Geopower: Reflections on the critical geography of disasters

Abstract

This paper discusses disaster risk reduction (DRR) in the context of emerging geographical ideas about topologies and assemblages. It focusses on the role of expert advice in DRR and the resulting political and epistemological issues. The critical geography of disasters still struggles to communicate with persistent scientific technical-rational approaches to hazard assessment. Furthermore, recent studies have shown the potential for expert advice to be (mis)used for political purposes. Assemblage theory might be useful in opening up this hybrid area of research, as it allows a nuanced view of disasters and DRR that can incorporate complex human-environmental relationships and diverse knowledges.

I Introduction

This paper aims to provide a broad overview of emerging themes in disaster risk reduction (DRR) research[1], from a critical human geography perspective. It argues that assemblage thinking can provide a means to "open up" DRR by gathering together its diverse components and examining the relations between them. In framing DRR as an assemblage (to which the assemblages of individual disasters contribute), this paper seeks to show the potential for human geography to gain new insights into the becoming of disasters and the processes that are involved in managing them. It argues that DRR can start to reconcile within itself the different epistemologies and ontologies that

[1] DRR research in this paper refers to a diverse and extensive body of literature whose focus is DRR: 'reducing disaster risks through systematic efforts to analyse and reduce the causal factors of disasters' (United Nations International Strategy for Disaster Reduction).

are often present in human-versus-physical approaches to disasters (e.g. Gaillard and Mercer, 2013; Hewitt, 1983, 2013). Furthermore, the increased emphasis on scientific advice in the Sendai Framework for DRR 2015-2030 provides an important opportunity for geographers to interrogate the interface between science and policy in disasters, alongside human geographical approaches to vulnerability and transformation (e.g. Pelling, 2003, 2010; Cutter, 2003).

This paper is highly interdisciplinary and is necessarily broad as a result. It does not aim to explore in detail all of the issues that it raises, but to provide an overview of emerging themes across a range of geographical literature. It is necessarily synoptic and theoretical in its approach. Initially, the paper discusses recent debates in DRR research and places them in a critical geographical context related to broad ideas of risk, knowledge and power. The following sections establish the theoretical framework within which the paper works, elucidating first assemblage theory and then geopower. Finally, six interlocking dimensions of the DRR assemblage are examined, to illustrate the human-natural flows of power and knowledge (geopower) that reverberate through the DRR assemblage, and to provide a broad framework for future research.

II Challenges, controversies and categories in DRR

Disaster risk reduction (DRR) research has explicitly distanced itself from a "technical-rational" model of disasters (White, 1945; Hewitt, 1983; Wisner et al., 2004, 2012). It has applied the concepts of vulnerability, adaptation and resilience to provide insights into the process of disaster risk reduction – and produced many critiques of these concepts (e.g. Alexander, 2013; Weichselgartner and Kelman, 2014; Cannon and Muller-Mahn, 2010; Adger, 2006; Cutter, 1996, 2003; Manyena 2006; Lewis and Kelman, 2010; Sudmeier-Rieux, 2014; Bankoff 2001). This separation of the "hazard paradigm" from the "vulnerability paradigm" (e.g. documented by Gaillard and Mercer, 2013) has been extremely productive for human geographical understanding of disasters, but is still not as effective as it might be in many practical applications (e.g. as noted by Manyena et al. 2013; Gaillard

and Mercer, 2013; Weichselgartner and Kelman, 2014; Hewitt, 2015): the hazard paradigm often dominates in governments and in the physical sciences – and often retains a positivistic epistemology (Gaillard and Mercer, 2013; Hewitt, 2000, 2013; Porter and Davoudi, 2012). Human geography has tended to focus on "bottom-up" approaches, and linking these with governmental "top-down" approaches has proved challenging (e.g. Wisner, 2003; Gaillard and Mercer, 2013). However, there is scope for moving beyond this vertical representation to examine the spaces between the vulnerability and hazard paradigms, without compromising commitment to reducing social vulnerability through transformative practical action (Pelling, 2010; Pelling and Wisner 2012).

