

Risky spaces: Creating, contesting and communicating lines on environmental hazard maps

Graham Haughton¹ | Iain White²

¹School of Environment, Education and Development, University of Manchester, Manchester, UK

²Geography, Environmental Planning, Tourism Studies, Faculty of Arts & Social Sciences, The University of Waikato, Hamilton, New Zealand

Correspondence

Graham Haughton
Email: graham.haughton@manchester.ac.uk

Funding information

University of Waikato; Economic and Social Research Council, Grant/Award Number: RES-000-22-3070

This paper examines the tensions involved in the production, presentation and revision of hazard maps, focusing on the controversies that have become increasingly common when they are used to change government policy. Our scope includes all the major environmental hazards currently being mapped in New Zealand, one of the world's most exposed and hazard-aware countries. Selecting one country also allowed a multi-hazard approach to be taken that helps provide messages for other countries. Drawing on interviews with 24 key informants, the paper identifies a range of reasons for explaining the recent growth in hazard mapping and why hazard maps sometimes resulted in high-profile controversies. Two themes emerged out of this analysis: an inconsistency in modelling and mapping hazards that created opportunity for challenge and the selective mobilisation of scientific uncertainty to dispute the legitimacy of official maps, particularly on developed land. The findings highlight the multiple roles of mapping, positioning maps as potentially instruments of both depoliticisation and repoliticisation. We emphasise how conflicts are most likely when maps are used as technocratic instruments of depoliticisation, and that creating maps in a more open way can generate valuable opportunities to engage with communities in more creative policy-making regarding the threats they face and how they can respond. Mapping processes that open up the space for critical debate can act as important debate-support tools as well as decision-support tools, particularly when used to give voice to those not normally heard or treated as equal.

KEYWORDS

environmental hazards, knowledge controversies, maps, planning, risk, uncertainty

1 | IDENTIFYING RISKY SPACES WITH MAPS

The risks associated with environmental hazards have become a prominent feature of 21st-century life, evident in regular media and political debate about their causes and consequences. Although risk profiles vary widely between countries, the managerial approach is more consistent, commonly comprising an investment in science to build an evidence base for improving policy responses (UNISDR, 2015). It is in this context that hazard maps have become an important tool of government, used to help inform policy about which areas are most susceptible to hazards (Bell et al., 2014; Thompson,

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

The information, practices and views in this article are those of the author(s) and do not necessarily reflect the opinion of the Royal Geographical Society (with IBG).

© 2017 The Authors. *Transactions of the Institute of British Geographers* published by John Wiley & Sons Ltd on behalf of Royal Geographical Society (with the Institute of British Geographers).

Lindsay, & Galliard, 2015), and to communicate this information to the public so that they too can make better-informed decisions. Flood risk maps, for example, are now widespread, with national coverage required in the USA, Canada and in the European Union with the consequence that an increasingly sophisticated capacity for modelling and mapping has emerged (de Moel, Van Alphen, & Aerts, 2009; Landström, Whatmore, & Lane, 2011). Other hazards regularly mapped for official purposes include earthquakes, tsunamis, soil liquefaction, volcanic eruptions, wildfires, landslips and future coastal retreat.

There are important differences evident in how this mapping is approached, varying across countries and hazards. For instance, although some authorities collect, analyse and model data in-house, many commission studies from specialist consultancies or independent organisations (Haughton, Bankoff, & Coulthard, 2015; Landström et al., 2011). One consequence of this has been a proliferation of approaches to producing hazard maps, displaying a diverse mix of methodologies, data and models. This is positive in terms of encouraging improvement through diversity and competition, but there are drawbacks regarding perceived consistency and reliability.

It is typically when hazard maps are used to change policy that controversies emerge, leading some government agencies to control their public use or insert liability waivers (Clark & Priest, 2008). In labelling certain spaces as officially “risky” while being silent on other areas, several redistributive consequences follow. Those living in areas designated as high risk typically fear loss of property value, although some studies reveal that actual impacts are less than expected and also short-lived (Timar, Grimes, & Fabling, 2014). Other possible impacts include higher levels of anxiety and a higher take-up of insurance, albeit at a higher cost. For those outside designated areas of risk, often referred to as areas of residual risk, different consequences can ensue, such as a false sense of security and reduced sensitivity to exposure. More positively, property buyers ought to be better informed about possible hazards and markets may respond to influence behaviour. In short, hazard maps are political and have power: while only some areas are officially designated as “risky spaces”, the effects are felt both sides of the boundary.

This paper draws on empirical evidence from New Zealand, framed by debates on political economy, postpolitics, environmental controversies and critical cartography, to provide:

1. An improved understanding of the diverse motives for producing hazard maps;
2. A better understanding of how and why public controversies sometimes emerge over these maps; and
3. A better appreciation of maps as potential political “debate-support” tools.

In setting about this task we recognise the political choices imbued in mapping practices (Leszczyński, 2012), not least in the selectivities involved in who maps, how, for whom and with what purpose. With much hazard mapping outsourced to a combination of private companies or research institutes, hazard mapping is not just a scientific practice; it is also a commodity, bringing an interesting set of tensions around responsibilities, processes and liabilities.

Given the scientific uncertainty involved in hazard prediction, combined with inconsistencies in methods and the potential for redistributive effects, perhaps inevitably hazard mapping sometimes becomes a source of public controversy. However, as this paper will reveal, the reasons for public disputes are rarely about simply protecting development rights or property values. Instead they become enmeshed in debates about scientific communication, poor public engagement and the reduction of complex science to lines on maps. As such, we highlight the politico-cartographic nature of what may appear to be largely technical processes, helping explain why some approaches to hazard mapping become embroiled in controversies while others do not, with some practices seen as closing down space for political debate prior to controversial policy decisions, while others opened up valuable spaces for public engagement about future options.

The research draws on interviews with 24 key actors in New Zealand hazard and planning policy, using a snowballing technique from an initial sample of national and local government officials active in shaping policy in this area. Interviewees included civil servants from several government departments, two major national stakeholder bodies, local government officials drawn from across the resource management and planning spheres, scientific advisers specialising in hazard research and hazard mapping, plus the mayor of one of New Zealand’s larger cities. All interviews were recorded and transcribed, in all cases with informed consent and guarantees of anonymity. Interviews were semi-structured with a short summary of topics to be discussed sent to participants, covering: the reasons for the growth in hazard mapping; the benefits and potential problems; identifying areas which had encountered particular problems or successes; boundary effects associated with lines on maps; and why controversies sometimes emerged. Interviews were analysed through multiple readings from which key organising themes emerged. Rather than focus on a single hazard or controversy, our approach was to look generally at mapping environmental hazards, to reveal more about the diversity of rationalities and practices involved.

