

Landfarming: A Contested Space for the Management of Waste from Oil and Gas Extraction

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Abstract

The extraction of unconventional hydrocarbons, particularly through hydraulic fracturing ('fracking'), has generated both support and opposition in many countries around the globe. Along with arguments about economic benefits, decarbonisation, transition fuels and groundwater contamination etc., the rapid expansion of this industry presents a pressing problem as regards the disposal of the resultant waste – including drilling and cutting material, oil and gas residues, various chemicals used in the process, salts and produced water. One putative solution – 'landfarming' – is a disposal process that involves spreading oil and gas waste on to land and mixing it with topsoil to allow bioremediation of the hydrocarbons. This paper examines the case of landfarming in New Zealand where the practice has proved controversial due to its association with fracking, fears about the contamination of agricultural land and potential danger to milk supplies. Drawing upon Gieryn's notion of cultural cartography and boundary work as well as the literature on the politics of scale it analyses the struggles for epistemic authority regarding the safety of landfarming. The paper concludes that scalar practices were central to the production of knowledge (and ignorance) in these credibility struggles, and that the prevailing cultural cartography of knowledge remained the arbiter and basis for policy. The case has wider implications in terms of the management of waste from unconventional hydrocarbons as well as other environmental issues in which the politics of scale figure in contested knowledge claims.

Key words: Boundary work, cultural cartography, fracking, landfarming, politics of scale

Introduction

Drilling for the exploration and extraction of oil and gas produces large amounts of waste that needs to be managed and disposed of. The potential health and environmental impacts of that waste are coming under increasing scrutiny by communities and regulatory authorities, amplified by the potential for hydraulic fracturing ('fracking')¹ to greatly expand the scale of exploitation from unconventional oil and gas resources (Ball et al, 2012; Maloney and Yoxtheimer, 2012; Measham et al, 2016). How such waste is dealt with is an interesting socio-geographical phenomenon, not least because it often involves a physical separation between the site of its production and the site of its disposal. This creates a new space in which the benefits and risks of both conventional and unconventional oil and gas exploitation are contested and debated.

'Landfarms', in which drilling and fracking waste is spread onto land and incorporated into the soil, are one such space. Their idealised use as "engineered bioremediation systems" (NSW EPA, 2014) to manage and dispose of waste often confronts a public concerned about safety. For example, expansion in exploration and production from shale gas fields across the USA has seen vast numbers of wells drilled. This has put pressure on the disposal of the solid and liquid waste produced, including on landfarms, with local residents, non-governmental organizations and environmental agencies questioning the practices used and regulatory effectiveness (ADEQ, 2009; Steinzor and Baizel, 2015; Rawlins, 2014).

Notwithstanding the more technically oriented research, landfarming has attracted little attention thus far amongst social scientists. In contrast, there is now a sizeable critical literature on fracking. For example, various authors have scrutinised the discourses and framings that shape and are shaped by debate on the topic (e.g. Dodge and Metze, 2017; Metze and Dodge, 2016). A common aspect across these studies is that the various protagonists, disputants, institutions and reports discussed, are involved, either explicitly or implicitly, in making and justifying knowledge claims. As Metze (2017: 48) observes, "knowledge and politics are intertwined in environmental

controversies”, with debates often dominated by contested facts – presumed knowable if not avowedly rooted in scientific research, and interpreted from a specific socio-political frame. These contests are played out within the processes and deliberations of regulatory authorities, in the media, and amid public debate and protest. Thus, cutting across the diversity of viewpoints, the surety of knowledge claims and what counts as evidence present notable, enduring and disputed features.

Taking this as our starting point, here we examine the debate around landfarming in New Zealand, where the practice has proved divisive, particularly because of associations with fracking waste. Our conceptual approach brings together two strands of analysis, each of which addresses the construction or framing of reality. The first is Gieryn’s (1999) notion of cultural cartography in respect of struggles for epistemic authority in science. This offers a sociological view of disputes in and about science and its relationship with other bodies of knowledge amidst credibility contests to account for different domains of reality. Second, we draw upon the conceptualisation of scale and in particular the politics of scale which has proved a fertile (albeit contested) area of debate in human geography (and related fields) over the past decade or so and highlights ways in which discursive constructions of scale serve as framings of reality that have political antecedents and ramifications (e.g. Jones, 1998). Though stemming from different disciplines it is worth noting an evident connection between these two theoretical perspectives: matters of scale frequently figure in the work of many scientific fields, either because of an emphasis on quantification and scales of measurement or the more general constitutive role of spatial concepts, metaphors and imaginaries in the framing of research problems and theory building (Cohen, 2012; Neumann, 2009; Swyngedouw, 2004). Scale frames and scale practices are thus an important feature of science and as such may be expected to figure in epistemic struggles over credibility. Aligning questions of scale with cultural cartography allows us to highlight the politics surrounding the governance of landfarming.

Considering landfarms as spaces whose boundaries, composition and properties are the object of contestation, we observe the discursive moves by which different

factions sought to marshal *the* facts in respect of the risks posed by landfarming and how matters of scale and political regulation/governance were deeply enmeshed within the arguments. Focusing on appeals to science/scientific knowledge among the different disputants involved, we examine the boundary work, the enactment of cultural cartography in the struggles for credibility with regard to landfarming. In particular, our analysis considers the scale practices involved in concerns over food safety, including contested sampling procedures related to waste residues in soil and milk. Although we focus on the case of landfarming in New Zealand we contend that it has broader relevance in terms of the management and regulation of oil and gas industry waste products, including those from fracking.² In the following sections we discuss the ideas of cultural cartography and the politics of scale in more detail before reviewing the practice of landfarming as an option for managing the waste from oil and gas exploitation. We then proceed to examine the controversy over landfarming in New Zealand.

