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Navigating futures: Anticipation and food supply chain mapping

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This paper examines the use of supply chain mapping by actors in the UK food system to anticipate problematic futures. Supply chain mapping as an anticipatory practice is a response to a recent food scare that has reinforced concerns about the safety, quality, and authenticity of foodstuffs circulating within supply chains. Our analysis of this novel set of mapping practices is based around the visibility of the supply chain that they offer and the ways in which this is generated or made to relate to future problems as both objects and processes. Supply chain maps as objects can induce surprise and uncertainty over the future, but they can also demonstrate responsibility for risk or be a means of allocating and assuring accountability for future problems. Looking at mapping as a process highlights both the difficulty of mapping supply chains and what is actually involved in using supply chain maps to give form to potential future problems. We characterise both of these processes as navigational, based on creating and reading "signposts" that allow risky food futures to be plotted as trajectories in space and time. Supply chain maps describe a process as well as a set of spatial relations, and navigating futures with these maps is a skilled task involving accumulated knowledge about food risks and learning to recognise supply chain maps as encompassing time and space. Our analysis highlights how things not made visible by the map, but present through those involved in the mapping, are as important in its anticipatory use as the things made visible. Maps are part of a wider process of making sense of risky food chain futures that is filled with uncertainty and power relations.

KEYWORDS
anticipation, mapping practices, maps, risk, supply chain mapping, UK food system

1 | INTRODUCTION – RISKS IN THE PIPELINE

In a basement room of a Westminster conference centre, a group of food systems experts are gathered for a final feedback session on the day's tasks. Academics, policymakers, and regulators, along with food industry managers, consultants, and trade body representatives, have been asked to identify and assess a range of threats to the UK's food supply. A representative from one of the "big four" supermarkets voices a concern: We have been talking about different problem sources and impacts, but we have not been talking about the supply chains that connect them together. Working with supply chains, notes the speaker, helps us to understand the complexities of risks in the "pipeline."

Supply chains are the infrastructural form of a globalised food system, generating and governing flows of materials, information, and people. As such they are seen as "vital and vulnerable" and requiring protection (Cowen, 2014). But

supply chains are not just at risk, they are also generative of risk. While a constantly circulating food-supply is the key function of supply chains, foodstuffs themselves can become risky, freighted with potential problems for food businesses and consumers. Is the food free from pathogens or other harmful contaminants? Does it meet specified standards for ingredients and production processes? Is it what it purports to be (the right species of meat, the correct country of origin)? These questions concerning the safety, quality, and authenticity of food in the supply chain are increasingly considered together as matters of "food integrity" (Hoorfar et al., 2011) because the problems frequently materialise together. Fraudulent species substitution may introduce contaminants because the animals were not intended for the food chain (e.g., veterinary medicine residues in meat from race horses), or because criminals do not follow hygiene and safety standards. The possibility of these problems occurring and impacting on those further down the chain means that food supply chains are conduits for uncertain futures: the risks in the pipeline. Other spatial metaphors for food supply chains are intended to demonstrate a collective responsibility for food integrity, from production to consumption, such as "farm to fork," "stable to table" and "gate to plate" (Paul, 2012). Maps, especially with the widespread availability of GIS, have been suggested as a way to provide improved food chain visibility in order to help manage food risk (Thompson, 2015).

Our main aim in this paper is to offer a theoretically informed account of food supply chain maps as a means for managing problematic food integrity futures. We analyse supply chain maps as forms of spatial-temporal imagination and visualisation that we characterise as combinations of mapping practices (Kitchin & Dodge, 2007) and anticipatory practices aimed at making the future present (Anderson, 2010), describing the different ways in which visibility is connected to futurity – discursively and in practice. The maps involved have no standard form, sometimes looking like familiar territorial maps and other times looking like flow charts of the food production process. However, location is important to these maps and new GIS-based tools are being used to integrate supply chain data via flexible interfaces. Our consideration of food and futurity through mapping is not focused on the long-term trends in food sustainability or alternatives to the current global food system, often called food futures (e.g., Carolan, 2015; Smith et al., 2016). We are concerned with the routine practices of making-present more specific and immediate futures to be acted on *within* the operations of global food chains. We consider expert management of food risk not as a purely scientific or technical matter, but as an anticipatory process of "making sense" of complex space-times and regulatory pressures. Our findings have relevance beyond the practicalities of food chain mapping. We draw conclusions that add to those of recent processual approaches on maps as means for engaging with potential future problems (Haughton & White, 2018; November et al., 2010). By considering the role of space in expert sense-making of food risk we add to work on the spatialities of expert and lay anticipation of food risk (Bingham & Lavau, 2012; Everts et al., 2018), which also has relevance for other forms of risk.

The empirical work on which this paper is based was conducted in the UK over 2015–2017. We draw on a subset of 14 interviews conducted in the UK with (1) specialist food supply chain mappers (from commercial consultancies providing mapping services to major food businesses), (2) supply chain, food safety, and quality managers working within food businesses, and (3) state regulators, as well as participation in three industry training, research, and futures events.[1] We did not set out to investigate specifically either food supply chains or mapping. Rather, we undertook exploratory research into anticipatory activities in the food system and the ways in which these drew on and remade relationships between the various actors, knowledges, and materialities in play.[2] Supply chains emerged as a dominant way of conceptualising relationships within the food system; mapping them, while not a wholly novel practice, was becoming more closely connected to ideas about food integrity and problematic futures.

2 | ANTICIPATION AND MAPPING

What we mean by anticipatory practices is grounded in a recent set of discussions around the future in geography and related disciplines that have centred on consideration of "the ways in which the future organises social action" (Newhouse, 2017, p. 504). While acknowledging a longer history of thinking on risk and uncertain futures as problems for government (e.g., Beck, 1992), some authors have pointed to the rise in uncertainty over the future as diagnostic of a shift towards forms of government that take the radical novelty of the future as a core element of their operations, working under the assumed inevitability of emergencies (Anderson, 2010; Dillon, 2007; Posner, 2004). Others have highlighted how techniques of anticipation can be used to open or close political debate (Donaldson, 2008; Haughton & White, 2018). This diverse body of scholarship on established and emerging modes of anticipation serves to highlight the range of situations that might involve thinking and making futures, and that those futures are always made and represented in complex assemblages of environments, technologies, imaginaries, bodies, and affects (Groves, 2017). Anderson (2010) has called on geographers to denaturalise the future through examination of the ways in which it is brought into being and folded into the

present. Central to his analysis is understanding the experience of the future in the various anticipatory practices – calculative, imaginative, or performative – which give it form.