Although focused on New Zealand, which is exposed to a particularly wide range of hazards, the research draws on experience elsewhere and its conclusions raise important issues for those studying and responding to environmental hazards wherever hazard maps are an important policy tool.

2 | THE CHALLENGES OF MODELLING COMPLEXITY, MAPPING UNCERTAINTY AND PRESENTING REALITY

It is impossible to have a wholly objective representation of a complex reality on a map. (Thompson et al., 2015, p. 21)

Maps are important as a means for communicating the complex science behind hazard predictions – they have an immediate visual appeal, not least as people can check if they live in an area deemed at risk. For government authorities, maps are often valued because they help project a sense of “objectivity and certitude” (Monmonier, 2006, p. 373), since they are expected to have been compiled by experts in positions of trust. In the process, hazard maps become part of an instrumental, managerialist framework for managing risk and with this comes a responsibility regarding the quality of information and how it is used (Bell et al., 2014; Gustafson, 2015; Lane, 2014).

Building public and governmental support for hazard mapping typically involves a number of inter-connecting strands. In some decision-making arenas maps provide evidence and decision support; for instance, hazard maps are widely used to inform land use planning. In addition, in the public inquiries that follow major hazard events a regular recommendation is for better public information, including maps (Landström et al., 2011; Porter & Demeritt, 2012).

The rise of hazard mapping can also be seen in political economy terms, not least the changing roles of the state and the individual in risk management. Over the past three decades the discourse of risk management has become widely adopted by governments, used to prioritise state spending, promote risk reduction strategies or justify policies that reduce government liabilities (Beck, 2009). Hazard maps also facilitate markets for risk-management products and services, from household insurance to property protection measures (Connelly et al., 2015; White & O’Hare, 2014). Alternatively, from a governmentality perspective, providing citizens with information can be rationalised as increasing choice and awareness, while also shifting the balance between the state and the individual in assuming responsibility. Changing expectations around responsibility can also be used by decision-makers to deflect blame and defend institutions (Kuklicke & Demeritt, 2016; Porter & Demeritt, 2012).

Work on postpolitics has identified risk management as part of the repertoire of tools for the “effective” modern state, with growing reliance on expert practices contributing to a de-politicisation of policy-making (Allmendinger & Haughton, 2012; Swyngedouw, 2009). This literature suggests that depoliticising practices can mask disagreements or suppress dissent for a period, but in some cases this results in built-up resentments leading to major protests calling for fundamental political reform. Alternatively, localised protests may be tolerated and indeed encouraged by authorities, allowing them to demonstrate their reasonableness and responsiveness, provided the existing order of things is unthreatened (Swyngedouw, 2014). This argument, however, makes it hard for authorities to counter charges of being postpolitical, since they can be criticised both if they don’t respond to protests and also if they do, which helps explain some discontent with aspects of postpolitical theory (Beveridge & Koch, 2017; Mitchell, Attoh, & Staehli, 2015; see also responses from Dikeç, 2017; Swyngedouw, 2017).

In response to these debates, this paper argues that the importance of the postpolitical critique concerns the ways in which political challenges are framed as claims to recognition of new rights or equality of treatment by those whose voices had been previously dismissed as “noise”. From this perspective, postpolitics is helpful in distinguishing between those practices which suppress dissent and can lead to major protests as part of a fundamental challenge to existing political order, and smaller scale protests that authorities can manage by making minor concessions within the existing register of governance possibilities (Haughton, Gilchrist, & Swyngedouw, 2016; Rancière, 1999). More difficult for the authorities to deal with are those political movements which mobilise to challenge the fundamental disposition of rights in the existing political order, demanding that previously marginalised claims for rights are recognised as legitimate (Haughton et al., 2016). The recent granting of equivalent human rights to the Whanganui River at the behest of local Māori (Ainge Roy, 2017) is an example of a political movement that succeeds in moving from “noise” to being recognised as “voice”, claiming new rights to equality. The paper makes a contribution to these debates because rather than framing mapping as inherently postpolitical, we highlight the contingency, fluidity and multiplicity in mapping processes, ranging from those which

disenfranchise certain voices to those which create opportunities for opening up debate to those who would not otherwise be heard.

Work on environmental controversies has generated a different set of insights relevant to the challenges of hazard mapping, with recent work on floods in particular revealing problems between scientists, decision-makers and the public regarding how lay and scientific knowledge claims are mobilised (Haughton et al., 2015; Landström et al., 2011; Lane, 2014; Lane, Landström, & Whatmore, 2011). A particular concern for those seeking to communicate science to the public and policy-makers has been how to represent scientific uncertainty (Kuklicke & Demeritt, 2016; Landström et al., 2011; Thompson & Calkin, 2011). Stuart Lane outlines some of the main tensions using the example of flood risk maps, which, he argues,

are generally right in that they can achieve inundation patterns that are 80% to 90% accurate ... but wrong in the detail that matters in relation to those who live with flood risk (the remaining 10% to 20%) ... Thus, such maps can be the origin of significant hydrological controversy both within and beyond scientific communities ... If the nature of science is to proceed through showing elements of scientific knowledge to be incorrect, then this implies the translation of supposed certainties into supposed uncertainties which in turn motivates new scientific enquiry ... Second, the nature of "ignorance" is that we do not know what else we do not know, especially in environmental systems. (2014, p. 931, citations removed)

This quote effectively captures the difficulties that scientists have in building models to predict an inherently uncertain future. Even the best models have incomplete information in terms of the historical record of hazards, their possible impacts and the way in which human–environmental interactions condition the likelihood of future events (Lane, 2014; Thompson & Calkin, 2011). Moreover, new data, alternative models and “unprecedented” events can all undermine earlier models or certainties.

In the wider context of public attitudes moving away from an uncritical acceptance of expert knowledge, there has been growing attention within policy and scientific communities on improving the communication of science and acknowledging community knowledge (Haughton et al., 2015; Lane et al., 2011). Work on the public understanding of science has been particularly helpful in foregrounding cultural understandings of risk, simultaneously helping explain issues and promoting a shift away from a “knowledge deficit” approach in favour of a dialogue approach. This emphasises citizen science and the contribution that lay knowledge can have in challenging, ground-truthing or adding to expert knowledge (Hulme, 2009; Lane, 2014; Lane et al., 2011). Despite considerable progress in this area, long-standing tensions remain: while scientists work with uncertainty and complexity, citizens and decision-makers are often inclined to prefer certain or deterministic solutions (Bell et al., 2014; White & Haughton, 2017).

Hazard maps are important here because they are a preferred means for communicating complex information to the public. However, recent geographical scholarship reveals the importance of understanding how maps are produced, distributed and used. In particular, the constructivist turn in critical cartography (Harley, 1989; Smith, Wall, & Blackstock, 2013) helped expose the fallacy of neutrality and objectivity in the production of official maps, encouraging a move towards exposing the power relations and representations of institutional power that maps embody. This has given rise to research drawing on poststructural theories that examine the performativity of mapping practices and advance ideas about how maps shape, and even produce, our understanding of the world (for a review, see Kitchin, Perkins, & Dodge, 2009).