Cultural Cartography

Rather than approaching science as a fixed monolithic institution Gieryn's approach offers us a more dynamic picture, one that emphasises the endemic struggles between different groups in contests over credibility, over the perceived "legitimate power to define, describe, and explain bounded domains of reality" (Gieryn, 1999: 1). Within any controversy or dispute in which scientific knowledge is invoked, a claim that a particular group has access to the facts implies that other groups do not: one speaks objectively for reality whilst others are seen to be trapped by outmoded ideas or lacking rigorous methods for example. The presentation of facts is, of course, frequently a major element of debate and the more that a disputant is seen to provide solid facts, the greater their potential credibility. In actor-network terms, knowledge claims may be made more robust by aligning more and more actants, including putative objective 'facts' (Latour, 1987). But facts do not speak for themselves, they must be framed as such and thereby presuppose boundaries; to be seen as independent or objective is to be separated from, for example, vested or partial interests.

Some groups might dispute specific claims by certain representatives of science (e.g. due to association with vested interests) whilst still affirming the possibility of better, more objective knowledge. This discursive differentiation between unbiased knowledge and partiality, between truth and falsity, between *us* and *them*, constitutes an instance of *boundary work* (Gieryn, 1999; Jasanoff, 1987). It offers the audience (e.g. the media, regulators, the lay public) a simple mapping – cartography – by which the path to objective/scientific knowledge can supposedly be navigated amid an otherwise confusing landscape of competing knowledge claims. In contexts of contestation then, the cultural boundaries of science become implicated in the discourse of various groups, “each trying to arrange cultural territories and landmarks into a map that best suits their interests and purposes” (Gieryn, 2008: 91) as they see them.

When it comes to disputes connected to the environment, the heterogeneity of actors involved can be prominent, with the struggles over knowledge and expertise presenting a commensurately complex picture. Here, science is frequently interpreted and evaluated in ‘extended peer communities’ not content to passively accept the knowledge provided by experts (Funtowicz and Ravetz, 2003). For instance, De Rijke (2013: 17) notes how some environmental groups have an “ambiguous relationship with science”, in particular when there is a clash between esoteric knowledge and local experience. On the other hand, some NGOs may procure, or even serve as co-producers of scientific knowledge for explicit public consumption (Eden et al, 2006). It is because of the potential complexity and confusion arising from the struggle for credibility regarding a given issue that an established cultural cartography may derive its appeal.

The notions of cultural cartography and boundary work emphasise the role of spatial metaphors in knowledge claims. However, the cultural map of knowledge and the boundaries that sustain it should not be reified (Eden et al, 2006), they are contingent, part of an ongoing negotiated order. Moreover, whilst acknowledging the critical responses to Gieryn’s take on science (see also: Berbrier, 2002; Brown, 2015; Kinchy

and Kleinman, 2003), it is important to point out that we are not concerned with the character of science *as such* but rather the *boundary work* inherent in the discursive ways in which science is invoked in public debate over the safety of landfarming and thereby how the struggle for epistemic authority is performative as regards its regulation. In short, *boundary work* has symbolic and material consequences (Berbrier, 2002), it constitutes an exercise of power.

The Politics of Scale

The discussion of scale in human geography, political ecology and related fields manifests a range of positions involving a variety of ontological and epistemological commitments and conceptual nuances. The literature on the topic has been the focus of multiple reviews (e.g. Herod and Wright, 2002; MacKinnon, 2011; Marston, 2000; Neumann, 2009). In particular, work on the 'politics of scale' has argued for the fluidity of scale and its social production in processes of political struggle between different actors and groups seeking to manipulate and control scale in pursuit of their interests (e.g. Cox, 1998; Smith, 1992; Swyngedouw, 2004). Within this literature, authors have drawn attention to the politics of environmental conditions and, in particular, the construction and contestation of appropriate scales of environmental governance or authority (e.g. Cohen, 2012; McCarthy, 2005; McCauley and Murphy, 2013). A key contribution is the inseparability of nature and society in processes of scale construction (Huber and Emel, 2009; McCarthy, 2005; Swyngedouw, 2004), and thus the consideration of non-human actants and biophysical processes (Neumann, 2009). Pertinent to our analysis is how the socio-environmental effects of oil and gas exploration and extraction, and the materiality of the waste produced, come to matter in the politics of scale (Boyle, 2002; Huber and Emel, 2009).

In this paper we draw on an approach in the politics of scale literature that is concerned with contending 'framings' of scale – particular interpretations of scale purposefully invoked to shape understanding and effect change (Delaney and Leitner, 1997; Kurtz, 2003). The discursive representation of socio-political struggles in terms of scale is consistent with a constructionist perspective in which scale is an

epistemological category – a way of knowing the world – rather than an ontological structure that simply reflects the world as it is (Jones, 1998; Marston, 2000). A key feature of this conceptualisation of scale relevant to our analysis is the notion that disputants in a controversy may strategically shift the scale at which an issue is framed in their arguments in order to secure their interests in, or stance on, that issue (Jones, 1998).³ Defining an environmental problem in different scale terms can extend or contract the frame of reference for the debate, justify particular levels of regulatory response or oversight, or render some solutions reasonable while eliminating others (Harrison, 2006; Kurtz, 2003; Lindseth, 2006; Mansfield and Haas, 2006). Such rescaling is not simply a discursive or rhetorical shift, but can have tangible consequences for processes and outcomes (Jones, 1998; Marston, 2000).