As well as the "when" of a possible future, anticipatory practices involve a "where" and a "what" (Groves, 2017; November, 2004). These might be the many interrelated places, bodies, and practices through which the future is made present and experienced (Groves, 2017, p. 29) or the "wheres" and "whats" of the future anticipated: what might happen, what might it involve, where might it happen? If anticipation is the folding of the future into the present, it also entails the folding together of spaces and times. For Newhouse (2017), the everyday acts of anticipation involved in making a (precarious) living can include acts of geographical imagination, with considerations of other places as well as other times. Similarly, Bingham and Lavau's (2012) account of a food safety inspector's visit to a restaurant kitchen demonstrates how various forms of anticipation are mixed in an encounter that loosely draws multiple "elsewheres" and "elsewhens" together in one place through the work of the inspector, enabled with embodied knowledge, sensory experience, regulatory authority, and a sheaf of paperwork. The anticipatory practices we address in this paper involve mapping practices, intended to make other places, as well as other times, present and actionable. Our conceptualisation of mapping practices is rooted in Kitchin and Dodge's (2007) account of maps as always in a process of being (re)made. This processual perspective follows the argument that maps are made things that also do work in the world, but shifts focus from the object of the map to how maps "emerge in context and through a mix of creative, reflexive, playful, affective, and habitual practices, affected by the knowledge, experience, and skill of the individual to perform mappings and apply them in the world" (Kitchin, 2008, p. 214). Mapping practices are embodied, social, and technical and encompass not only the acquisition, processing, and presentation of data as maps, but also the articulation of maps in practices such as "recognizing, interpreting, translating, and communicating" (Kitchin, 2008, p. 213). So, mapping practices might include professional and informal cartography, but they will also include a whole range of other forms of practice and geographical imaginary by which people understand space and relationality. These practices exist potentially wholly independently of any physical map, but come into play when a map is made, used, interpreted, and so on; they can all take part in ongoing "mappings," which are "sets[s] of practices aimed at solving spatial problems" (Kitchin & Dodge, 2007, p. 337).

If, as we have asserted, making futures is a spatial problem, then mapping can be a way of engaging with that problem. Maps can be used to elicit and present possible future scenarios in urban or environmental planning (Corner, 1999; Forrester et al., 2015). They can be used in various ways to visualise vulnerability and imagine catastrophe by showing the spatial reach of a physical hazard (Atkinson et al., 2012) or a deliberate attack (Collier & Lakoff, 2008). However, problems can arise owing to the interpretation – much discussed and critiqued – of maps as authoritative representations of the world as it is (e.g., Crampton, 2010; Kitchin & Dodge, 2007; Massey, 2005). We risk a perception of maps as specifying the possible and the impossible. Haughton and White (2018) note that risk and hazard maps do not communicate well the uncertainty over the futures they present. They argue that, when viewed through the processual lens, such maps should be considered as "debate support tools" in a process of contestation and debate about courses of action. November et al. (2010) argue that "mimetic" perspectives, which assume the ontological fixity of the map, hamper anticipation by relegating risks on maps to a realm of subjectivity in opposition to the map's reality. To demonstrate how mapping might become more anticipatory, they develop a processual interpretation of mapping which they call "navigational." This approach decentres the map itself as an object, instead drawing our attention to the practices of navigation that the map is implicated in. Navigation entails following signposts that encode relationships between things the navigator will encounter as they move through the world. The navigational perspective is not focused solely on the act of following signposts, but also on how the signposts encode sets of relationships in such a way that they become useful to a navigator. Signposts are points in a chain of reference, a series of translations of elements of the world (Latour, 1999) that are inscribed into the map. This deambulatory view of mapping does not permit a jump from world to map, but demands examination of each step by which the world is transformed into a map and by which the map is then made to refer back to other things in the world. Whereas a mimetic view presents a future as already "out there," in the navigational mode risks can be thought of as trajectories through the signposts (which should include the references necessary to trace the emergence of those risky spaces and times). This approach, in which a map becomes an interface, is inspired by the widespread adoption of GIS and digital mapping techniques better able to assemble the range of information needed.

We use this division, between mimetic mappings as focused on the map as an object and navigational mappings as concerned with process, to analyse food supply chain mapping as anticipation. We will see that mapping can be used to make futures present in this context, but can also be associated with other aspects of governing futures in the food industry. To elaborate the context within which these actions occur, the next section provides an overview of food risk governance.

3 | FOOD RISK GOVERNANCE

Food risk is the anticipation that food integrity (safety, quality, authenticity) might be compromised at some point in the future. At the turn of the millennium, the management and governance of food risk in the UK and the EU underwent significant change (Smith et al., 2004), driven by a series of high-profile food scares – public unravellings of food integrity that are often given prominence in excess of the actual level of danger posed to the wider public (Everts et al., 2018; Flynn et al., 2003). Uncertainty and anxiety about food, coupled with a growing willingness to question authority on risk matters, led to a public distrust of the food sector (Smith et al., 2004). Increasing scientific attention to food risk raised public awareness and facilitated the development of a global food risk management regime (Henson & Caswell, 1999). Policy responses to this state of affairs have two important dimensions for us: the reinforcement of corporate food retailer power and a focus on supply chains (Flynn et al., 2003).

Regulators and consumers came to see food integrity as the responsibility of the retailers (Flynn et al., 2003). The establishment of Food Standards Agencies in the UK and EU institutionalised both a consumer (trust) dimension in food risk regulation and a scientific approach to risk management. Rapid cross-territorial movements of foodstuffs led to supply chains becoming a focus for regulation. Large food retailers had already developed their own system of regulation based around private standards and supply chain management, so the state's focus on these and on industry responsibility served to reinforce the power of retailers to regulate supply chains (Bourlakis & Weightman, 2004; Flynn et al., 2003; Smith et al., 2004). This private regulation anticipates problems by using standards and contracts to reassign accountability and responsibility for potential breaches of food integrity (Hinchliffe et al., 2017).

The supply chain focus was a recognition of food risk as spatially "transacted" through the increased distance between producers and consumers, in terms of both length and complexity of the food chain (Stassart & Whatmore, 2003). For consumer groups turning to "quality" food, quality often meant shorter supply chains (Goodman, 2003). Despite retailers sometimes playing to this construction of risk with "buy British" responses to transnational food scares (Jackson, 2015), they largely have sought ways to maintain their complex global supply chains. A-seasonal, "just-in-time" models, that prioritise delivery on demand and rapid substitution of foodstuffs to ensure a constant and varied supply of food available to consumers, require complex supply chains with inbuilt redundancy and a global reach. In recognition of this reality, regulatory and policy bodies in the UK and Europe used the chain as a metaphor for connectivity and cooperation between producers, consumers, and government; better communication up and down the whole chain was recommended to alleviate food risk (Jackson et al., 2006; Paul, 2012).