Most recently, the emergence of processual understandings of mapping, informed by relational thinking, has drawn attention to the need to study the processes through which maps are produced, the work they do and the ways in which they change (Kitchin, 2014; Kitchin, Gleeson, & Dodge, 2013). Thinking of “mappings in motion” in this way opens up new ways of thinking about maps as a process of emergence, examining both how dominant knowledge framings shape practices, and how these come into existence through different ways of seeing and understanding (Kitchin, 2014). Here, multiple modes of mappings can exist which draw on different scientific and lay knowledges about existing worlds and future possibilities. Evidence of the multiplicity of mapping approaches can be found in two reviews of flood mapping in Europe, which reveal the substantial national differences regarding dominant representational practices, the types of information being modelled and how scientific uncertainties are communicated (de Moel et al., 2009; van Alphen, Martini, Loat, Slomp, & Passchier, 2009). These reviews also highlight how hazard maps distil scientific complexity down to variable forms of spatial representation: sometimes shades, sometimes colours, sometimes lines.

Returning to the notion of multiple mappings, and its counterpart multiple modellings, greater computer power and the availability of new data sources have made it possible to assemble ever more complex data into map form. The multiplicity of ways in which maps are created and consumed as simple, temporary assemblages of information has become part of

everyday life (November, Camacho-Hübner, & Latour, 2010). The rise in digital mapping is changing how the public access and use maps, as rapidly updated digital maps are available on smartphones and computers, but they capture only part of the data on which they draw. The rise of open source data and mapping tools presents a further dynamic, opening up new possibilities for both scientists and citizen groups to model and map a range of hazard scenarios (Knight, Prime, Brown, Morrissey, & Plater, 2015; White, Kingston, & Barker, 2010). In addition, the continuously evolving nature of scientific understanding means that all models and maps will have a limited lifespan, creating an inbuilt dynamic for frequently renewing maps to reflect changing knowledge.

In part reflecting this opening-up of mapping information and speeding up of mapping practices, the use of multiple maps to illustrate alternative scenarios is now commonplace in scientific reports. This, however, only serves to highlight the scientific and political selectivities at work when a preferred map is adopted, an issue that is well illustrated by land use planning. The processes for creating and updating plans need to go through formal systems for assembling and assessing evidence, developing policy options, consulting with diverse stakeholders and the general public, before finally getting political approval. In effect, a plan-making process involves opening-up for widespread consultation, then closing-down once a plan is formally approved (Allmendinger, 2016). Once approved, a typical land use plan has an operational timespan of at least a decade. The issue which arises is that while the evidence base can be quickly updated to reflect changing scientific understanding, adopted maps in a statutory plan cannot be changed so readily. Research on flood risk mapping to inform land use policy in England has revealed the tensions and changes to policy that emerged as land use planners sought to reconcile their need for certainty in developing clear, defensible policies, and the fact that the evidence base could be updated and changed even as they were drawing up their proposals (Porter & Demeritt, 2012). The process of translation from technical mapping to approved land use plans also proved controversial in the case of landslide maps in southern Appalachia, where vocal vested interests concerned about the impact on property values successfully mobilised to have landslide maps not only taken out of planning consideration, but also removed from the local government website (Gustafson, 2015).

These examples are not isolated, nor do they reflect a universal pattern. They do, however, emphasise the tensions between scientific traditions and the demands of regulators and policy-makers (Landström et al., 2011; Lane, 2014), and in doing so raise questions about how these processes and practices can engender such different issues and experiences, concerns now turned to in the empirical parts of the paper.

3 | UNCOVERING THE REASONS FOR HAZARD MAPPING IN NEW ZEALAND

This section engages critically with the suggestion in the postpolitics literature that technocratic instruments of government, such as hazard mapping, can be used to frame issues in ways that attempt to foreclose political debate by favouring expert judgement. This suppression of opportunities for debate and engagement can sometimes backfire however, in some accounts linked to increasing urban protests (Swyngedouw, 2009) or legal challenges to planning decisions (Allmendinger & Haughton, 2012). In this context, interviewees were asked about the growing use of hazard maps in policy and their impacts on publication. This line of questioning revealed widespread agreement about the central role of legislation, in particular the Resource Management Act (RMA), which covers planning and environmental management. Introduced in 1991, the RMA reflected the political drive to enable a more market supportive framework and a move away from the former welfare state approach (Grundy & Gleeson, 1996). Crucially, the RMA embodied a political drive to devolve more responsibilities from central to sub-national government (in New Zealand there are two sub-national tiers, regional government and territorial, or local, government). The RMA gives regional and territorial governments considerable discretion in deciding how best to deal with hazards in their areas, including how they are addressed in regional and local plans.

Another key piece of legislation cited was the Local Government Official Information and Meetings Act of 1987, which requires local authorities to disclose information to the public. This act was highlighted by interviewees as providing the basis for the requirement that local governments place all the hazard information they possess on land records for prospective property purchasers. As such, the potential effect on property values was identified as one of the main triggers of public unease about hazard maps.

After legislative demands, the most commonly encountered explanation among policy-makers for the growth in hazard mapping was the desire for reliable information to inform decision-making, including the need to ensure that market forces could be harnessed to enable consumers to make choices about housing and insurance:

You want efficient markets. And the key criterion for delivering that is information. So if a map is truly grounded in good science, which let's assume it has to be, then the map is simply recording the factual state of affairs which will go to valuing properties affected by that. And that's actually good information and makes the market more efficient. (Interview: Local Government 3)

Even when economic justifications were prominent, this was typically tempered with consideration of wider issues, in particular meeting moral and legal obligations to ensure that official information was shared with the public. Related to this was sensitivity around public liabilities: if a disaster was to occur and the authorities had withheld information, it would provoke criticism. This revealed an awareness of what have been termed first and second order risks (Porter & Demeritt, 2012; Rothstein, Huber, & Gaskell, 2006), where, in addition to the visible risk to people and property, local government interviewees in particular were conscious that they and their institutions were also subject to future reputational risk if they failed in their responsibilities.