This section charts some broad theoretical debates within and around DRR research, and some emerging ideas about its future directions (e.g. Gaillard and Mercer, 2013; Weichselgartner and Kelman, 2014; Grove and Pugh, 2015). It initially focusses on two related aspects of expert advice in disasters that have received relatively little attention in the literature – the latent, multiscalar power dynamics that exist behind the language of DRR (e.g. Pelling and Dill, 2010; Bankoff and Hilhorst 2009), and the problem of different epistemologies underlying scientific advisory practice (e.g. Donovan and Oppenheimer, 2015a). These issues open up broader questions about the epistemology and ontology of DRR research, which are discussed in the following section and lead into the argument that assemblage theory may provide a lens through which both DRR and disasters can be profitably studied.

1 Knowledge topologies between the 'paradigms'

Several authors have called for a greater interest in the politics of disaster management (e.g. Pelling and Dill, 2010; Weichselgartner and Kelman, 2014). Bankoff and Hilhorst (2009) point out that the "different political interpretations of risk reduction often remain concealed behind the facade of a shared language of disaster response". They show differences between NGO approaches to disasters in the Philippines and those of the government, and suggest that meaningful collaboration between these groups requires an assessment of "underlying values and ... intent of the various actions".

69 These issues have also been raised recently by geographers taking a Foucauldian approach (e.g.
70 Grove and Pugh, 2015), particularly in relation to climate change adaptation (CCA), which some
71 authors regard as converging with DRR (the main difference being the inclusion of geophysical
72 hazards in DRR; Schipper and Pelling, 2006; Mercer, 2010). For example, Grove (2010, 2014a)
73 discussed the framing of CCA as a form of biopolitics. The ways in which climate change policy is
74 communicated and enforced have increasingly been linked with ideas of species security. He
75 catalogues a range of examples of "power-laden assertions" within the reports of the UN and the
76 World Bank concerning climate change and associated hazards. Other writers have also argued that
77 "resilience" and "vulnerability" discourses have provided a means of control on populations (e.g.
78 Gaillard, 2010; Reid, 2012; Grove, 2013; see also the discussion in Weichselgartner and Kelman,
79 2014), and that they contain certain assumptions about the desirability of certain aspects of social
80 being (Davoudi, 2012; Amin 2013; Dalby 2013; Joseph 2013). There are ideological undertones to the
81 language of DRR that can be carried into different contexts in different ways by people in positions
82 of power. This requires that approaches to reducing vulnerability have to be critical and reflexive
83 (Pelling and Dill, 2010), and any Sendai Framework advisory mechanism will have to take this into
84 account.

85 These power dynamics are closely related to knowledge in CCA, but while there has been
86 considerable work on the application of knowledge in DRR research (e.g. Agrawal, 1995; Wisner,
87 1995; Gaillard and Mercer, 2013; Mercer, 2010; Mercer et al., 2007, 2009; Cadag and Gaillard, 2012),
88 there is less work on the power relationships involved in the provision of physical scientific advice
89 (but see Glantz, 2003 and Wisner et al., 1976). Gaillard and Mercer (2013) set out a number of
90 suggestions for improving the integration of scientific and local knowledges, noting the importance
91 of trust and spaces for dialogue in the process (see also Wisner, 1995). One issue however is that
92 "local knowledge" and "scientific knowledge[2]" are not always readily distinct, and may themselves

[2] In this paper "scientific knowledge" refers to a broad disciplinary spectrum of knowledge obtained through formal education.

represent different degrees of political empowerment (Cox, 1998; see also Mercer et al., 2010). Vulnerability and local knowledge are often associated with each other: as Gaillard and Mercer note, vulnerability is often the result of uneven distributions of power between decisionmakers and communities that are closely tied to emphasis on scientific knowledge by the former. For local knowledge to be incorporated into decision-making could be perceived as a threat both to scientific authority and to government, and as practically challenging – which perhaps explains in part why the vulnerability paradigm has had limited success at national levels despite its acceptance at international levels (Gaillard and Mercer, 2013).