Risk within the food industry, as in other professional fields, usually denotes an essentially calculable future that can be extrapolated from past events; it assumes predictable continuities based on known causal pathways (Spink et al., 2017; see also Anderson (2010); Collier (2008)). It is also strongly associated with an idea of the supply chain as a means of organising anticipation. The scientific risk analysis defined by international regulatory frameworks for food trade is a global assessment that must be interpreted locally at each point within each supply chain (Henson & Caswell, 1999). The global standard Hazard Analysis and Critical Control Points (HACCP) process locates points in processes that might lead to known food integrity problems and modifies them (Besseling & Montes Saavedra, 2015), but is a localised practice that is difficult to apply across a whole supply chain (Sperber, 2005). In the period of regulatory change described above, other concepts were sought to reconnect the supply chain. Traceability would enable sources of contamination to be found rapidly in an emergency by tracking of foodstuffs back to origin. Transparency was the ideal that any firm in a supply chain should have access to any information it required from other firms, to help in assessing and managing risk. Not only can these be difficult to realise, but the environment that drives food risk regulation is not static: new problems emerge that can prompt further changes in practice. In 2013, horsemeat was deliberately substituted for beef in the early stages of the supply chain, which led to it being widely found in products – typically, processed ready-meals such as lasagne – from major supermarkets. This incident developed into a food scare that revived public concerns over the global reach and complexity of food chains (Jackson, 2015). Among regulators (both public and private), this brought to the fore new supply-chain-focused concepts for considering uncertain futures. "Vulnerability" draws attention to events that have not happened before and asks which points in a supply chain leave it open to novel, and potentially unmanageable, future problems (Spink et al., 2017; Svensson, 2002). Although this is a break with a vision of the future based on the past, it entails the same problems as trying to extend HACCP chain wide: full chains are rarely visible to risk managers. Making actionable futures requires knowledge of the present disposition of the chain, so vulnerability brings with it a focus on visibility as enabling better anticipation (Elliot, 2014; Spink et al., 2017). Our research was conducted as these new ideas for making sense of supply chain futures were worked through into industry practice. Mapping was being explored as a means for making supply chains visible in order to anticipate where and

how breaches of food integrity may arise and how they might travel through the chain (the "risks in the pipeline"). We analyse this in section 5. However, maps also emerge as a tool or a technique into an existing set of power-laden commercial and regulatory relationships, as described above, that affect how they might come to be used. This is what we turn to next.

4 | MIMETIC MAPPINGS: MAPS AS OBJECTS

While processual perspectives argue for an analytical decentring of the map, maps are still experienced as things in themselves. In this section we outline three ways in which supply chain maps are experienced as objects, standing-in in various ways for a reality external to the practices in which they are encountered: as a strategic research focus, as a commercial product, and as a regulatory device. These three examples share a common referent in the horsemeat incident that was still actively driving concern for the future among our respondents. Having been content to prevent or be prepared for recurrence of past problems, managers felt compelled to seek out and act on "unprecedented" threats or vulnerabilities (Interview: quality manager), with maps a means to make visible their supply chains.

The first supply chain map we saw was revealed to a small group of researchers and policymakers as the culmination of a presentation on vulnerability to food fraud, such as occurred in the horsemeat case. The work took specific supply chains as case studies and mapped them to assist in identifying vulnerabilities. The members of our team who were present were waiting to see how this visualisation worked, how it might help make futures present. The map was of the UK beef sector and took the form of a series of interlinked boxes depicting stages in beef production from animal rearing to slaughter and cutting, processing and retail. Some labelling indicated stages occurring outside of the UK, but there was otherwise no locational component to the map. We were hoping for specific locations of major producers, logistics corridors, a sense of nodes around abattoirs or ports: a visual sense of the spatial distribution of the network. The detailed locating of food risks that was so important to the risk managers we had spoken to was absent. In part, this is because the map had a sectoral as opposed to firm or product "focus" (Gardener & Cooper, 2003). It did not represent a specific supply chain, but purported to be a best summary of activity in the sector. Such maps might serve a strategic purpose for industry bodies, regulators, and companies: to focus attention on emerging issues, to identify the types of risks and risky places that might be present in any specific chain, and to identify gaps or oversights in existing policies and practices (Brooks et al., 2017; Knoll et al., 2017), but this use was not much evident in our research (see section 5 for one example). Here, our focus is on the effect that the map had in that room. We might have been disappointed, but others were surprised. Some because even this level of mapping is difficult, others because there was more complexity in the chain than expected, with several stages of production potentially broken up across different sites. This capacity to induce surprise at the complexity of the chain and the range of possibilities that must be engaged with was something we encountered again. A group of regulators enthused over the impact of a picture of a common food item (a burger or pizza) overlaid with a map showing the range of possible ingredients and their global origins, their sudden realisation of the ramifications this could have for food integrity. Supply chain maps can open up the future as full of possibility and danger before any form of detailed engagement with them takes place.

Unlike sectoral maps, firm-specific supply chain maps show each individual business involved, from the firm commissioning the map back to the first farm or factory, with all the detailed locational data and network mapping that are absent from the sectoral map.[3] We encountered these maps in the context of another set of practices: the provision of a commercial product.

> So, why supply chain mapping? Well, ultimately the supply chain is both a tool that can be used to react to problems … but also a proactive service for a business, you know, recognising where those dangers lie and how you perhaps can best avoid them. (Interview: supply chain mapper 1)

The above interview opened with an effective sales pitch complete with PowerPoint slides showing visual metaphors of risk and emergency management. The presentation of mapping as a service, and a map as an effective anticipatory tool, focuses on utility and authority.

> The thing about horsemeat was if [retailer] had had our system and our transparency it wouldn't have taken them two weeks to work out where the horse was coming from. (Interview: supply chain mapper 2)

In this commercial setting, supply chain mapping services use GIS and centre on the provision of a digital user interface as well as the overview that a third party, outside of the chain, is able to provide. Again, the map is presented as a simple but clever object.

> We're very, very good administrators with an incredible piece of software. It's a very trite way to describe it if you want, but it sort of works. (Interview: supply chain mapper 2)

A digital interface can switch between: geographical views that locate sites on a world map; network views that show all of the links between sites without spatial data; and hierarchical views that show firms by their position within the production process (as primary producers, processing and manufacturing, logistics intermediaries, etc.). Each is useful for identifying different potential problems, such as exposure to environmental or geopolitical threats, critical points of failure (where a problem with a single firm could disrupt the whole network), or shortage of suppliers. At present, they are focused on supply chain transparency, the desire for end-to-end information gathering, such that the client can have greater visibility of their supply chain and hence identify potential future problems. The current methodology of the mapping providers we encountered is a form of cascading information request. Maps are almost exclusively commissioned by large firms close to the retail and consumer end of the chain (such as supermarkets). The mappers contact each of the client's suppliers for a particular product and then continue back along the chain, collecting relevant business information (such as processing activities and certifications) and details of the backward supply chain contacts until they reach the original producer. Third-party consultants can provide this visibility because they have no commercial stake in the chain themselves and can offer their services to each firm in the chain. The approach is not without problems, which we will discuss in the next section, but these are obscured by the presentation of the complete map and digital interface as product, a ready-made solution for detecting and managing problematic futures presented to the client. The impetus to buy mapping services also comes from the pressures of the regulatory environment outlined in the previous section:

> So, [major food manufacturer] started [mapping] because of the increasing NGO activity, looking at their business, horsemeat and so on. They also wanted to look at their supply chain in order to mitigate risk. (Interview supply chain mapper 1)

The firm in question wanted a map to demonstrate that they were taking responsibility for their supply chain. But mitigating risk can mean passing on responsibility for that risk to other actors in the supply chain, once those actors are made visible. The map becomes a means to regulate in relation to future problems.