Hazard maps have played a role in both recovery from a major event and preparing for the future, strongly evident in the aftermath of two major earthquakes in 2010/2011 in the Canterbury region. Interviewees told us how a strong mapping evidence base had existed and been released to the public, but had limited impact on attitudes:

If I take you back before the earthquakes, we had sea-level rise maps of Christchurch; we had liquefaction information on property records. We had information that was out in the public realm that didn't cause a stir at all. In fact when we produced our climate maps strategy we showed 20,000 properties with wet feet, basically under water because of sea rise. We put that out and it was the front page of The Press, but it was just "information". A majority of people that we engaged with said "that's fine, it's not happening in my lifetime..." People saw those things as far off, way in the future. (Interview: Local Government 1)

Since 2011, considerable effort has gone into producing and consulting on new hazard maps, reflecting that the earthquakes had revealed important risk interactions with coastal flooding, landslips and urban flooding as land elevations changed. The most well-known of these has been the official map outlining three zones for Christchurch, with the red zone the most discussed because it defined areas where householders could not move back into properties and were offered government compensation for relocation.¹ Here lines on maps mattered, because they affected both how governments would compensate affected residents and businesses, and also the future development potential of neighbouring areas on the other side of the line:

Some people who were zoned in the area that was unfit for human habitation, the Red Zone, they were thrilled, they thought "fantastic, I can move on now, I've got certainty, I know that the government are going to come in and buy my property and I can buy somewhere else". ... it gives certainty and there is a timeline and people get it and they can move on with their lives.

On the other hand though we had some people in the Green Zone which was supposed to be OK, that were neighbouring those Red Zone areas. People were really concerned about their well-being. Because all of a sudden a whole neighbourhood is being ripped up and they were sitting on the fringe of it. (Interview: Local Government 1)

This example is illustrative for the range of social, political and economic considerations involved, attempting to ensure present residents were looked after and that future development was guided away from high-risk areas. There was also a moral hazard argument, since the government compensation scheme only applied to those who had insurance coverage to avoid sending out the signal that residents need not take out private insurance in the future. This quote also reveals the stark boundary effects that can be associated with lines on official maps, a topic discussed again later.

Public controversies were most associated with the release of new maps and related policies which re-designated an existing developed area from not being in an "at risk" area to being in one. In such cases property might have been built and bought in good faith according to the official plans and knowledge available at the time, so homeowners understandably felt upset when the designation changed. Our public-sector interviewees thought this raised important issues, because they had obligations to both current and future residents. Civil servants and some local government interviewees framed these difficulties as "legacy issues", dealing with decisions made in an earlier era when less was known about potential hazards in an area.

A further tension identified by several interviewees was that some householders did not want to see new hazard information made public, but this was a problem from a public interest perspective because it passed on costs to future citizens. In a related vein, a strong argument was made by many of our local government interviewees to place information in the public domain because this stimulated political debate, helping generate decisions to be made on behalf of all, not just those with vested interests:

It's all very fine for the landowner to say well, actually, we are the ratepayer here, you have an obligation to look after our interests, but the community is a bit bigger than that and sooner or later they will move on . . . So my take on it is that the only way to resolve all of those is to find out as much as we can and tell the truth.
(Interview: City Mayor)

This suggests a complicated set of entanglements around recognising different claims to rights, ranging from those protesting property owners keen to protect existing legal rights and others anxious to bring into consideration the rights of others, including future property owners and more broadly future generations. When viewed through the lens of postpolitics, this suggests the need to develop an awareness of the complexity of multiple demands for existing and new rights to be heard and respected by policy-makers and the redistributive consequences involved in renegotiating these rights.

Interviewees were all asked whether they felt that hazard mapping could exercise re-distributional effects, framed in terms of “winners” and “losers”. The responses tended to be broadly similar: those who could make location decisions informed by new maps were felt to be beneficiaries, while those who had made decisions previously, without the benefit of the current state of knowledge, were seen as potential losers if property values fell, insurance costs rose or the state decided to remove infrastructure funding. All of our interviewees supported providing more and better information to local residents, even though they knew that sometimes this might lead to heated political debate because of the potential re-distributional impacts. The general view was that providing information to the public should be seen as a first step in opening up a debate about how to deal with future hazard management. If there was an outcry, then that was an acceptable political outcome, helping generate informed debate on which to base decisions on future choices. In this widely shared view, the publishing of hazard maps is positioned as a vital part of the political process, with the potential for disagreements readily recognised and welcomed.

Reflecting our earlier discussion of processual mapping (Kitchin, 2014; Kitchin et al., 2013) and “mappings in motion”, rather than issue maps as definitive scientific documents to support a policy change, the emerging preferred approach was to release maps that were provisional and changeable, in the process creating opportunities for dialogue across all concerned actors.

4 | RECONCILING NATIONAL CONSISTENCY AND ENCOURAGING LOCAL VARIABILITY

A recurring theme in our interviews related to a lack of consistency across the country in how to identify, prioritise and address environmental hazards. As previous studies have indicated, this can leave authorities open to challenge (Kuklicke & Demeritt, 2016; Lane, 2014). New Zealand is particularly interesting because its commitment to devolving responsibility for hazard maps to regional and territorial government has been accompanied by a reluctance to impose central guidance, leading to considerable local variations in whether and how different hazards were being mapped. This situation reflected a desire to promote local discretion, based on a belief that local authorities were best placed to decide which hazards were important to them and how to address them. In effect, there was a trade-off between the benefits of encouraging innovation across both local government and the providers of mapping services, and the costs of potential duplication and inefficiencies.

One of our interviewees helpfully summarised some of these issues, in part as context for a call for a national mapping exercise that could be supplemented, where required, by detailed local studies:

There's no benefit to anybody of multiple providers doing essentially the same, or different things, all over again in different parts of the country . . . Councils commissioning the same request all over again, sometimes from the same provider, sometimes from a different provider, getting sometimes the same sometimes different answers, based on sometimes the same, sometimes different model assumptions, scenario assumptions, etc.
(Interview: Scientific Adviser 2)

The absence of national-level mapping and agreed protocols for undertaking local hazard studies has become a subject of lively debate among New Zealand hazard-planning professionals, with a recent report (Parliamentary Commissioner for the Environment [PCE], 2015) highlighting how individual local governments commissioning LIDAR (Light Detecting and Ranging) datasets leads to economic inefficiency and different levels of accuracy and baseline calibrations. As the report argued,

national consistency is essential. There is no good reason for a 50 centimetre contour to mean one thing in one part of the country and something else in another. It also ensures that science assessments and planning decisions are comparable. (PCE, 2015, p. 74)

Local government interviewees argued that the absence of clear national guidance imposed a range of costs on local government, particularly in areas where hazard research was relatively new to policy-makers, such as boulder falls. In addition, leaving local government to decide what kinds of scientific methodologies to accept or propose when commissioning work led to differences in approaches, which in turn made it easier for third parties to appeal against their scientific credibility or chosen standards of protection:

It is pretty inefficient, but the councils across the country are having to fight the same battles over and over again.