Expert identification of particular groups as "vulnerable" can also result in the reduction of civil liberties and the introduction of new bureaucratic requirements that ultimately inhibit freedom, as it does in the case of terrorism and other anthropogenic threats (Collier and Lakoff, 2008, 2014). This can also be a form of biopower: the management of human beings in the context of threats to life and the implicit responsibility of the individual to help the state protect them is a "form of power that regulates social life from its interior" (Hardt and Negri, 2000). Furthermore it is a form of power that can make use of the natural system – and knowledge or uncertainty about the natural system – for its own ends (e.g. Nelson, 2010; Grove, 2010, 2013, 2014a; Yusoff, 2010; Oels, 2013; Cupples, 2012; Mahony 2014). Lövbrand et al (2009) discuss the concept of "Earth System Governmentality", which involves the coupling of human and natural systems in the climate change discourse. For Lövbrand et al., "the governmentality concept helps us to think of science as a socially embedded practice interwoven into the fabric of rule and authority" (Lövbrand et al., 2009:8; see also Platt, 1999 and Glantz, 1976). Critiques of the IPCC and other scientific advisory institutions have included a rich analysis of the roles, power and rationalities of (physical) science (Hulme, 2009; Lövbrand et al, 2009; Hulme and Mahony, 2010; O'Brien, 2010; Davoudi, 2012; Bulkeley, 2005). Moving towards an international advisory system for disasters – as called for by Wisner (2003) and more recently by Cutter et al (2015) – requires that critical social scientists work with physical scientists, and that the power dynamics of expert bodies are reflexively managed.

Physical science can make significant advances in both warning systems and in mitigation technologies, and therefore has an important role in reducing the risk from natural hazards. In doing so, though, it does not act in isolation, but forms an integral part of the social system: science and social order are co-produced (Jasanoff, 2004) and science cannot be separated from its social context. However, many authors note the continued persistence of positivism in the physical scientific approaches to hazards (Weichselgartner and Kelman 2014; Porter and Davoudi, 2012): this remains the primary challenge in interdisciplinary approaches, and is a key challenge in implementing the Sendai Framework for DRR with a broad view of 'science'. Human geographical input into risk assessment can be greatly beneficial (e.g. Lane et al., 2011; Demeritt et al, 2010, 2013), and can increase the confidence of local people in the scientific process. A major challenge of recent disasters has been the justification and communication of decisions made under uncertainty – the most striking example perhaps being the court case surrounding the L'Aquila earthquake (Alexander, 2010, 2014) – and this is exacerbated by advisory groups that are composed purely of physical scientists. That disasters are "largely acts of man" (White, 1945) is an accepted doctrine, but it has to incorporate human geographical understandings of the power dynamics, reputational fears, disciplinary limits and uncertainties *of scientists* in the risk assessment process (e.g. Mahony, 2014; Donovan and Oppenheimer 2015b; Hulme, 2009): the topology of knowledge is more complex than human-versus-physical. It also requires engagement with the nature of causality in disasters: this is at the root of the separation between the "hazard" and "vulnerability" paradigms.

2 Complexity and the attribution of causality

The complexity of a disaster undermines abilities to model or explain it, and clearly renders deterministic approaches overly simplistic, yet deterministic thinking is very pervasive. To give an example, human geographers have argued persuasively that the term "natural disaster" is a misnomer, and this has been accepted by many practitioners (O'Keefe et al., 1976; Cannon, 1994; Hewitt, 1983, 2007, 2013; Gaillard and Mercer, 2013; Wisner et al., 2004, 2012). Yet even within