As part of the regulatory framework generated by standards for food integrity, a map can be an object of audit and token of assurance. At the level of individual businesses, approaches to making and managing futures are shaped by both state and private standards. These set out principles by which potential problems should be identified and managed and the forms of auditable evidence required to demonstrate conformance. These standards operate as forms of assurance through which businesses demonstrate to their customers that appropriate actions are being taken to identify and manage potentially problematic futures. Businesses might be subject to more than one standard, depending on the requirements of their customers. Dominating discussions of standards during our research was the introduction of The British Retail Consortium Global Standard for Food Safety Release 7 (BRC7). BRC7 belongs to an internationally equivalent family of standards that provide a basis for auditable certification of food integrity procedures and practices. BRC certification was a basic requirement expected by most of the food companies and industry bodies we interviewed during our research. BRC7 introduced a requirement for vulnerability assessment for the first time, aimed at addressing food fraud and therefore clearly related to the issues emerging from the horsemeat event. Although mapping is not a specific requirement of BRC7, the need to identify vulnerabilities was driving the need for greater understanding of supply chains, which many food businesses and consultants associated with mapping. Some actors were taking a further step and suggesting that a map could be an indicator that businesses had sought to gain greater visibility of their supply chains. While for some this desire to see a map from their suppliers remained informal, there were suggestions that other food retailers' standards could go beyond BRC7 and require suppliers to produce the map at audit.

All of these examples take the map to be mimetic, a directly representative visualisation of the real supply chain. Maps can be recognised as a creative means for making futures present, but they can also readily become part of the private regulatory system, detailed in the previous section, in which powerful retail end actors aim to make others accountable for risks. Presenting maps as a commercial and regulatory requirement serves to reinforce the certainty with which visibility of the

present is equated with knowledge of the future, giving the maps greater ontological authority. This fixation on treating a map as if it provides certainty is not, according to one experienced supply chain mapper, helpful:

> So I could give you a full map of my supply chain. So what? Unless I'm able to flag actually there's a risk point here and there's a risk point here, so you could go from having no data to too much data to be able to make sense of. (Interview: supply chain mapper 3)

Supply chain maps do not come with problematic futures ready visualised; they must be made from the potentially overwhelming data made available by the map. In the following section, we present a navigational understanding of mapping that shows how food system actors make maps and make sense of supply chains and futures together through that mapping.

5 | NAVIGATIONAL MAPPINGS: MAPPING AS PROCESS

> The problem with supply chain mapping is it's a vogue area but actually it doesn't work because a map is just a map. It's how do you navigate it? (Interview: supply chain mapper 3)

The above quote completes the interviewee's critique of the supply chain map as an object and establishes the need to understand how mapping might be engaged with in a more processual way. Navigation is not only a useful conceptual term for a processual theory of mapping, it is also a term that can be used within the food industry to draw attention to the practices that make mapping operate as an anticipatory practice. In this section we examine three aspects of navigational mapping practices as they pertain to making futures: the assembly of the data points for a supply chain map, the skilful reading of those as signposts to risk trajectories, and the role of model maps in establishing visibility as enabling anticipation.

The first aspect is the production of a firm-specific supply chain map, described in the previous section as a process of cascading information gathering. The extent of many firms' knowledge of their supply chains is the legal requirement for one link up and one link down traceability of food ingredients (that is, recording your immediate supplier and customer for each consignment). Firms find going beyond this "very, very difficult to do, very difficult" (Interview: compliance manager 1). This is one reason for the emergence of third-party mappers and the cascading approach to mapping. The cascading approach itself is a form of navigation from site to site, following the signposts provided at each stage, to work through the chain. Assembling a picture of supply chain topology in this manner is still difficult. Some firms' record keeping may be less detailed than that of others. Some firms and some sites may operate under more than one name, so it can take additional time to recognise these as a single point in the chain (and possibly a risky point, if they handle different foodstuffs that might cross-contaminate). These problems make a chain harder to visualise and hinder navigation. The nature of some supply chain spaces generates further opacity. Cidell (2015) highlights "fire spaces" (Law & Mol, 2001) in supply chains that flicker in and out of existence, both absent and present. For Cidell, this results from the exigencies of an outsourcing economy: firms do not want management responsibility and are happy to use contractors that come and go. In the case of food chains, it can also result from the prevalence of agents who buy ingredients from multiple, changing sources, sell bulk mixed batches, and guard their contacts' details out of commercial necessity. Sometimes there is simply no reliable knowledge about the source; an example was given of mangoes grown in India, left at a crossroads for collection by donkey cart. For these reasons, supply chains take time to map and might always have gaps. Chains are also dynamic, firms go out of business and new ones emerge, relationships change for many reasons. One interviewee described a map as a "snapshot" (Interview: supply chain mapper 3), a moment in time in a chain. Given that a supply chain can take up to a year to map, a better analogy might be a blurred long-exposure. So, an initial supply chain map is a product of a difficult navigational process with its own uncertainties. The contingencies of the mapping process are obscured when the map is presented as a tool or auditable object providing mimetic visibility of the chain.

The second aspect is the matter of signposts. November et al. (2010) describe navigation as a process of following signposts that chart a safe path through the world. The initial mapping, as described above, assembles the chain by treating each site/firm as a signpost to the next step. The signposts needed to make futures present are another layer of the mapping. The business of following them is not as strictly calculative as the navigational metaphor might suggest. An instructive encounter involved meeting Deb, an experienced technical manager for a food retailer, on a meat-species assurance training course. We practised assessing the risk of species adulteration from different suppliers using a series of grid-based tools.