So if a national view was found that said “actually this is the level that we agree upon as a country, plan for that please” then that would take away a lot of legal challenges. Because then we were just following government advice. (Interview: Local Government 1)

Most of our interviewees in local government and some civil servants argued that more national guidance would be helpful. However, as one local government interviewee who also called for improved national guidance wryly observed, local authorities tended to hold contradictory views regarding central direction:

We constantly say we’re tired and dismayed and disappointed with the rigidity of a lot of national legislation that comes down from on high. And yet on the other hand when it gets difficult for us, we are quick to say “well, where is the national framework minister?” (Interview: Local Government 9)

Some of our interviewees used the publication of new flood maps in 2012 for Hamilton, the country’s fourth largest city, as an example of how leaving decisions to local government could lead to problems. In this case a new map led to around 28,000 property owners being told that their properties were now designated as “at risk”. A strong public backlash led to a rapid reassessment, with around 22,000 properties taken out of these areas.² For some interviewees, this was an example of a technocratic Decide, Announce, Defend (DAD) approach going badly wrong, creating a major public backlash.

Others argued that the core problem was that the council had adopted an overly-simplistic approach to modelling rather than commissioning more detailed work, a problem which national guidance on agreed acceptable mapping protocols might have helped avoid. For all those interviewees familiar with this example, it was felt to exemplify how things could go badly wrong when releasing hazard maps, something that had to be improved on in future.

To summarise, the dilemmas posed by New Zealand’s model of devolving hazard-planning responsibilities has generated debates about whether the current model has the right balance between central guidance and local discretion, but this is not framed in ideological terms. Instead respondents engaged in a process of reflection on whether the benefits of the current approach outweighed disadvantages. This led to a complex set of responses where respondents might call for greater central guidance or even national provision of hazard mapping alongside expressing concerns about losing too much local discretion. In this discourse, the multiplicity of local mapping practices was constructed as both a problem, in terms of national consistency, and a strength, in terms of sensitivity to local needs and encouraging innovation through competition.

5 | LINES ON MAPS AND COMMUNICATING SCIENTIFIC UNCERTAINTY

The existence of scientific uncertainty has increasingly been used to attempt to discredit findings, most evident perhaps in the case of climate change sceptics (Hulme, 2009; Wilby & Keenan, 2012). Some of the recent public opposition to hazard mapping in New Zealand has used scientific uncertainty to challenge policy changes, as a recent report on planning for

future sea-level rises noted (PCE, 2015). Seeking to shed light on how this situation had emerged, the report highlighted how certainty and uncertainty co-exist in scientific modelling practices: for instance, while there is certainty about sea levels rising, there remained considerable uncertainty about how different areas would be affected and how best to prepare.

The issue of communicating scientific uncertainty to the public was a recurrent theme during our interviews, particularly when representing scientific knowledge with probability lines on maps. One of the most well-known mapping controversies at the time of our research involved the Kapiti Coast district, where the local authority commissioned an independent scientific report to identify areas at risk from future sea-level rise as a result of climate change. In this case, a relatively small consultancy had been commissioned and the results were then put on to individual property records by the council. Property owners were then informed if their homes had been re-designated as being in areas of risk. A group of well-resourced residents came together to critique the methodology of the consultants and their use of scientific protocols, drawing on their own expertise and that of hired consultants. Amid considerable local and national media coverage, a case was taken to Judicial Review in 2013 to appeal against the council's decision. In an interim judgement, it was found that although the council was obliged to share hazard information, in this case there was a problem because the use of lines on maps was "starkly simplistic" in its representation of complex scientific information.³ The council quickly withdrew the maps and assured residents that information from this study would not be placed on property records. This case was particularly important for some of the national civil servants interviewed, who were working through its implications:

You can also advise that decisions are based on the best available information, but the best available information also comes at a cost. And that's something that's also raised its head in the Kapiti Coast issue, is that a number of residents complained about the modelling that was done, and I don't think that the modelling that was done was bad or wrong, but some people judged it inadequate. (Interview: Civil Servant 3)

At the heart of these concerns were the twin questions of communicating uncertainty and dealing with the multiplicity of possible scientific models that might produce different results. This was aligned in some cases to a view that the science was becoming more, not less, uncertain, as a result of climate change producing dynamic change and sometimes unpredictable impacts, not least where hazard risks interacted, such as sea-level rise, coastal erosion and increased storminess. It would be possible to commission a more expensive expert study; however, interviewees told us this would not resolve the underlying issues:

It's only going to be a more expensive study, and it won't remove uncertainty at all. Certainly, in anything that we've done, we try to make it clear that uncertainty is not going away, and planning for uncertainty is really the issue. And I guess in some ways maps don't help that message do they, because maps look absolute. The first thing that anybody does when they get shown a map, is look for themselves on it, and probably remembers, am I in a red area or a blue area, rather than considering the nuances and the uncertainties. (Interview: Civil Servant 3)

As several respondents made clear to us, not all hazard maps resulted in controversy, with some seen as opening up valuable political space to debate how to deal with the issues. When used purely for information, hazard maps could be presented as works in progress, used to inform the public of what the scientific evidence suggested while openly acknowledging the uncertainty and calling for public debate about future policy. The tensions tended to emerge at a later stage in most cases, when the maps were translated into "legal" lines on particular types of official document:

Where it starts biting is when it starts being put in to planning documents. The lines on the maps suddenly become legal lines rather than points of discussion. (Interview: Local Government 1)

Generally, consultations worked well in terms of using the evidence base to inform land use and other policies. As one official explained, the normal processes of planning consultation could often flush out issues and provide the basis for agreement:

We had a lot of initial resistance, because of some of the rules that were proposed, but through that consultative process, the rules got eased here and there, but the underlying body of knowledge remained represented in planning maps which ended up in the district plan. (Interview: Local Government 2)

Nevertheless, our interviews revealed a range of concerns about how hazard maps from scientific studies were translated into simplified forms to help inform the zoning of future development in land use plans. The background reports used by planners might include multiple maps for different scenarios, and multiple lines or shadings on any given map to indicate a spectrum of risks. However, when using the science base to inform their zoning decisions, planners in New Zealand, as elsewhere, have traditionally preferred single lines for the clarity they provide for development rights. A distinction was often drawn based on the purposes of a map:

If it's just an information map . . . then it's one thing because that's a little bit more pure, potentially, and also might be changed more easily. But the work I'm doing is in relation to mapping in the district plan and that's a lot more locked in; once it's in the district plan it's much harder to change. (Interview: Local Government 8)

Local planners explained in interviews that they often preferred single lines on maps because they needed to produce clear-cut policies that could stand up to challenge by developers, up to the level of the Environmental Court. In the case of zoning for future development, this typically meant marshalling evidence to create clear and enforceable single lines on maps that designate risk. However, while the act of simplifying evidence to single lines helped planners defend decisions, it left them open to challenge both about why, for instance, they chose particular probability levels and whether the science underpinning the line on a map was sufficiently robust to justify allowing people on one side of a line certain development rights or expectations of investment, but not those on the other (Kostelnick, McDermott, Rowley, & Bunneyfield, 2013).