Viewing scale in epistemological terms casts light on how the framing of environmental issues might shape the scientific process and thus by implication knowledge. That is, the kinds of questions that are asked (or not asked) and how they are pitched in relation to specific levels of environmental governance (e.g. global, national, regional, district) shape the production of knowledge (and ignorance), which in turn has implications for policy (Kinchy, 2014; Mansfield and Haas, 2006).⁴ Shaping conceptions of reality, and thereby what is made visible and what is obscured, is of course central to the sorts of epistemic struggles over credibility highlighted by Gieryn. For example, as adumbrated by Kinchy (2014: 250) in respect of shale gas extraction in the USA:

scientific credibility contests have implications not only for what is known about gas drilling, but also which level of government has authority to govern the industry. Supporters and critics of gas drilling strategically work to shift the scale of political oversight in order to bring knowledge about the impacts of the industry to light, or ensure certain things remain unknown.

In summary, we contend that cultural cartography and boundary work, including the performance of scale, are intimately interwoven in the production of knowledge (and ignorance) regarding the risks of landfarming as a means of dealing with oil and gas

industry waste and thereby have important implications in terms of its regulation and governance.

Landfarming and its Regulation

Land treatment or land application, often known as 'landfarming', is a well-established *ex situ* treatment and disposal option for oil and gas waste (Maila and Cloete, 2004).⁵ It involves the controlled spreading of waste onto the land surface and its incorporation into the soil. The aim is to allow the dilution and natural attenuation of any contaminants in the waste (Ball et al, 2012) and has been used in a range of geographic conditions around the world (Tomei and Daugulis, 2013).

Waste from oil and gas drilling operations typically comprises drill cuttings – rock and other material brought to the surface, possibly containing heavy metals and radionuclides; drilling fluids – water, oil or synthetic based muds containing various chemical additives, acids and salts, and weighting agents such as barite, pumped down the well to cool and lubricate the drill bit, support and stabilise the well, and return cuttings to the surface; well work-over fluids and hydraulic fracturing return fluids; produced water from deep underground that commonly has a high salt content; and of course hydrocarbon residues from produced oil and gas. Drilling waste can contain a complex variety of hydrocarbons – including polyaromatic hydrocarbons (PAHs) and volatile organic compounds such as benzene, toluene, ethylbenzene and xylene (BTEX) – some of which are toxic and carcinogenic (Ball et al, 2012; MFE, 2014).

In landfarming, the hydrocarbons from drilling and fracking waste are lost through volatilization or are bio-degraded by naturally-occurring micro-organisms, such as bacteria and fungi in the soil. The time taken for this bioremediation process can vary substantially, being dependent on the molecular weights of the various constituents and a complex array of environmental conditions (Ball et al, 2012; NSW EPA, 2014; Vidali, 2001). Heavy metals in the waste are toxic and persist, but their concentrations can be kept to low levels by restricting the number of applications of waste on a given area of land. Although barite concentrations can be high, its relative insolubility

reduces its toxicity. High concentrations of salts may be toxic to soil biota and plants, but over time they are leached out of the soil (Cavanagh, 2015).

The process of natural attenuation may be assisted by irrigation to maintain moisture levels, periodic tilling to stimulate aerobic microbial activity, and the addition of supplementary minerals and nutrients (such as fertiliser). While landfarming is a relatively low-cost process with low technology input, it does require available land and is not suitable for waste with high concentrations of contaminants (Ball et al, 2012; Maila and Cloete, 2004; NSW EPA, 2014; Tomei and Daugulis, 2013). Landfarms are exposed to prevailing climactic conditions, including seasonal changes in temperature, rainfall and wind-led erosion. They need to be managed to ensure that the soil's capacity to bioremediate waste is not exceeded, and to prevent migration of contaminants into nearby surface or ground water, or into the air through vaporisation of volatile constituents. Concentrations of targeted contaminants are monitored to measure progress of the bioremediation process and against specified maximum levels for any intended future land use (Ball et al, 2012; NSW EPA, 2014).

Landfarming of drilling and fracking waste in New Zealand has occurred predominantly in the Taranaki region, on the central west coast of the country's North Island, which has a history of oil and gas exploration. An average well in Taranaki produces an estimated four thousand cubic metres of drilling waste (RNZ, 2013c), which is transported to and spread on landfarms in the region, typically on marginal agricultural land, such as sandy, erosion-prone coastal sites. The waste is applied to a spreading area from which the topsoil has been removed and stockpiled. After the waste has dried, it is tilled into the subsoil. The removed topsoil is then restored, before the area is fertilised, re-sown and brought into pasture. To date, the process has comprised a single application of waste to a designated treatment area. In addition to disposing of problematic waste, the landfarming process is seen to improve the soil, potentially making marginal land more stable and productive (TRC, 2013).

In New Zealand, as internationally, the landfarming of oil and gas waste is subject to environmental regulatory compliance. Under New Zealand's Resource Management

Act, regional councils are responsible for controlling discharges of contaminants to the environment, such as drilling wastes and fracking fluids, while city and district councils control the effects of land use (TRC, 2013). The resource consents or permits granted by these authorities for landfarming typically focus on the suitability of the proposed application site, transport and storage of the waste, the volume of waste and contaminant load applied to a particular land area, the method of waste application and mixing with topsoil, the control of movement of contaminants to groundwater or surface watercourses, and the monitoring of salinity, metal and hydrocarbon levels over time. The levels of these contaminants have to fall below specified soil endpoints before the granted consents expire or are surrendered (Cavanagh, 2015; MFE, 2014; TRC, 2013). The Taranaki Regional Council issued its first landfarm consent in 1996. Its landfarming consents and monitoring process is based on practices established in Alberta, Canada (AER, 2016), but adapted to the Taranaki coastal environment (TRC, 2013). In 2013, there were twelve consented landfarming sites in Taranaki, although five of those were no longer taking waste for disposal (RNZ, 2013c).