Each grid plotted one risk factor on the X axis and one on the Y axis, with low/medium/high ratings, thus giving nine levels of risk for two combined factors. The first grid had "degree of comminution of product" – how finely ground the meat was – on the X axis and "value of product" on the Y axis. Deb was hesitant to share her scores, having spent a lot of time debating whether to elevate certain risk scores due to factors not on the grid – for instance, because one product was processed in a cutting plant known to handle multiple meat species. The second grid caused Deb further concerns. It charted complexity of machinery (more complex cutting and processing machinery is more difficult to clean) against the number of species processed and the rigour of their separation. One plant was not BRC certified and the supplier had not provided any information on their segregation methods. In reality, Deb would never approve an uncertified supplier, or one who had provided incomplete information on their operations. Another problem supplier processed multiple species with only a 15-minutes clean down between runs – though it was only dealing with large cuts of meat. But Deb pointed out that the supplier had not provided information on their BRC certification status. Combined with the plant's questionable species segregation practices and the fact that the supplier was based overseas, the absence of a BRC certificate elevated the plant to critical risk status in her judgement; she would either de-list the supplier or send in the auditors immediately. Deb chafed at the limitations of the grid method and the instructor agreed with her judgements, explaining that he had deliberately included extra information in order to remind us that there were always other factors to be taken into account.

This encounter highlighted the material complexities of what needs to be mapped: the processes of disassembling and assembling of foodstuffs throughout the chain. It also evinced the role of skilled experience in navigating risks. Even though they may use pre-formatted tools for risk assessment, managers will go with their guts. The type of judgement Deb brought to bear is summed up in a conversation between two compliance managers (Interview: CM2 and CM3) for a major food retailer discussing how their judgement of risk was based on consciously researching past issues, but also something else:

CM2: And then our own industry knowledge. It's your gut, you know?

CM3: Yes, a lot of it is just that, it's just gut feel. You know that supplier, you work with them, you know what their business is about … You just get a feel.

The "gut" recurs as a metaphor for expertise that is not "codified" (Interview: senior director), but consists of sedimented, embodied experience gained through years of work and rendered implicit. Grids are a navigational tool, a way of triangulating risk signposts, but sometimes the gut takes precedence. Deb only decided the grid was a useful tool because it agreed with her own conclusions. As with Bingham and Lavau's (2012) inspector, futures are made based on understanding in the moment; there is a history involved, but the archive is personal and embodied, not a database of statistics. There is a paper (or digital) archive but, in reading signposts, the "body of evidence" that matters is something more.

Another type of signpost is evident in Deb's focus on the physical location of certain suppliers. This also concerned our two compliance managers:

CM2: Where they're based as well.

CM3: Where they're based. Yes, location is a huge thing.

CM2: Which country they're manufacturing in, how much knowledge you have of their supply chain.

Location matters because local standards might be loose; distant sites mean you cannot personally audit them as easily, you will never get matters verified to your own satisfaction. Risk managers can control what happens at their own sites to their satisfaction, so the bigger risk is that bad futures may happen because of something that someone else did, some*where* else in the supply chain. Risky foodstuffs are risky because of where they have been: differentiated risk is a matter of "same food, different environment" (interview: state regulator). This involves a combination of factors tied to both location and the practices at that location, all of which can provide signposts that allow a trajectory of risk to be plotted, through and between sites.

The third aspect of navigation is the way in which visibility and anticipation are linked through the incorporation of a sense of time into supply chain mapping. The movements of foodstuffs in space, through and between sites, are also movements of foodstuffs in time. Movements take time to happen and this opens up the possibility of intervention:

Because of our geographic location here in the UK, it takes six to eight weeks for a product to move from China to here. But Australia gets that product within two weeks. … So, once we have the Australian data coming in, issues emerging out of China will be flagged in Australia four to six weeks before that ingredient arrives in the UK. (Interview: supply chain mapper 3)

Maps that incorporate problematic ingredients can then be used to determine when and where a problem is likely to arise. This time dimension is taken into account through a particular form taken by supply chain maps. Figure 1 shows a model supply chain taken from a document that provides guidance on identifying the potential for deliberate attacks on food integrity. Model maps are further abstracted than the sectoral map we discussed in section 4, but are more likely to be encountered in policy documents, practitioner guides, and academic textbooks. The map has two key features: it shows that supply chain maps are process maps, documenting different stages in food production as well as the movements between them, and it shows the arrow of time for that process. The focus on process, on a causal sequence for possible problems, has been central to thinking about food integrity since the introduction of HACCP. The various futures in which food integrity is compromised belong to a catalogue of possibilities (in documentation and personal experience), covering different aspects of production and ingredients. They are understood in terms of cause and effect: the various factors that can produce each undesirable outcome are worked backward in sequence with the aim of finding a root cause. These factors can be mapped onto the production process and therefore onto the supply chain. There is a model of risk trajectory that fits a model supply chain mapping.

The causal direction for risk trajectories can be seen in the "upstream" and "downstream" labels. Foodstuffs flow from upstream to downstream and the further downstream you are from a supplier, the less certain you are of their practices and the potential risk they pose. This is the problem that improving supply chain visibility is supposed to solve. Although the arrow of time suggests a relentless downstream movement of risk-carrying foodstuff, the space-time of supply chains, once understood as navigable, is more malleable. Understanding the space-time as navigable means being able to identify signposts and recognise future problems as having trajectories through the supply chain. It is a speculative mapping (Corner, 1999) that uses the map to explore different courses of action. With this understanding, the trajectories of potential futures can be modified at different points. The last quote from our supply chain mapper showed that downstream actors benefit from a time lag in emerging issues that have to travel through the chain. The corollary of this is that action can be taken further up the chain to mitigate identified risks before they emerge. Downstream actors can opt, as Deb suggested, to drop risky suppliers or to force them to comply with new procedures or standards. Aside from helping build this understanding of navigation, model and sectoral maps might also enable regulators and supply chain managers to identify certain categories of upstream business or sites that might cause problems and take action on a larger scale. (This was beginning to
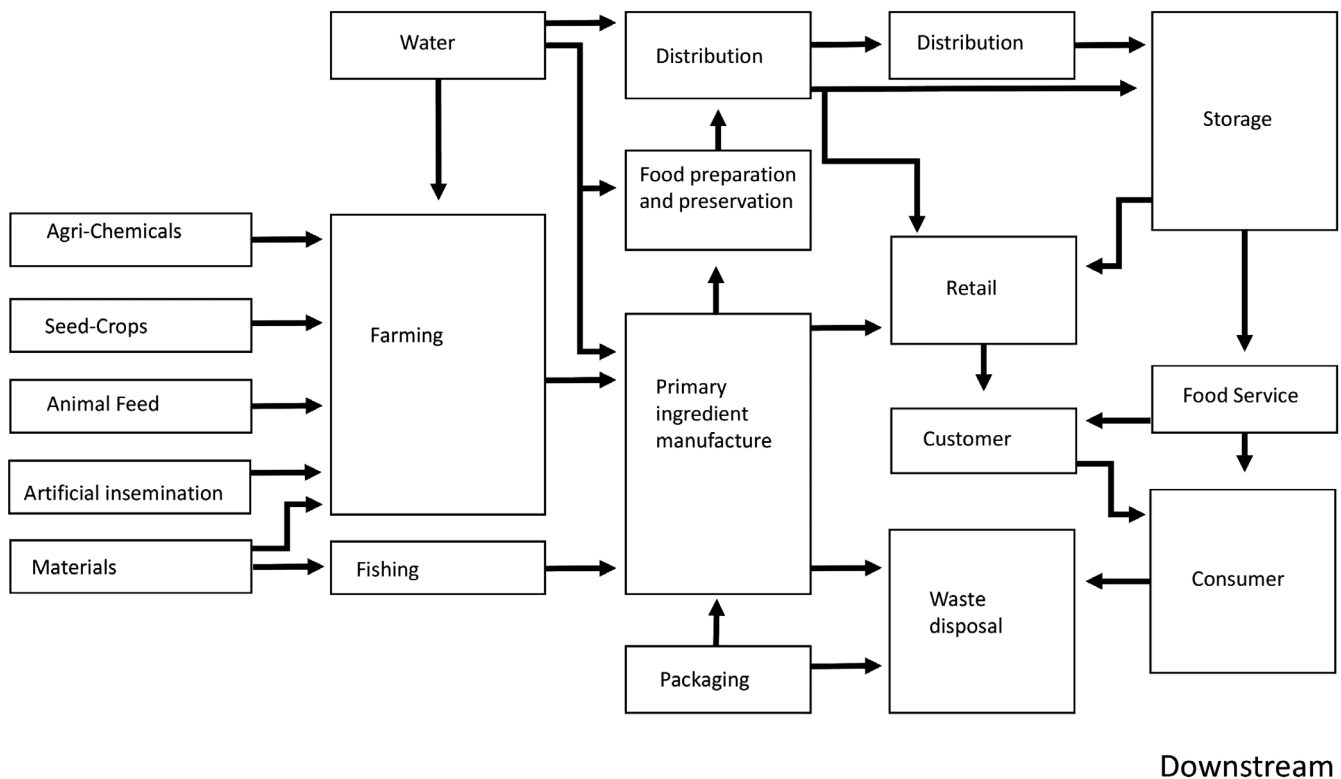
FIGURE 1 A model supply chain based on BSI (2017).