The interviews provided evidence of the growing awareness among hazard-planning professionals of the need to find new ways of engaging with the public concerning the scientific basis of policy-making, not least since “if you don't bring the community along with you, then you end up battling them through the courts” (interview: Local Government 2).

For most interviewees, future hazard-mapping practices would need to move beyond improving public communication towards improving public awareness of how science works and working with communities to identify acceptable, workable policy solutions. One example raised by a number of our interviewees was the extensive community consultation processes about tsunami risk areas in Wellington, which led to an imaginative, award-winning solution⁴:

They ended up painting a blue line across the streets and footpaths at the point which corresponds to the zone deemed to be safe, for a maximum credible event. And there was some initial pushback, especially from people who lived right at that line, and what it would mean for property values, all the usual . . . impacts on business, all that sort of thing. That quickly died away. (Interview: Civil Servant 4)

Crucially here, this co-produced approach helped allay the concerns that this was an externally imposed solution, resulting in a dual-track approach to representing risk, lines on maps,⁵ which might not be accessible on-line during an emergency, and also lines drawn on to the physical fabric of the city. This approach resonates with the Highwaterline art project in New York City which in 2007 also involved temporary blue chalk lines on surfaces of parks and other public spaces.⁶ In Wellington, however, the approach is less about using art to raise awareness and more about a community generating a more permanent approach to dealing with the potentially tricky issue of representing risk visually.

To summarise, recent high-profile public controversies over hazard mapping were seen by most interviewees as the product of difficulties in communicating scientific uncertainty to policy-makers and to the public. This was leading to considerable soul-searching about how to avoid such disputes in the future, with the widely agreed preference being to open up the process of hazard mapping to greater public engagement and scrutiny. It also required improving public understanding that while scientific models and maps could help inform the policy-making process, they could not provide definitive answers to difficult problems, not least in relation to predicting future hazard events. Put simply, to help reduce controversies hazard mapping needs to become seen as a space for political, as well as technical, debate.

6 | CONCLUSIONS: MOVING TOWARDS MAPPINGS IN MOTION

A map, almost by definition, never is able to portray uncertainty very well. A line is always a line. (Interview: Scientific Adviser 2)

The research reveals that the reason for introducing hazard mapping tended to be more varied and complex than has been found elsewhere (Porter & Demeritt, 2012), spanning legislation, markets and behavioural change, and the need to balance public interest issues against individual rights. The diversity and complexities of politico-cartographic practices defied static forms of categorisation, such as being technocratic instruments of depoliticisation, demonstrating instead qualities of multiplicity, fluidity and contingency.

One practical implication of this research is that hazard maps should be conceived of as debate-support tools, not just decision-support tools, due to their value in opening up political space for communities to debate uncertain risks and future options. Other lessons include the need to find new ways for planning systems to be more flexible in how they deal with changing scientific knowledge, allowing maps to be treated as provisional and subject to change. Here, more use can be made of granting temporary land-use development rights for areas at risk, say for 40 years rather than in perpetuity, which might allow productive use of a site for a period after which risks can be reassessed as knowledge evolves. The research also revealed how new uncertainty always emerges, such as the developing knowledge of how various risks intersect, and so uncertainty needs to be actively acknowledged and made visible rather than managed technocratically. Differences in representational practices across the hazard research community also contributed here, for instance drawing hazard lines in relation to loss of life or the probabilities of a major event. This is an area where considerable research is needed urgently to allow communities to understand aggregated risks and how they can be better communicated.

Conceptually and methodologically, this paper has argued that foregrounding hazard mapping as a contested means for identifying risky spaces requires a shift away from arguing whether maps are accurate representations of scientific knowledge or not (Frankel, 2013; Stein, Geller, & Liu, 2012), and instead thinking of them as a process of identifying, modelling and communicating different types of scientific and community knowledge in different ways. In this context, mapping processes cannot be reduced to technical devices of postpoliticisation; instead, they are revealed as contested and contingent processes that are used in various guises, from using expert voices that impose technical judgements, to alternatively opening up political spaces where differences are aired, uncertainties discussed and choices outlined, prior to decisions being taken. Thinking of postpoliticisation in such processual terms addresses some of the recent criticisms of work in this field, with the disruptive potential of mapping processes providing an alternative, an antidote even, to de-politicising tendencies.

Several related findings stand out. First, the research reveals the complexity of motives cited by those commissioning, producing and using hazard maps. At the heart of this was a desire for good science to inform future policy development, but more managerialist motives were also visible regarding providing better public information to create more effective risk markets. Overt though economic rationalities were on occasion, they were typically intertwined with wider concerns about moral obligations to ensure the public had access to high-quality information, along with a series of public interest concerns, such as balancing the rights of current and future generations. Similarly, while it was recognised by government officials that the process of regulating societal risks also brought institutional risks (Rothstein et al., 2006), the emerging preferred approach was to move away from technocratic, expert government approaches in favour of using hazard maps more creatively to provide a political space to debate changing knowledge and options. The result was a nuanced account of the complexity and multiplicity of logics adopted by policy-makers and scientific advisers for commissioning hazard maps and using them to improve policy.

The more processual approach to cartography advocated in recent years (Kitchin et al., 2013) proved helpful in understanding the tensions that emerged between the multiplicity of scientific practices and the desire of policy-makers for simplified representations of risk on maps. Central to this search for simplicity was a desire to ensure contentious maps were “attack proof”, with multiple mappings seen as open to vested interests using alternative maps to question the robustness of “official” modelling and mapping. A political economy ran through this as local authorities, responsible for commissioning hazard maps, had limited resources and central government guidance at their disposal.

All lines on maps matter and all lines can be challenged, but our interviews revealed that controversies were more apparent when science led to technically driven policy changes that rapidly redistributed winners and losers. Where maps had been openly acknowledged as provisional and open for debate, interviewees argued that this had produced better decisions and fewer controversies.

Nonetheless, recent high-profile disputes about hazard mapping have led to a period of reflection among New Zealand practitioners and scientists about how best to use maps to facilitate public debate and improve political decision-making. While moves were afoot to shift towards co-production of hazard maps, in reality these were often still technical exercises in capturing community information in the hope of ground-truthing expert models, rather than acting as a fundamentally different blending of lay and expert knowledge, from commissioning work through to its final adoption. Arguably, at this level of engagement, from a postpolitics perspective (Swyngedouw, 2014) the concessions made are those of managing conflict rather than enabling more fundamental changes to the existing political order. This is not to say these are not

valuable changes, but rather it highlights the limited concessions on offer. The findings revealed the difficulties of addressing “the tyranny of the present” in hazard management (White & Haughton, 2017), with both “rational technocratic” government and narrowly constructed environmental protests struggling to recognise and accommodate equality of treatment for future residents, and indeed, future generations, particularly when faced with protestors seeking to protect their existing rights. Opening up mapping processes offers one way forward, creating the political space for rival claims to be debated, and communities to take a long-term view and agree future trigger points and thresholds.