Debating Landfarming in New Zealand

Method

Our analysis of landfarming in New Zealand focuses on escalating public concerns and the various regulatory responses that occurred between 2011 and 2015. It is based on our critical reading of a corpus of texts collected from a wide range of publicly available documents pertinent to the controversy. These included official reports and records of various relevant central and regional government agencies; newsletters and press releases from industry and advocacy groups that became interested in the issue; print and broadcast media coverage. The various texts were assembled in chronological order. This allowed us to map out and create a timeline of the events surrounding the emergence of fracking and landfarming as issues of public concern, together with the various regulatory responses to them. Based on this we constructed an initial narrative of the landfarming controversy in New Zealand, which anchored our subsequent analysis and served as a reference tool with which to make sense of individual texts.

The chronological ordering of our data also enabled a juxtaposition of the accounts of particular events from different actors. We examined each text to establish the actors involved, their stated interests and concerns, and the arguments that they articulated in relation to fracking and landfarming. From this initial process, it was apparent that both proponents and opponents of landfarming were engaging in a debate over the ‘facts’ of landfarming, and that it could be analysed in terms of a contest over credibility. We then conducted more detailed coding to identify how different actors invoked science and other forms of knowledge in their discursive contestation over the safety of landfarming and efficacy of its regulation. As we proceeded, we identified concepts of scale implicated in some of these arguments, leading us to pinpoint both the framing and shifts of scale involved.

Origins of the Debate

Landfarming first came to public attention in New Zealand in 2011, when it was linked to the controversial practice of fracking (Rennie, 2013). At that time, fracking was receiving increasing media attention due to rising concerns about the environmental risks and potential health impacts of fracking operations, particularly amongst environmentalists, and fuelled by popular reception of the 2010 US documentary, *Gasland* (Saunders, 2011). The New Zealand Parliamentary Commissioner for the Environment would soon commence an investigation into the environmental risks associated with fracking, eventually producing two reports that expressed concern about the state of oversight, regulation and monitoring of fracking, including the disposal of associated waste (PCE, 2012, 2014).

While some New Zealanders are upbeat about the benefits of an expanding oil and gas industry for national and local economies (e.g. Venture Taranaki, 2015), others are less sanguine, fearing that much of the economic benefit will bypass regions, leaving the costs and adverse effects to be borne by local communities (e.g. RNZ, 2014a) – a “scalar mismatch” in the distribution of the industry’s costs and benefits (Huber and Emel, 2009: 374). In particular, some Māori have expressed environmental and cultural concerns; for example, the risks to waterways and wāhi tapu (culturally significant

sites) (Māori Television, 2013), or the cultural offense in transferring drilling waste from outside the region to Taranaki landfarms (RNZ, 2012).⁶

At the beginning of 2011, a local community group, Climate Justice Taranaki,⁷ became active in opposing the expansion in drilling for oil and gas in Taranaki, and in particular the practice of fracking. Under pressure from Climate Justice Taranaki, supported by the Green Party,⁸ the Taranaki Regional Council admitted that it did not require resource consent for fracking operations and consequently did not know the identity or volume of chemicals being used in fracking (CJT, 2011; Green Party, n.d.). Nor were fracking fluids being specifically identified in landfarming consents as they were treated as general drilling waste (PCE, 2012). Subsequently, in mid-2011, the Council changed its practice, requiring the future disposal of wastes arising from fracking activities to be explicitly consented. By 2013, only one landfarm in the region had been consented to dispose of fracking return fluids, deep well injection being the preferred disposal method (TRC, 2013).

Contested Food Safety

In June 2013, landfarming became national news when a primetime television programme revealed that Fonterra, New Zealand's largest dairy producer, was being supplied with milk from Taranaki farms on which landfarming was practiced. The programme framed the co-location of oil and gas operations in Taranaki, including landfarms, alongside dairy farming as a potential food safety issue: "Do we want to drink milk ... from what is essentially an industrial landfill?" (TV3, 2013). The Green Party was quick to respond, calling for Fonterra to suspend the collection of milk from landfarms and highlighting the reputational risk to the New Zealand dairy industry "as producers of safe, clean food" (Green Party, 2013). In doing so, the Green Party discursively 'scaled up' the issue from a regional level to a national and even international level, drawing attention to the possible consequences for all New Zealanders and the country's dairy export markets. For example, the Green Party's Russel Norman featured in the television programme, pointing out: "It's very simple when you look at it from the point of view of the new parent who's feeding their

children infant [milk] formula” (TV3, 2013), and then arguing, “Our clean, green image is worth billions for our food exporters ... Grazing our dairy cattle upon the waste of the oil industry is a risk to our [national] brand” (Norman, 2013). Similarly, his colleague Gareth Hughes, Green Party MP, later commented, “I think that many consumers *around the world* would be horrified to find we’re putting oil and gas waste from the fracking process on dairy farms” (RNZ, 2013d, our emphasis). This shift in scale effectively increased the stakes associated with the perceived risks of landfarming in Taranaki.

Fonterra initially expressed confidence in the regulatory process, stating that landfarming posed “no risk to the integrity of the milk” (TV3, 2013). However, several weeks later it announced that it would not issue any new contracts for milk from dairy farms that included landfarming of oil and gas waste. In changing its terms and conditions of supply, the company cited the inconvenience and cost of testing the milk for contaminants, but also acknowledged that the perception of a safe and clean dairy industry was a factor in its decision (RNZ, 2013a). The decision was greeted with dismay by the oil and gas industry, which offered to pay for the testing (Ewing, 2013c), and by the Federated Farmers of New Zealand.⁹ The latter accused the Green Party of “scaremongering” (Ewing, 2013a) and suggested that Fonterra had “taken a knee-jerk reaction to concerns over the practice” (RNZ, 2013a).

As one of the main regulatory actors in the case of landfarming, the Taranaki Regional Council commissioned a range of investigations intended to help establish the safety of the practice as a waste disposal process. In public debate it was able to invoke these studies as scientific evidence in support of its position, simultaneously justifying the legitimacy of its processes and actions around landfarming and its independence from the oil/gas and farming industries. For example, in responding to Fonterra’s announcement that it would not take milk from further landfarms, the Council was reported as “maintaining its confidence in its science-based approach in regulating landfarming activities” (Ewing, 2013c) and declaring “Fonterra has responded to fear and perception about contamination and not science” (Locke, 2013).