happen in relation to the agents noted above as creating uncertainties – new standards were being put in place to regularise their practices). In the supply chain model of risky futures, pushing the problem back ("upstream") in space is the same as pushing it back in time, further enhancing the speculative capacity afforded by these mappings.

Comparing these three navigational readings of mapping to the previous examples of the map as object draws out some important points about visibility. We have shown that mapping a supply chain is a process of navigation not an authoritative memetic overview. Uncertainties are embedded in the mapping as a result of the dynamic nature of the chain. At face value, this undermines the objective utility and authority of the map seen in the previous section. However, making futures present via the map does not rely only on what is visible. It involves the connection of signposts available from the map and draws on a wider understanding of possible problems, often characterised as tacit or gut reactions (which can be hidden behind a numerical risk score). This process is underpinned by an understanding of supply chain maps that is present in the most basic of them: the supply chain as a navigable space-time. While a full map for a specific supply chain might not adequately capture the dynamics of the chain, it does not, as Massey (2005, p. 108) suggests some maps do, fix a space-time. A supply chain map as a process map contains within it the possibility that the process can be modified. This, we have argued, is the very reason that anticipation corresponds with visibility. The most basic model supply chain maps help risk managers recognise a supply chain map and know what to do with it, how to integrate their own knowledge and experience into it and how to think with a supply chain map in a navigational way. The practices of identifying signposts and using them to navigate risks that we outlined in this section exemplify the skills needed to navigate such a map. But, if the skilful practice involved in making futures from supply chains is set aside, the same correspondence between supply chain visibility and anticipation expressed by supply chain maps that enables their navigational use also underpins their use as means of regulation and control as outlined in the previous section. We can also, in retrospect, see this same correspondence at work in the response of academics and regulators to the first supply chain map we saw.

6 | CONCLUDING DISCUSSION

Our research revealed that the process of food supply chain mapping as a means for anticipating risks to food integrity is not as straightforward as the food industry narrative in which maps provide better supply chain visibility which leads, in turn, to better anticipation. Through adopting a processual perspective on maps, we have highlighted the many mapping practices involved in anticipatory supply chain mappings. Here we draw together insights from considering maps as both objects and processes. The analysis highlights the speculative uses maps may be put to in navigational processes, and the discourses and practices of power that maps-as-objects can help reinforce or modify.

To those charged with managing food integrity, problematic and uncertain futures are seen to emerge from the spatial complexity of the present: the global reach and interconnectedness of supply chains. The various material transformations that might lead to bad futures – e.g., contamination by pathogens or other substances, adulteration with other ingredients, both deliberate and accidental – are important in providing a baseline for assessing risk. However, the focus is on the locations that problems might emerge and the routes by which they can travel through, and be further complicated by, the chain. These trajectories are the always-imminent risks in the pipeline. Food risk managers consider maps to provide the visibility of the supply chain needed to better identify possible problems, especially vulnerabilities in distant parts of the chain. We have argued that the fact that supply chain maps always present the chain as a process provides the connection between visibility and anticipation that underpins maps articulated as both objects and processes. This is also evident in the observed capacity of maps showing complex chains to induce surprise and anxiety over the many ways in which problems might emerge. From a processual, navigational perspective, this connection opens up the possibility of speculative mappings: the identification of risky sites and routes by which risks might be "transacted," based on the signposts inscribed in the map. However, the mimetic view of the map-as-object assumes a direct leap between the world and the map's visualisation of it. Simply having the map provides more certainty. When articulating maps in this way our interviewees did not talk about using the maps to determine risk, but to manage it. Visibility meant knowing where responsibility for food integrity and accountability for future breaches could be allocated. The map was not only about making the supply chain visible in this way, but also about having visible evidence that a firm had acted responsibly by considering their supply chain as a source of future problems. Although mappers talk about transparency, they mean how well they can map a chain, not that data are accessible to all. Visibility is not shared and depends on who has the map and on their position in the chain. These are important points: mapping was proposed as a means of uncovering problematic futures, especially unprecedented futures or vulnerabilities that could emerge as a result of supply chain processes, but it might also be used to extend the authority of the already-powerful food chain actors who exert control through obligatory standards.

Maps-as-objects obscure both the mapping into visibility and the ongoing mapping of making futures present. The objective authority of supply chain maps was challenged by an examination of the processes behind them. The collection of mapping data was shown to be a messy process of navigation in itself. Supply chains are dynamic and often difficult to follow due to the impermanence of certain links. An important point to emphasise here is that the visibility of an initial mapping is a product not only of the skills and resources of the mappers collecting data about the locations and food-processing activities of firms in the chain, but also of those who provide data about their own practices and connections. From this perspective, maps do not offer certainties but do permit speculative engagements with the chain. These mappings can be undertaken whether the map is sectoral, firm, or product focused. Speculative mappings use the information available in the map as signposts to possible points of emergence and trajectories of risks. Our research showed that they also involve things that are not made visible by the map: absences of information and the embodied knowledge and experience of risk managers. This finding further problematises the understanding of maps as enabling anticipation by providing visibility. This is why we characterised the use of maps as part of a process of making sense of food risk. If we take our findings relating to maps as objects and processes together, we see that speculative mappings of risk and vulnerability, drawing on what is visible and not visible, may also include in them questions of responsibility and accountability: who should act and how they should act.