144 social science, the phrase is still used (e.g. Neumayer et al., 2014; Spillius, 2013; Chen et al., 2012;
145 Hochreiner and Mechler, 2011), and it is ubiquitous in the biomedical and physical scientific
146 literature. Removing the "natural" is an interpretative rather than descriptive move, and one that
147 therefore hints at a deeper epistemological problem resulting from deterministic approaches. Simply
148 put, in a deterministic framing, the description of a volcanic eruption as a human problem suggests
149 that if the eruption was removed, there would be no disaster. With climate-related disasters, the
150 point may be less clear-cut because of the role of human-induced climate change, but the
151 collaboration of the earth system in the disaster at best makes causation murky. Furthermore, as
152 noted by Pelling and Dill (2010), the term does allow distinction between anthropogenic hazards and
153 natural hazards. This argument does not undermine the accepted notion that social inequalities,
154 corruption and poverty are major factors in the progression from natural hazard to disaster. What it
155 suggests is that opposing the paradigms is problematic – partly because of ontological differences
156 between groups of users in how causation is understood – and that taking a relational approach may
157 be more appropriate (Kruger et al., 2015): disasters are more than natural, but they are also more-
158 than-human (Whatmore, 2006). Assemblage theory has a great deal of potential here because it can
159 cope with relational thinking and also with realism (e.g. Allen, 2012), enriching the collaborative
160 application of human and physical approaches to disaster at all levels.

161 Dittmer (2014), in calling for a "posthuman geopolitics rooted in assemblage theory", notes that
162 such an approach would enable objects and environments to gain agency in geopolitics (Dittmer,
163 2014; Dalby, 2009). This view of human-nature interactions that focusses on agency rather than
164 causality – "it entails no determinism at all" – allows reassessment of the ways in which disasters are
165 formed out of multicomponent social and natural factors, all of which are connected in ways that are
166 often non-linear and qualitative. Disasters may be best conceptualised as assemblages: gatherings
167 of relationships and topologies that are characterised by an event but are defined by their content
168 and the distribution of power. The DRR literature shows this in its consideration of the multiplicity
169 and complexity of individual case studies. For example, Ferreira (2011) shows that "blindness" in

international interventions, the particular combination of legislation and a range of dysfunctional relationships between institutions and agencies fed into the "precariousness" that contributed to the impacts of the 2010 Haitian earthquake. O'Connor et al (2014) read the aftermath of the earthquake through the lens of biopolitics, demonstrating the use of aid as a mechanism for governing the failed state: "liberalism invents strategies to govern at a distance". The problems encountered by the Haitian state are framed as failures of democracy, and failures of democracy allow the UN and associated bodies the power to make aid conditional upon aspects of democratic reform (O'Connor et al., 2014). The earthquake, however, as a physical phenomenon, compounded this not only in the involvement of the physical environment in exacerbating the social problems, but also in the lack of knowledge it revealed. The faultline on which the earthquake occurred was unmapped (Calais et al., 2010), but the presence of seismic hazard in the region should not have been a surprise (e.g. Taber, 1922). This demonstrates the oft-ignored importance of knowledge topologies in the context of disasters: lack of knowledge may be part of the challenge, but the placing of knowledge is also non-trivial – the translation of knowledge across boundaries may be closely tied with the topologies of power and geopolitical representations.

This paper suggests that assemblage thinking can "open up" a relational approach to disasters that integrates the critical thinking within the vulnerability paradigm with a broader range of ideas from human geography that extend DRR into geopolitics and geography of science[3], and draws on the materiality of physical science. The physical sciences will always be needed by governments in the context of hazards – and there are human processes within the physical sciences that deserve serious scrutiny (e.g. Morss et al., 2005; Demeritt et al., 2010, 2013; Hulme 2009). The conclusion that governments can reduce disasters through better governance (Hewitt, 2013) can also actually empower governmentality (Reid, 2012; see also discussions of the "emergency state" in Adey and Anderson, 2011; Anderson and Adey, 2012). Furthermore, DRR has a tendency to encode its

[3] The geography of science has been described extensively in the work of Livingstone (2003, 2005), Powell (2007) and others.

methods into what Grove and Pugh (2015) refer to as “a modernist imaginary” – concepts that seek to render a situation governable, such as adaptive capacity. As Grove and Pugh (2015) argue regarding participatory research, the challenge is to “work against the categorical closures of a liberal will to truth”. Assemblage theory allows a nuanced approach that can focus DRR around its inherent transdisciplinarity. In the next section, this is explored in more detail.

III Assemblage, knowledge and power

This section first defines and explains the use of assemblage theory in this paper. It then contextualises this discussion in the broader history of social thinking about disasters to show the emergence of the DRR assemblage.

