribution to biosecurity citizenship:

"It would be nice but its not something I sort of dwell on, its just the way it is. It won't affect my income, it wont affect my way of farming if I was a C5. The cows might be worth a little bit more but Im not going to sell them so it's a low priority" (K7, bTB status: C1, 240 cows)

By contrast, for those farmers without ties to Karamea, and for whom expansion and development were significant motivations in farming, the impact to their C status from bTB was one reason why they may seek to move out of the area to farm. For example:

"Put it this way, one of the reasons for us to go, it would be imperative that we went to an area with C10 after being in a TB area because the opportunities to trade stock because of the technologies we've got with sexed semen and embryo transplants and the rest of it, to be able to rear more stock and make the farm more profitable then it'd be a major consideration to go to an area that has a long history of being clear for TB" (KF15, bTB status: infected, 340 cows)

Local farming practices have therefore evolved around the management of bTB that affect the ability of market instruments like C status to impact upon biosecurity citizenship. Karamea's isolation and the desire to contribute to and be part of the local community conspire to limit the meaning of C status in shaping biosecurity behaviour. This does not mean that achieving C10 is not seen as desirable, but that the specific conditions of bTB in Karamea mean that it has become increasingly irrelevant: the metrics do not fit the socio-spatial circumstances to which they are applied.

4.2.4. Trust and marginality

The marginality of farming in Karamea mediated the meaning of C status in other ways too. For Karamea farmers, C status had significance not just at a farm or local scale, but also at a national scale where it came to symbolise their marginality to national disease control efforts. To understand this national dimension to C status requires an understanding of the governance of the disease across New Zealand. Unlike much of the rest of New Zealand, the level of bTB on the West Coast remains high. For farmers on the West Coast, this situation is reminiscent of their relative isolation from the rest of New Zealand and raises concerns that they are not receiving their fair share of attempts to eradicate the disease. The fact that Karamea was extremely isolated – accessible only by one road and 100 kms from the nearest town the other side of a mountain – was of considerable concern to farmers. They could not understand why bTB was still a big problem despite the successful use of the same control mechanisms elsewhere in the country. Many thought that they had been abandoned by the AHB who had put Karamea in a 'too difficult box', preferring to invest in disease control in other areas. The failure to reduce bTB in Karamea and the West Coast worried many farmers that in its bid for bTB freedom, the AHB would somehow separate Karamea from the rest of the country. By removing Karamea from the bTB national statistics, this would allow the AHB to claim that New Zealand had eradicated the disease. For example:

"I do worry that as the rest of the country gets clear of TB they'll look at Karamea and think right that's moving up our average, we'll just close that off" (K1, bTB status: infected, 210 cows)

For these farmers, the C classification was therefore not a reflection on their own personal disease status, but reflected the national effort being put into managing the disease. C status did not suggest how many years a farm had been disease free, nor describe a farmers' commitment to biosecurity, but instead symbolised the extent to which they felt the disease was being successfully managed at a national scale and preserve their identity as farmers. Thus, in reflecting on the desirability of being C10, farmers viewed that status as being a proxy for the extent to which the problem was being dealt with as a whole, rather than being stuck in a cycle of reinfection:

"[Being C10] would mean that [the AHB] would be on top of TB, instead of getting towards C4 or C5 and then getting infected, and suspended" (KF9, bTB status: C4, 150 cows)

5. Conclusion

Market instruments and their metrological systems like C status have the potential to create forms of biosecurity citizenship and guide farmers' behaviour towards better disease management practices. In an era when neoliberal governance is replacing traditional forms in the governance of animal disease, such MIs fit perfectly with the ethos of voluntarism and deregulation. However, the reception of MIs on the ground and their role in shaping and farmers' biosecurity practices is not simple. At one level, C status in New Zealand is used readily by farmers to assess risks of cattle movements to and from different herd statuses. Farmers report C status creating value and shaping their behaviour directly and indirectly. The language of C status has been readily adopted by farmers and has become part of the everyday language of farming.

Yet, when confronted with C status, farmers do not always see the same meaning. This is because farmers' experiences of disease leads them to generate complex spatial understandings of disease in which disease risks are situated in a set of social, environmental and economic relationships. At a local level, farmers' place-based experiences of disease – the lack of certainties in testing and infection – and their embeddedness in the local community, places limits on the utility of market instruments like C to inspire biosecurity citizenship. It is not that farmers do not think biosecurity citizenship is important – far from it. Rather, in areas of high bTB incidence, C status is no accurate guide to who should have bTB or why they have got it. Aspiring to be C10 appears to be irrelevant: it no more reflects good or bad farming that it does pro/anti-biosecure citizenship.

At a national scale, C status therefore comes to reflect farmers' confidence in the disease control system as a whole. Rather than reflecting what it means for local farmers, C becomes a proxy for the effort that national bodies are putting into disease control in marginal places and the extent to which isolated communities remain part of it. In effect, C status is an indicator of the extent to which farmers feel they are part of a national disease eradication programme, or isolated from it – both physically and practically.

The case of Karamea is unique and further research is required to assess how animal disease MIs work in different disease contexts and farming systems. For example, how do RBTs function in low risk areas amongst large-scale commercial farms? Nevertheless, it is notable that the findings from Karamea also reflect other similar research. Firstly, studies of MIs for different agricultural policies likewise conclude that the adoption of MIs is context dependent and related to existing practices and institutional relations (Higgins et al., 2012). However, this analysis also demonstrates how different spatial imaginations of disease, and their embeddedness and attachment to place, influences the meaning of MIs and subsequent disease practice. In the context of disease management, at least, it is not so much that MIs are ignored, more that their meaning adapts to local circumstances. The extent of factors such as place attachment should be investigated for other MIs that relate to disease behaviour. Secondly, despite the unique circumstances of Karamea, farmers' understandings of disease share similar characteristics to those found in other studies of animal disease. In particular, the significance of luck and trust in government have been recognised in other studies in other countries, despite having different governance arrangements (Enticott, 2008). This suggests that encouraging farmers to adopt disease prevention faces systemic challenges relating to trust in government and the handling of uncertainty in diagnosing disease. Thus, whilst MIs may be part of a new neoliberal approach to managing animal disease, it is likely that policy makers will continue to face broader questions about how best to govern animal disease.

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