The new digital supply chain maps that were being developed as commercial products very much took the form suggested by November et al. (2010) as better for anticipation, but that is not all that is involved. As a generalisable point from our work, we can say that mapping practices take on anticipatory function through joining larger assemblages of concepts, practices, and bodies with anticipatory capacities (Groves, 2017). This is of particular pertinence to geographers developing mapping techniques as means of engaging with aspects of food chain risk (e.g., Hocknell et al., 2018). In our specific case, this means that food system firms and regulators need to continue to recognise and value the embodied skills and experience of those tasked with identifying problematic food chain futures, and also aim to understand how these capacities relate to mapping as it becomes a more established practice. More communication between those making initial mappings and those using maps to anticipate might be helpful in understanding the uncertainties involved and the data required. In other anticipatory uses of maps, it might mean that attention needs to be paid to the other knowledges and understandings in play. Mapping as a way of engaging with possible futures is not just a matter of what is being made visible or how it is being made visible; it is also the relationship of spatiality and futurity. In our case this already exists through understandings of supply chain complexity and process; in others, it might be multiple or contested (Haughton & White, 2018). We suggest that the navigational approach, adapted to take into consideration the skills and knowledge involved in navigating, will be a useful tool as it draws attention to the many steps by which maps and futures are made present together.

Finally, our analysis of supply chain mapping as anticipation adds to understandings of the spatiality of food risk. Maps increase the distance and time (as the two are linked through supply chains) over which risky futures can be grappled with. While this fits a narrative of control, through making firms accountable or making longer-range risk analyses possible, it is also diagnostic of a situation that lacks control and is rife with uncertainty. Consumers experience food risk as spatially differentiated (Everts et al., 2018) and feel anxiety as they seek to manage food risk literally "beyond their control" (Jackson, 2015, p. 193). Food risk managers within supply chains, as we have shown, and at the interface of food safety and consumption (Bingham & Lavau, 2012) also have to make sense of spaces and futures that are outside of their control. On the one hand, there is a commonality of experience in the need to "navigate" complicated "riskscapes" that can help to conceptually flatten the analysis of expert and lay understandings of food risk, and enable us to counter hierarchies of expertise (Everts et al., 2018). On the other hand, we have demonstrated here a distinction in the experts' deployment of a technique – mapping – that makes material and visible the need to connect and hold apart certain spaces and futures. In doing so, it facilitates the spatial distribution of accountability and responsibility for food risk. Though this is tied into particular discourses of supply chains as generative of risk, it is more than a discursive exercise of power; it is a set of material and knowledge practices that can remake relationships in the food chain as they make futures present. We suggest that this finding invites further examination of the specific anticipatory practices and techniques – including mapping – by which risky food futures are made present and by which responsibility and accountability, across industry and consumer alike, are spatially distributed. This focus on the spatial distribution of risk and accountability also provides a basis for critical analysis in situations other than food geographies where connections are being made between mapping and futurity.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in UK Data Service Reshare at http://doi.org/10.5255/ UKDA-SN-852796.

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ENDNOTES

[1] Occupational identifiers are used for interviewees, pseudonyms for ethnographic accounts. The project overall involved 50 interviews, seven site visits, and eight research and training events. Interviewees were recruited through existing contacts, snowballing, and events attended to give coverage of: supply chain actors from production to retail; regulators and policymakers; and those supplying services such as mapping.

[2] Alongside the mapping and risk assessment detailed in this paper, we also encountered horizon scanning, emergency planning (by firms and regulators), exercise staging, HACCP, and various forms of surveillance and certification/audit.

[3] An example sectoral map can be found in Brooks et al (2017); firm-specific maps contain confidential commercial information and we were not given permission to record or reproduce the brief examples we saw.

REFERENCES

Anderson, B. (2010). Preemption, precaution, preparedness: Anticipatory action and future geographies. *Progress in Human Geography*, *34*, 777–798. https://doi.org/10.1177/0309132510362600

Atkinson, P., Clark, M. J., Lewis, H. G., Bevington, J., Murdock, A., & Branson, J. (2012). *State-of-the-art in risk mapping*. London, UK: Government Office for Science.

Beck, U. (1992). *Risk society*. London, UK: Sage.

Besseling, P., & Montes Saavedra, E. (2015). *Hazard and risk analysis in food processing (Second Edition): New approaches towards HACCP and food safety*. CreateSpace Independent Publishing Platform.

Bingham, N., & Lavau, S. (2012). The object of regulation: Tending the tensions of food safety. *Environment and Planning A: Economy and Space*, *44*, 1589–1606. https://doi.org/10.1068/a44394

Bourlakis, M., & Weightman, P. W. H. (2004). *Food Supply Chain Management*. Oxford, UK: Blackwell.

Brooks, S., Elliott, C. T., Spence, M., Walsh, C., & Dean, M. (2017). Four years post-horsegate: An update of measures and actions put in place following the horsemeat incident of 2013. *Science of Food*, *1*, 5. https://doi.org/10.1038/s41538-017-0007-z

BSI. (2017). *PAS 96 Guide to protecting and defending food and drink from deliberate attack*. London, UK: BSI Standards Limited.

Carolan, M. (2015). Adventurous food futures: Knowing about alternatives is not enough, we need to feel them. *Agriculture and Human Values*, *33*, 141–152. https://doi.org/10.1007/s10460-01509629-4

Cidell, J. (2015). Distribution centres as distributed places: Mobility, infrastructure, and truck traffic. In T. Birtchnell, S. Savitzky & J. Urry (Eds.), *Cargomobilities moving materials in a global age* (pp. 17–34). London, UK: Routledge.

Collier, S. J. (2008). Enacting catastrophe: Preparedness, insurance, budgetary rationalization. *Economy and Society*, *37*, 224–250. https://doi.org/10.1080/03085140801933280

Collier, S. J., & Lakoff, A. (2008). Distributed preparedness: The spatial logic of domestic security in the United States. *Environment and Planning D: Society and Space*, *26*, 7–28. https://doi.org/10.1068/d446t

Corner, J. (1999). The agency of mapping: Speculation, critique and invention. In D. Cosgrove (Ed.), *Mappings* (pp. 231–252). London, UK: Reaktion books.

Cowen, D. (2014). *The deadly life of logistics: Mapping violence in global trade*. Minneapolis, MN: University of Minnesota Press.

Crampton, J. (2010). *Mapping: A critical introduction to cartography and GIS*. Oxford, UK: Wiley-Blackwell.