Industry groups with an interest in landfarming were also keen to mobilise the authority of science in defence of the practice. In relation to the Fonterra announcement, the CEO of the Petroleum Exploration and Production Association New Zealand (PEPANZ) was quoted as saying, “Fonterra have categorically said the milk is safe, science tells us” (Ewing, 2013c). From the farming community, the Taranaki representative of Federated Farmers, Harvey Leach, stated, “Let me be clear, because the science is crystal clear – there is no issue” (Leach, 2013), whilst a Taranaki dairy farmer was reported as saying that “Fonterra is using emotion rather than science as a basis for its decisions” (RNZ, 2013b).

The contrast drawn between science and emotion or fear is a discursive move intended to enhance the credibility of a particular, *scientific*, position by demarcating and discrediting the opposing claims (Metze, 2017). It differentiates between the purported objectivity of science and the alleged subjectivity of non-scientific arguments. We can see this illustrated further when the Federated Farmers representative quoted above commented on the Green Party’s call for Fonterra to boycott milk from landfarms: “We are hitting new lows ... when the sum total of a political party's *research effort* is a television news segment” (Ewing, 2013a, our emphasis); and on the next day, “You are often asked for facts and reports, evidence, to back up what you are saying. That same standard doesn’t seem to apply to those taking pot shots at those ‘involved/qualified’ on an issue” (Leach, 2013).

It is clear that Mr Leach believed that the Green Party had no authority or expertise to speak about landfarming. While he and others “involved/qualified”, including the Taranaki Regional Council, marshalled facts, the Green Party was no better than a “conspiracy theorist” (Leach, 2013). Similarly, a Council representative also questioned the authority of the Green Party spokesperson, saying, “I’m not sure what technical competence Russel Norman has to challenge agricultural guidelines” (Ewing, 2013a). Leach also specifically cast doubt on Russel Norman’s qualifications to speak on landfarming. However, he did so by drawing on a different cultural authority to science – that of practical experience: “Now I ... assume he has never handled a post-hole

borer ... As a farmer, I know cattle are incredibly sensitive to contaminants, yet the ones I have seen on landfarms appear to be thriving” (Leach, 2013).

Mr Leach is close to the land – a farmer who “know[s] cattle”. The supposition here is that his practical knowledge of farming (Bickerstaff and Simmons, 2004: 394) and his connection to the region make him more “involved/qualified” in relation to landfarming than Norman, a politician based in the nation’s capital city. Leach’s cultural authority as a farmer is able to co-exist alongside the enrolment of science in his arguments. In terms of cultural cartography, the relative cultural positioning and standing of different areas of knowledge, the discursive move evident here places practical farming knowledge distant from the politics and associated knowledge claims of the environmentalists and by implication closer to science. The focus on the level of the farm further justifies this particular form of cultural expertise and its relevance to the problem being debated. Also noteworthy here is the evocation of the “thriving” cattle, the vitality of the animals symbolising the healthy condition of the landfarm. Aligning these (independent, politically neutral) actants with the claims being made grounded them, thus potentially added to their credibility.

Invoking a quite different performance of scale, in a media stunt reminiscent of the UK agriculture minister feeding his four-year-old daughter a burger to demonstrate the safety of British beef in the BSE ‘mad-cow disease’ crisis (Brown, 2000), one dairy farmer was shown drinking “a glass of milk fresh from the vat on his South Taranaki farm ... to illustrate the safety of his milk, despite it being taken from cows grazing on pasture where [drilling] waste ... has been spread” (Ewing, 2013b). The boundary work involved here implied that the fear associated with the allegedly transgressive or dangerous mixing of categories – that is, extractive/fracking waste and agriculture – was without substance. The symbolism of this action also implied a dramatic shift in scale, with the health of the farmer supposedly standing in for the safety/health of the wider milk consuming public.

Contested Soil Samples

In September 2013, the Taranaki Regional Council released a report on landfarming (hereafter referred to as the Edmeades report) that it had commissioned from a soil and pasture consultant, who examined whether the modified soils of three former landfarms subsequently being used for dairy or dry stock farming were 'fit for purpose'. The report concluded that:

The concentrations of: nutrients (macro and micro), heavy metals and soluble salts in these soils and pasture are similar to normal New Zealand soils. The form of barium present is as environmentally benign barite, and there is no evidence of accumulation of petrochemical residues.

(Edmeades, 2013: 2)

A Taranaki Regional Council representative claimed that Dr Edmeades' findings were scientific vindication of the Council's policy on landfarming: "We're satisfied we're getting the science right" (Ewing, 2013d). Similarly, a Federated Farmers media release embraced the report under the headline, "Science validates Taranaki landfarming", with Mr Leach quoted as saying, "We now have a robust independent scientific report saying that landfarming is not only safe but can be environmentally positive. That's why we need to base discussion on hard facts and evidence and not for short-term political gain" (Federated Farmers, 2013). Again, the epistemic authority of science was invoked alongside his practical knowledge as a farmer:

Being a farmer, I know that earthworms are a strong indicator of soil health and Dr Edmeades found them in large numbers. That's a key thing for me because he described earthworms as a soil scientist's 'canary in the mine' (Federated Farmers, 2013).

As with the "thriving" cattle, it is worth noting that the reference to earthworm activity – "the 'canary in the mine' with respect to soil biological activity" (Edmeades, 2013: 5) – again imputed a voice to nature as it were; one that stood as apparent testimony to the health of the soil at the landfarms. As suggested by the positive response of Mr

Leach, it was a reference that might strike a chord with the farming community. The abundant worms in the soil and the thriving cattle grazing on the pasture, represent different but interconnected ecological 'levels' that together indexed the apparent safety of landfarming.