More generally, the model for the public communication of science in New Zealand, as elsewhere, is quickly changing, leading to a questioning of previous efforts to move directly from scientific knowledge to simplified maps in policy documents. Interestingly, many authorities are seeing the need for an additional step, where the public becomes much more involved in deciding how best to respond to the challenges that new mapping exercises present, including which policies to pursue, rather than the previous model of leaving the public to debate preferred policy options outlined by authorities. Maps in this type of approach have the potential to be disruptive and controversial, but this was seen by many of our interviewees as a desirable quality.

The implications of this research reach far beyond New Zealand. Rather than reject maps because they are not easily defensible, or simplify the science too much, the challenge is to use maps to help identify the political implications of ever-present scientific uncertainty and complexity. Mappings in motion from this perspective requires a move away from producing a single “finished”, defensible map to also viewing maps as a preliminary act, a means for opening up public dialogue about the uncertainty of future hazards and the varied ways communities can respond. This might not only reduce the potential for reputation-damaging and costly processes of public dispute, but might also help render more visible the politics behind mapping and create valuable space for political debate into how maps affect communities now and in the future.

ACKNOWLEDGEMENTS

We gratefully acknowledge advice from the Editor and reviewers, Angela Connelly, Richard Kingston, Julia McMorrow, Paul O’ Hare and Chris Perkins, and funding supplied by ESRC grant RES-000-22-3070 and a University of Waikato Academic Research Visitor grant.

ENDNOTES

- ¹ The open comments section below the main report is interesting for the diverse views about red-zoning in Christchurch: <http://www.stuff.co.nz/the-press/news/70638977/Living-in-a-wasteland-Christchurchs-red-zone-stayers> Accessed 20 May 2016.
- ² See <http://www.scoop.co.nz/stories/AK1211/S00349/hamilton-property-owners-updated-on-flood-information.htm> Accessed 20 May 2016.
- ³ See <http://www.kapiticoast.govt.nz/whats-on/News/Previous-years/2013/Judge-rules-on-Weir-judicial-review/> Accessed 7 April 2016.
- ⁴ See <https://wellington.govt.nz/your-council/news/2012/09/blue-tsunami-lines-win-international-award> Accessed 18 September 2017.
- ⁵ See <https://www.wremo.nz/hazards/tsunami-zones/> Accessed 18 September 2017.
- ⁶ See <http://highwaterline.org/new-york-city/> Accessed 30 August 2017.

REFERENCES

- Ainge Roy, E. (2017). New Zealand river granted same legal rights as human being, *The Guardian*. 16 March
- Allmendinger, P. (2016). *Neoliberal spatial governance*. London: Routledge.
- Allmendinger, P., & Haughton, G. (2012). Postpolitical spatial planning in England: A crisis of consensus?. *Transactions of the Institute of British Geographers*, 37, 89–103. <https://doi.org/10.1111/j.1475-5661.2011.00468.x>
- Beck, U. (2009). *World at risk*. Cambridge: Polity Press.
- Bell, J., Saunders, M. I., Leon, J. X., Mills, M., Kythreotis, A., Phinn, S., . . . Morrison T. H. (2014). Maps, laws and planning policy: Working with biophysical and spatial uncertainty in the case of sea level rise. *Environmental Science and Policy*, 44, 247–257. <https://doi.org/10.1016/j.envsci.2014.07.018>
- Beveridge, R., & Koch, P. (2017). The post-political trap? Reflections on politics, agency and the city. *Urban Studies*, 54, 31–43. <https://doi.org/10.1177/0042098016671477>
- Clark, M. J., & Priest, S. J. (2008). *Public awareness of flood risk: The role of the Environment Agency flood map*. ESRC End of Award Report, RES-000-22-1710. Swindon: ESRC.
- Connelly A., Gabalda, V., Garvi, S., Hunter, K., Kelly, D., Lawson, N., . . . White, I. (2015). Testing innovative technologies for flood resilience. *Water Management – Institution of Civil Engineers*, 168, 66–73. <https://doi.org/10.1680/wama.14.00063>
- de Moel, H., Van Alphen, J., & Aerts, J. C. J. H. (2009). Flood maps in Europe, methods, availability and use. *Natural Hazards Earth System Sciences*, 9, 289–301. <https://doi.org/10.5194/nhess-9-289-2009>