Dillon, M. (2007). Governing through contingency: The security of biopolitical governance. *Political Geography*, *26*, 41–47. https://doi.org/10.1016/j.polgeo.2006.08.003

Donaldson, A. (2008). Biosecurity after the event: Risk politics and animal disease. *Environment and Planning A: Economy and Space*, *40*, 1552–1567. https://doi.org/10.1068/a4056

Elliot, C. (2014). *Elliot review into the integrity and assurance of food supply networks – Final report*. London, UK: TSO.

Everts, J., Jackson, P., Meah, A., & Viehoff, V. (2018). Negotiating the riskscapes of convenience food. *Erdkunde*, *72*, 171–184. https://doi.org/10.3112/erdkunde.2018.02.08

Flynn, A., Marsden, T., & Smith, E. (2003). Food regulation and retailing in a new institutional context. *The Political Quarterly*, *74*, 38–46. https://doi.org/10.1111/1467-923X.00510

Forrester, J., Cook, B., Bracken, L., Cinderby, S., & Donaldson, A. (2015). Combining participatory mapping with Q-methodology to map stakeholder perceptions of complex environmental problems. *Applied Geography*, *56*, 199–208. https://doi.org/10.1016/j.apgeog.2014.11.019

Gardener, J. T., & Cooper, M. C. (2003). Strategic supply chain mapping approaches. *Journal of Business Logistics*, *24*, 37–64. https://doi.org/10.1002/j.2158-1592.2003.tb00045.x

Goodman, D. (2003). The quality 'turn' and alternative food practices: Reflections and agenda. *Journal of Rural Studies*, *19*, 1–7. https://doi.org/10.1016/S0743-0167(02)00043-8

Groves, C. (2017). Emptying the future: On the environmental politics of anticipation. *Futures*, *92*, 29–38. https://doi.org/10.1016/j.futures.2016.06.003

Haughton, G., & White, I. (2018). Risky spaces: Creating, contesting and communicating lines on environmental hazard maps. *Transactions of the Institute of British Geographers*, *43*, 435–448. https://doi.org/10.1111/tran.12227

Henson, S., & Caswell, J. (1999). Food safety regulations: An overview of contemporary issues. *Food Policy*, *24*, 589–603. https://doi.org/10.1016/S0306-9192(99)00072-X

Hinchliffe, S., Bingham, N., Allen, J., & Carter, S. (2017). *Pathological lives: Disease, space and biopolitics*. Oxford, UK: Wiley-Blackwell.

Hocknell, S., Hughes, A., Roe, E., Keevil, B., Wrigley, N., & Lowe, M. (2018). *Corporate food retailers, meat supply chains and the responsibilities of tackling antimicrobial resistance*. Retrieved from https://eprints.soton.ac.uk/id/eprint/426402

Hoorfar, J., Jordan, K., Butler, F., & Prugger, R. (2011). *Food chain integrity: A holistic approach to food traceability, safety, quality and authenticity*. Sawston, UK: Woodhead Publishing.

Jackson, P. (2015). *Anxious appetites: Food and consumer culture*. London, UK: Bloomsbury.

Jackson, P., Ward, N., & Russell, P. (2006). Mobilising the commodity chain concept in the politics of food and farming. *Journal of Rural Studies*, *22*, 129–141. https://doi.org/10.1016/j.jrurstud.2005.08.008

Kitchin, R. (2008). The practices of mapping. *Cartographica*, *43*, 211–215. https://doi.org/10.3138/carto.43.3.211

Kitchin, R., & Dodge, M. (2007). Rethinking maps. *Progress in Human Geography*, *31*, 331–344. https://doi.org/10.1177/0309132507077082

Knoll, S., Marques, C. S. S., Liu, J., Zhong, F., Padula, A. D., & Barcellos, J. O. J. (2017). The Sino-Brazilian beef supply chain: Mapping and risk detection. *British Food Journal*, *119*, 164–180. https://doi.org/10.1108/BFJ-07-2016-0346

Latour, B. (1999). *Pandora's hope*. Cambridge, MA: Harvard University Press.

Law, J., & Mol, A. (2001). Situating technoscience: An inquiry into spatialities. *Environment and Planning D: Society and Space*, *19*, 609–621. https://doi.org/10.1068/d243t

Massey, D. (2005). *For space*. London, UK: Sage.

Newhouse, L. S. (2017). Uncertain futures and everyday hedging in a humanitarian city. *Transactions of the Institute of British Geographers*, *42*, 503–515. https://doi.org/10.1111/tran.12188

November, V. (2004). Being close to risk: From proximity to connexity. *International Journal of Sustainable Development*, *7*, 273–286. https://doi.org/10.1504/IJSD.2004.005958

November, V., Camacho-Hubner, E., & Latour, B. (2010). Entering a risky territory: Space in the age of digital navigation. *Environment and Planning D: Society and Space*, *28*, 581–599. https://doi.org/10.1068/d10409

Paul, K. T. (2012). The Europeanization of food safety: A discourse-analytical approach. *Journal of European Public Policy*, *19*, 549–566. https://doi.org/10.1080/13501763.2011.614136

Posner, R. (2004). *Catastrophe: Risk and response*. Oxford, UK: Oxford University Press.

Smith, E., Marsden, T., Flynn, A., & Percival, A. (2004). Regulating food risks: Rebuilding confidence in Europe's food? *Environment and Planning C: Government and Policy*, *22*, 543–567. https://doi.org/10.1068/c33m

Smith, J., Lang, T., Vorley, B., & Barling, D. (2016). Addressing policy challenges for more sustainable local-global food chains: Policy frameworks ad possible food "futures". *Sustainability*, *8*, 299. https://doi.org/10.3390/su8040299

Sperber, W. H. (2005). HACCP does not work from farm to table. *Food Control*, *16*, 511–514. https://doi.org/10.1016/j.foodcont.2003.10.013

Spink, J., Ortega, D. L., Chen, C., & Wu, F. (2017). Food fraud prevention shifts the food risk focus to vulnerability. *Trends in Food Science & Technology*, *62*, 215–220. https://doi.org/10.1016/j.tifs.2017.02.012

Stassart, P., & Whatmore, S. J. (2003). Metabolising risk: Food scares and the un/re-making of Belgian Beef. *Environment and Planning A: Economy and Space*, *35*, 449–462. https://doi.org/10.1068/a3513

Svensson, G. (2002). A conceptual framework of vulnerability in firms' inbound and outbound logistics flows. *International Journal of Physical Distribution & Logistics Management*, *32*, 110–134. https://doi.org/10.1108/09600030210421723

Thompson, S. (2015, January 16). From trough to table: Mapping the food chain saves lives. *The Guardian*. Retrieved from https://www.theguardian.com/sustainable-business/2015/jan/16/trough-table-mapping-food-supply-chain