In his commentary on the Edmeades report, Leach also devoted a paragraph to establishing the scientific credentials of the report's author: "Dr Edmeades is a scientist who has completed [a prestigious] Fellowship and was [a] National Science Program Leader ... an expert in his field" (Federated Farmers, 2013).¹⁰ However, in subsequent media coverage of his report, Dr Edmeades found himself having to defend his scientific practice. When asked on national radio if his work had been peer reviewed (as a consulting report, it was not), he expressed his willingness to be judged by this scientific norm: "It is out in the public domain ... That's part of the science process ... I hope it'll stand up to rigorous peer review. That's what you expect as a scientist" (RNZ, 2013e). In the same radio news item, Dr Edmeades emphasized his scientific approach to the findings from his analysis:

I found everything so normal that I myself was surprised, but there's the data ... As a scientist, you say, 'Well, I might intuitively think this, but let's go capture the data, and look at that', and that overrides any preconceived notion I might have. (RNZ, 2013e)

In a television news item, Dr Edmeades was reported as saying that landfarming opponents were "ignoring science" and in interview he stated: "It seems that the environmentalists are simply opposed to any progress. Now, to me that's an anathema" (Ray, 2014). In discussing the Edmeades report other parties also emphasised the boundary between science and non-science, including intuition or emotion. For example: "if we could not rely on science that was available, then we could not rely on the emotional claims being made about land farming" (Taranaki dairy farmer cited in Rennie, 2013).

What can be discerned in the line of argumentation running through the various comments is an emphasis on objectivity, the independence or "value-freedom" (Kinchy

and Kleinman, 2003: 872) of the observer/scientist, not to mention progress (Gieryn, 2008). It upholds the familiar separation between science and politics, between facts and emotion or politically biased distortions. That landfarming was endorsed by someone who was seen to be an independent scientist, someone who expected to find problematic residues but did not, authorised the practice. Indeed, because it was an independent scientist saying that landfarming was ‘fit for purpose’ the report might not be seen to have been captured by the vested interests of the oil and gas industry, farmers, or the Regional Council.

Turning now to some of the opponents of landfarming, Climate Justice Taranaki bemoaned the absence of scientific peer review of Edmeades’ work (CJT, 2014). Green Party MP Gareth Hughes was interviewed on national radio on several occasions, questioning the adequacy of the Edmeades investigation:

With all due respect to Mr Edmeades, however, his report is a joke. The terms of reference were flawed. As you pointed out, it didn’t look at offsite environmental impacts and when you look at the testing sample size it’s absolutely tiny ... Dr Edmeades only looked at 8 soil samples across 4 sites ... Had we have used Canadian guidelines, given the size of one of these land farms – the Geary land farm is in fact 30 hectares – [then] what we should have seen is around 1200 samples taken across that single land farm. So the testing sample was incredibly tiny ... Dr Edmeades comes to the conclusion, from a very limited sample... (RNZ, 2013f, our emphasis)

The mention here of Canadian guidelines refers to the Alberta regulations governing the management of oil and gas industry waste (AER, 2016), and in particular the contaminant monitoring regime stipulated there. Taranaki Regional Council officials had previously stated that they had followed this ‘best practice’ guidance in consenting landfarming. A similar critical stance was taken by Climate Justice Taranaki which issued a media release commenting on the lack of consideration of off-site environmental effects and the small sample size, and that “only three completed landfarms were examined” (CJT, 2013).

At the heart of the criticism here is a notion of scientific methodology and the inadequacy of Edmeades' sampling regime – both in terms of matters of scale and the validity of inferences that might be drawn from it. By definition, sampling involves a scale frame, inferences about, for instance, a population or space conceived at a given scale are made on the basis of a subset or fraction of the assumed whole. As far as Edmeades' critics were concerned, his sampling technique (comprised of eight samples) was flawed when judged against the Taranaki Regional Council's own guidelines for monitoring landfarms. The critics questioned whether one could validly scale up the findings from such a limited set of samples to claim that they represented a landfarm in general (especially one with a heterogeneous distribution of wastes). Edmeades examined soil and pasture samples from only completed landfarms and did not consider off-site effects. Thus, while he might conclude that land returned to pastoral farming after several years following landfarming was 'fit for purpose', similar inferences about landfarming more generally – evident, for example, amongst supporters of the practice including the Taranaki Regional Council – could not be sustained by his report.

Perhaps more importantly, however, drawing attention to test results from the specific space of a landfarm inevitably masks the lack of information about the environmental effects beyond – for instance runoff into waterways or onto adjacent land.

Accordingly, it wasn't just the sample size that limited the sort of knowledge produced by the Edmeades' report but also the specific history of waste application at the sites concerned and the restriction of the analysis to on-site residues. But if scale is an epistemological category (Jones, 1998), it is also inherently political because whether a given report produces ignorance rather than knowledge, either way it constitutes an exercise of power (Swyngedouw, 2004), a matter that is of particular relevance when such work is seen to have direct policy implications.

Clearly, how the scale of a problem is framed is crucial in shaping the kinds of questions that are asked, the types of knowledge claims that are considered relevant, the sources of expertise that may be brought to bear on the problem (Kinchy, 2014), as

well as the spatial practices used to produce empirical knowledge (Bickerstaff and Simmons, 2004). When Taranaki Regional Council commissioned the Edmeades report, the task was simply described as determining whether the soil of the modified land was fit for pastoral farming. Framing the scale of the problem in this way legitimated the use of a farming consultant and the proximate scientific spatial practice (Bickerstaff and Simmons, 2004: 408) that he employed, including perhaps the somewhat pragmatic sampling regime.