- Dikeç, M. (2017). Disruptive politics. *Urban Studies*, 54, 49–54. <https://doi.org/10.1177/0042098016671476>
- Frankel, A. (2013). Comment on ‘Why earthquake hazard maps often fail and what to do about it’ by S Stein, R Geller and M Liu. *Technophyscis*, 592, 200–206. <https://doi.org/10.1016/j.tecto.2012.11.032>
- Grundy, K., & Gleeson, B. J. (1996). Sustainable management and the market: The politics of planning reform in New Zealand. *Land Use Policy*, 13, 197–211. [https://doi.org/10.1016/0264-8377\(96\)00001-4](https://doi.org/10.1016/0264-8377(96)00001-4)
- Gustafson, S. (2015). Maps and contradictions: Urban political ecology and cartographic expertise in southern Appalachia. *Geoforum*, 60, 143–152. <https://doi.org/10.1016/j.geoforum.2015.01.017>
- Harley, J. B. (1989). Deconstructing the map. *Cartographica*, 26, 1–20. <https://doi.org/10.3138/E635-7827-1757-9T53>
- Haughton, G., Bankoff, G., & Coulthard, T. (2015). In search of ‘lost’ knowledge and outsourced expertise in flood risk management. *Transactions Institute of British Geographers*, 40, 375–386. <https://doi.org/10.1111/tran.12082>
- Haughton, G., Gilchrist, A., & Swyngedouw, E. (2016). ‘Rise like lions after slumber’: Dissent, protest and (post)politics in Manchester. *Territory, Politics, Governance*, 4, 472–491. <https://doi.org/10.1080/21622671.2016.1141705>
- Hulme, M. (2009). *Why we disagree about climate change: Understanding controversy, inaction and opportunity*. Cambridge: Cambridge University Press. <https://doi.org/10.1017/CBO9780511841200>
- Kitchin, R. (2014). From mathematical to post-representational understandings of cartography. *Progress in Human Geography*, http://phg.sagepub.com/site/e-Specials/November_2014_especial.xhtml.
- Kitchin, R., Gleeson, J., & Dodge, M. (2013). Unfolding mapping practices: A new epistemology for cartography. *Transactions of the Institute of British Geographers*, 38, 480–496. <https://doi.org/10.1111/j.1475-5661.2012.00540.x>
- Kitchin, R., Perkins, C., & Dodge, M. (2009). Thinking about maps. In C. Perkins, M. Dodge, & R. Kitchin (Eds.), *Rethinking maps: New frontiers of cartographic theory*. London: Routledge.
- Knight, P. J., Prime, T., Brown, J. M., Morrissey, K., & Plater, A. J. (2015). Application of flood risk modelling in a web-based geospatial decision support tool for coastal adaptation to climate change. *Natural Hazards and Earth System Sciences*, 15, 1457–1471. <https://doi.org/10.5194/nhess-15-1457-2015>
- Kostelnick, J. C., McDermott, D., Rowley, R. J., & Bunneyfield, N. (2013). A cartographic framework for visualizing risk. *Cartographica*, 48, 200–224. <https://doi.org/10.3138/carto.48.3.1531>
- Kuklicke, C., & Demeritt, D. (2016). Adaptive and risk-based approaches to climate change and the management of uncertainty and institutional risk: The case of future flooding in England. *Global Environmental Change*, 37, 56–68. <https://doi.org/10.1016/j.gloenvcha.2016.01.007>
- Landström, C., Whatmore, S. J., & Lane, S. N. (2011). Virtual engineering: Computer simulation modeling for flood risk management in England. *Science Studies*, 24, 3–22.
- Lane, S. N. (2014). Acting, predicting and intervening in a socio-hydrological world. *Hydrology and Earth System Sciences*, 18, 927–952. <https://doi.org/10.5194/hess-18-927-2014>
- Lane, S. N., Landström, C., & Whatmore, S. J. (2011). Imagining flood futures: Risk assessment and management in practice. *Philosophical Transactions of the Royal Society A. Mathematical, Physical and Engineering Sciences*, 369, 1784–1806. <https://doi.org/10.1098/rsta.2010.0346>
- Leszczynski, A. (2012). Situating the geoweb in political economy. *Progress in Human Geography*, 36, 72–89. <https://doi.org/10.1177/0309132511411231>
- Mitchell, D., Attoh, K., & Staehli, L. (2015). Whose city? What politics? Contentious and noncontentious spaces on Colorado’s Front Range. *Urban Studies*, 52, 2633–2648. <https://doi.org/10.1177/0042098014550460>
- Monmonier, M. (2006). Cartography: Uncertainty, interventions and dynamic display. *Progress in Human Geography*, 30, 373–381. <https://doi.org/10.1191/0309132506ph612pr>
- November, V., Camacho-Hübner, 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>
- Parliamentary Commissioner for the Environment. (2015). *Preparing New Zealand for sea rises: Certainty and uncertainty*. (<http://www.pce.parliament.nz/media/1390/preparing-nz-for-rising-seas-web-small.pdf>) Accessed 6 January 2015.
- Porter, J., & Demeritt, D. (2012). Flood risk management, mapping, and planning: The institutional politics of decision support in England. *Environment and Planning A*, 44, 2539–2578.
- Rancière, J. (1999). *Disagreement: Politics and philosophy*. Minneapolis, MN: University of Minnesota Press.
- Rothstein, H., Huber, M., & Gaskell, G. (2006). A theory of risk colonization: The spiralling regulatory logics of societal and institutional risk. *Economy & Society*, 35, 91–112. <https://doi.org/10.1080/03085140500465865>
- Smith, H. M., Wall, G., & Blackstock, K. L. (2013). The role of map-based environmental information in supporting integration between river basin planning and spatial planning. *Environmental Science and Policy*, 30, 81–89. <https://doi.org/10.1016/j.envsci.2012.07.018>
- Stein, S., Geller, R., & Liu, M. (2012). Why earthquake hazard maps often fail and what to do about it. *Technophyscis*, 562–563, 1–25.
- Swyngedouw, E. (2009). The antinomies of the post-political city. In search of a democratic politics of environmental production. *International Journal of Urban and Regional Research*, 33, 601–620. <https://doi.org/10.1111/j.1468-2427.2009.00859.x>
- Swyngedouw, E. (2014). Where is the political? Insurgent mobilizations and the incipient ‘return of the political’. *Space and Polity*, 18, 122–136. <https://doi.org/10.1080/13562576.2013.879774>
- Swyngedouw, E. (2017). Unlocking the mind-trap: Politicizing urban theory and practice. *Urban Studies*, 54, 55–61. <https://doi.org/10.1177/0042098016671475>
- Thompson, M. P., & Calkin, D. E. (2011). Uncertainty and risk in wildland fire management: A review. *Journal of Environmental Management*, 92, 1895–1909. <https://doi.org/10.1016/j.jenvman.2011.03.015>

- Thompson, M. A., Lindsay, J. M., & Galliard, J. C. (2015). The influence of probabilistic volcanic hazard map properties on hazard communication. *Journal of Applied Volcanology*, 4, 1–24.
- Timar, L., Grimes, A., & Fabling, R. (2014). *That sinking feeling: The changing price of disaster risk following an earthquake*. Wellington: MOTU Economic and Public Policy Trust Ltd. (<http://motu.nz/our-work/urban-and-regional/housing/that-sinking-feeling-the-changing-price-of-disaster-risk-following-an-earthquake/>) Accessed 26 October 2016.
- UNISDR. (2015). *Global assessment report on disaster risk reduction*. (<https://www.unisdr.org/we/inform/gar>) Accessed 19 April 2017.
- van Alphen, J., Martini, F., Loat, R., Slomp, R., & Passchier, R. (2009). Flood risk mapping in Europe, experiences and best practices. *Journal of Flood Risk Management*, 2, 285–292. <https://doi.org/10.1111/j.1753-318X.2009.01045.x>
- White, I., & Haughton, G. (2017). Risky times: Hazard management and the tyranny of the present, *International Journal of Disaster Risk Reduction*. 22, 412–419. <https://doi.org/10.1016/j.ijdrr.2017.01.018>
- White, I., Kingston, R., & Barker, A. (2010). Participatory geographic information systems and public engagement within flood risk management. *Journal of Flood Risk Management*, 3, 337–346. <https://doi.org/10.1111/j.1753-318X.2010.01083.x>
- White, I., & O'Hare, P. (2014). From rhetoric to reality: Which resilience; why resilience; and whose resilience in spatial planning?. *Environment and Planning C: Government and Policy*, 32, 934–950. <https://doi.org/10.1068/c12117>
- Wilby, R. L., & Keenan, R. (2012). Adapting to flood risk under climate change. *Progress in Physical Geography*, 36, 348–378. <https://doi.org/10.1177/0309133312438908>

How to cite this article: Haughton G., White I. Risky spaces: Creating, contesting and communicating lines on environmental hazard maps. *Trans Inst Br Geogr*. 2018;00:1–14. <https://doi.org/10.1111/tran.12227>