In contrast, those critiquing the report framed the issue in international terms, contending that: “New Zealand deserves to be protected by world class regulation” (RNZ, 2013g). As Hughes argued: “It’s fair and reasonable for New Zealanders to demand best practice. This is a risky activity ... We should be looking *around the world* and making sure ... [Leaving] the industry to self-regulate. Clearly that’s not best practice” (RNZ, 2013d, our emphasis). In this way, the notion of ‘fit-for-purpose’ becomes supplanted by that of ‘international best practice’, and the very guidelines that the Taranaki Regional Council claim to follow are used by opponents of landfarming to demand a different scientific spatial practice involving a dramatically larger number of soil samples, “1200”, rather than the “8” taken for the Edmeades report.

Contested Milk Samples

Dispute about the measurement of waste residues in landfarming represents just one facet of the uneasy juxtaposition of agriculture and the oil and gas industry. As we have seen, another arises with respect to food products connected to land involved in the process. Milk associated with landfarming and all the negative symbolism that it might imply presented not just a potential marketing problem (as noted earlier) but, as things turned out, an epistemic one too; another case of contested scientific credibility in which sampling and its associated scale practices came under scrutiny.

In late 2013, the Ministry for Primary Industries, which has statutory responsibility for animal welfare and food safety issues in New Zealand, indicated that it intended to commence monitoring of milk from Taranaki landfarms to assess possible chemical

contaminants (RNZ, 2013g). In 2014, the Ministry published its report on the safety of milk from landfarms. The report found very low levels of barium and some hydrocarbons, concluding that “these did not represent a risk to consumers” (MPI, 2014: 2). It also suggested that there was no evidence that these residues resulted from exposure to drilling or fracking waste. However, the reassurances proved short-lived when the report’s scientific credibility was questioned: “Scientists at Massey University are concerned at what they say is a lack of scientific rigour in a government report that stated milk from Taranaki’s oil industry waste farms is safe” (RNZ, 2014b).

One of the scientists (based in the Centre for Public Health Research) was reported as saying that the Ministry’s “theory” that the low levels of contaminants detected in some milk samples did not come from landfarmed oil and gas waste “was conjecture and speculative”, and that the Ministry “needed to reference peer-reviewed science if it wanted its theories to appear credible” (RNZ, 2014b). Once again peer review was evoked as a landmark in the cultural cartography of knowledge. The Massey scientist argued that the “limited testing” presented in the Ministry’s report was insufficient evidence on which “to fully support and justify” landfarming (RNZ, 2014b). One can perhaps detect here a concern that the (political) use to which the report was put exceeded the adequacy of the scientific methodology on which it was based.

A similar concern was voiced a month later by another “senior Massey University veterinarian”, who suggested that the Ministry’s conclusion that any contaminants found in the sampled milk were not from landfarmed waste “seemed to be a predetermined conclusion ... that the report set out with that objective in mind ... [something] really quite concerning” (RNZ, 2014c). Furthermore, this veterinary scientist produced a critical commentary on the report for Climate Justice Taranaki (Thatcher, 2014), thus indicating the group’s observance and implicit acceptance of the prevailing cultural cartography of science. Thatcher’s analysis raised methodological points in relation to the adequacy of the sampling: in particular, a lack of control farms in the study; the timing of the samples in relation to the annual grazing and lactation regime of the cows involved; the decision to test milk but not meat; and the specific

chemicals that were tested for and thus those that were not, including potentially problematic metabolites produced by waste contaminants.

In fact, when questioned by a Parliamentary Select Committee in 2015, the Ministry for Primary Industries conceded that the milk tested had not necessarily come from cows that had grazed specifically on landfarmed areas of the properties sampled. Thus, the testing “provided a snapshot of the milk quality from cattle *potentially* exposed to landfarming property at the time of sampling” (MPI, 2015a: 86; emphasis in original). The choices involved in the sampling regime adopted in the study behind the report constituted a particular form of framing and scalar practice that had important implications in terms of the knowledge produced (or not). Not to mention political ramifications in terms of the regulation of milk supplies and landfarming, together with the concomitant effort to reassure the food industry and consumers as to the safety of milk from cows on landfarms. Though framed in scientific terms it would seem that the credibility of the Ministry’s report was in danger of unravelling.

Discussion

The question of where epistemic authority lies in the case of landfarming would seem to depend on who one listened to. Although proponents and opponents alike saw science in a similar way, as the ultimate arbiter of knowledge (Jasanoff, 1987), they differed as to whether specific claims about landfarming made in the name of science stood up to proper scrutiny. Accordingly, proponents of landfarming looked upon the various processes surrounding its management as scientifically sound, the hegemonic position occupied by science justifying and upholding the safety and benefits of landfarming. In contrast, those opposed drew no such conclusion, protesting a failure to adhere to appropriate standards for producing scientific knowledge and suggesting that “the best available science” (Metze and Dodge, 2016: 367) had not been used. Similarly, each party to this dispute accepted a dichotomy between science and politics (Jasanoff, 1987). When politics, vested interests, or perhaps simply flawed methodology, are seen to get in the way of doing science, the production of knowledge may appear corrupted or distorted.

Throughout the various discursive machinations, the prevailing cultural cartography with respect to science remained intact. For whilst challenging the epistemic authority of the specific reports, the critical responses of the environmentalist groups nonetheless affirmed the possibility of better, more objective knowledge, grounded in more adequate research designs, sampling frames and peer review. Demands for the application of science in the policy process reflect the assumption that its discipline will hold the research behind regulatory decisions to the same scientific standard (Jasanoff, 1987). Moreover, Climate Justice Taranaki's eliciting of the commentary by the veterinary scientist at Massey University concerning the report on contaminants in milk can be seen as illustrating the active role of this NGO in the production of scientific knowledge (Eden et al, 2006.) Not just being critical on the side-lines, they helped to shed light – knowledge - on the assumptions and methodological difficulties involved in trying to ascertain the safety of milk from cows grazing on landfarms. The relationship between such environmental groups and established scientists might be seen not only in terms of reflexive modernisation (Beck, 1992) but also indicative of the growing complexity of the cultural map of knowledge as more and more diverse organisations become engaged in environmental matters.

That the stance taken by environmentalist groups embraced the need for scientific knowledge indicates how their struggle for any kind of political authority depended on accepting the prevailing cultural cartography. To be taken seriously politically, the environmentalists had to be serious epistemologically. Aligning themselves toward science bolstered their credibility in terms of landfarming as well as their political capital. The media too also took the prevailing epistemic authority of science as given, with the struggles for credibility lending themselves to a reporting frame of dramatic/adversarial narratives.

Equally, in the case of landfarming, scale was important in framing the level at which processes of oversight and governance should operate. The evolution of landfarming in New Zealand as a local and regional activity meant that when it became the subject of public attention various government agencies were content to delegate responsibility

and expertise to the Taranaki Regional Council as the appropriate regulatory authority. Similarly, supporters of the practice were able to focus attention at the local level of the farm and individual farmer. However, as the debate over the appropriateness of landfarming and the subsequent use of landfarmed areas for agricultural production intensified, opponents such as Climate Justice Taranaki and the Green Party discursively framed the scale of the landfarming problem at a national and international level, thereby hoping to also shift the scale of political oversight. Arguably, we can say that these groups enjoyed a degree of success in doing so. For example, the Parliamentary Commissioner for the Environment appeared to be a receptive audience for their concerns, citing evidence provided by them in her report (PCE, 2014), while both the Ministry for the Environment and the Ministry for Primary Industries eventually issued national guidelines – on managing the environmental effects of onshore petroleum development activities (MFE, 2014) and ensuring animal welfare and food safety after landfarming (MPI, 2015b), respectively. While these guidelines fell short of the regulatory regime or end to landfarming hoped for by its opponents (Harvey, 2015; RNZ, 2016), arguably they were a tangible consequence of the rescaling of the landfarming problem.

Conclusion

This paper has drawn upon the concept of cultural cartography and work on the politics of scale to investigate the controversy concerning the landfarming of drilling and fracking waste in New Zealand. Following the discursive moves, scalar framing and associated boundary work between the various antagonists, we argued that within the ensuing epistemic struggle different sides publically upheld a commitment to scientific authority as arbiter of knowledge and basis for policy. We discussed two instances of contested epistemic authority involving reports concerning the possibility of waste residues in soil and in milk. The question of waste residues presented a problem of visibility, requiring sampling expertise and laboratory analysis in order to ascertain what the levels might be. But the resultant knowledge was partial insofar as it depended on the particular scalar framing/practices employed and their associated assumptions. In each case the reports drew attention to some aspects of residues from

landfarming and simultaneously obscured others, in a sense producing both knowledge and ignorance.

Questions of geography, knowledge and scale appear inextricably intertwined in the regulation of landfarming and by implication the wider dispute over fracking. Even if the waste produced from wells may be environmentally manageable at a local level, a question arises as to what would happen should drilling (or fracking) be scaled up to a major industrial operation? There have already been suggestions that Taranaki is running short of space for landfarming unless it extends the practice to new sites or allows multiple applications of waste on existing sites. Furthermore, waste from exploratory drilling on the east coast of New Zealand's North Island has been trucked to Taranaki for disposal because its geology is seen as the more suitable. However, the Parliamentary Commissioner for the Environment (PCE, 2014) has made quite clear that should those operations be expanded at some point this solution would not be tenable. Thus, the question of scale would seem to be pervasive, with the limits to safe waste disposal constituting an important consideration that pertains to other places beyond New Zealand, including the exploratory fracking sites recently approved in the UK. That scalar practices were at the very heart of the struggles for credibility in the case of landfarming indicates the utility of the conceptual approach taken here. Melding cultural cartography with the question of scale might also prove useful in investigating other environmental disputes in which knowledge/science is contested.

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Notes

¹ Hydraulic fracturing involves the high pressure injection of large volumes of fluid containing a proppant (usually sand or ceramic beads) and various chemical additives into an existing well in order to fracture the surrounding rock formations and extract oil and gas.

² Of course, this claim to the broader relevance of our study itself has scalar connotations.

³ We refer to actors 'shifting' scales, rather than 'jumping' scales (Smith, 1992) as we wish to emphasise not so much how actors 'relocate' or move between scales of operation, but rather how they (re)produce scale differentially in their socio-political praxis (Herod and Wright, 2002).

⁴ Equally, scientific knowledge claims may be central to particular scale framings.

⁵ Sometimes a distinction is made between 'land spreading' – a single application of waste to the soil, and 'land farming' – repeated waste applications to the same land area (Ball et al, 2012). Here we use the term 'landfarming' generically as that is how the process is referred to in New Zealand.

⁶ Māori are tangata whenua, the indigenous people of New Zealand, with an ancestral relationship to the land and environment. However, the picture is complex, with some individuals and local groups willing to engage with aspects of the oil and gas industry. While Māori perspectives do not feature in our analysis here, they remain the subject of our ongoing research.

⁷ While locally based, the group clearly sees itself as connected to a national and global movement concerned with climate change more generally (www.climatejusticetaranaki.info).

⁸ The Green Party of Aotearoa New Zealand (www.greens.org.nz) is a left-wing political party formed in 1990. It currently has 14 MPs sitting in opposition, and is part of the international network of Green parties.

⁹ Federated Farmers of New Zealand (www.fedfarm.org.nz) is an established farming advocacy organisation, with elected representatives from 24 provinces.

¹⁰ In contrast, one critic of his report highlighted Dr Edmeades' position as an anthropogenic global warming sceptic in an apparent attempt to marginalise his status as a scientist (Cheung, 2013).

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