1 Assemblage and Geopower

We will call an assemblage every constellation of singularities and traits deducted from the flow—selected, organized, stratified—in such a way as to converge (consistency) artificially and naturally; … Assemblages may group themselves into extremely vast constellations constituting "cultures," or even "ages"...

Deleuze and Guattori, 1987, p.406.

Social assemblages... contain mechanisms which, in addition to causal interactions, involve reasons and motives... assemblage theory, in which assemblages can be component parts of other assemblages.... can accommodate these complex forms of causal productivity.

DeLanda, 2006, pp.19-20.

Assemblage has been variously defined in the geographical literature (e.g. overviews in Robbins and Mark, 2009; Anderson and Mcfarlane, 2011). An assemblage is an entity that is composed of heterogeneous components that may be material or expressive and may be multi-scalar. The components of an assemblage may also be components of other assemblages, and the interactions

between the components can be difficult to assess or quantify – thus incorporating complexity and non-linearity. Assemblage theory has been applied to cities, social action groups, mosquito management, energy policy, participation in disaster management, and geopolitics, to give a few examples (e.g. Mcfarlane, 2009, 2011; Davies, 2012; Grove, 2014b; Grove and Pugh, 2015; Sassen, 2006; Harrison and Popke, 2011; Shaw et al., 2010). Its appeal was discussed by Dewsbury (2011) as arising out of the turn towards relational thinking and the limitations of networks as a means of interrogating socio-spatial entities. Assemblage implies a level of activity that is not adequately represented through network thinking. Thus, a city may be an assemblage of networks, resources, technologies and groups (Mcfarlane, 2011). A volcano might also be an assemblage of human-nature constituents, including the livelihoods, identities, cultures and imaginations of populations, alongside the physical movement of magma in the earth and the scientific interpretation of the signals it provokes.

Disasters and DRR can be viewed as assemblages. They incorporate networks, groups, concepts, power dynamics and physical/environmental/hybrid factors. They rarely exhibit any predictable linearity, but they can be represented on what DeLanda (2006) refers to as the axes that define assemblage: the roles that each component may play (ranging from material to expressive), and the processes in which they are involved, which either reinforce the identity of the assemblage (territorialisation) or undermine it (deterritorialisation). To these, DeLanda adds a third dimension, that of coding and decoding, which represents processes that involve particular expressive devices to either stabilise identity or to make it more flexible. This might include concepts such as "vulnerability" and "resilience", for example, which are often employed to stabilise the identity of DRR, but can also destabilise it. Equally important is that assemblage components are characterised by 'relations of exteriority': the components of an assemblage, and indeed the assemblage itself, can be part of other assemblages in which they have a different role.

241 Assemblage theory emphasises the relational construction of identity, which links directly to recent
242 geographical debates (e.g. Massey, 1999; Amin, 2004; Sparke, 2007): the identity of DRR, for
243 example, is closely related to the terminology it uses. In disasters, this takes on a different tone: the
244 relationship between people and a place can be dramatically changed, as the physical damage
245 defamiliarises the physical and human landscape and threatens identity. Space, like risk, is dynamic.
246 A volcanic eruption defamiliarises not only the physical landscape, but also the relationships
247 between people, and between people and the volcano, which may be cultural and economic: the
248 physical process of eruption deterritorialises the volcano assemblage (Donovan and Oppenheimer,
249 2015b), but it also changes it and adds to it. The eruption of Eyjafjallajökull was not a surprise to
250 volcanologists (e.g. Oppenheimer, 2010), but it sent shockwaves across governments and industry in
251 Northern Europe. It neatly demonstrates the intersection of knowledge networks, the aviation
252 industry, policymakers and the earth system. The volcano triggered a response that rapidly spread
253 around the globe, as aeroplanes were in the wrong places, flights were cancelled, and economic
254 impacts felt by governments, the aviation industry, travellers and insurers – and Icelandic farmers
255 (Adey et al., 2011; Donovan and Oppenheimer, 2011; Eiser et al., 2014). Eruptions are
256 transformative: they can force significant re-ordering of fragile human networks (Adey et al., 2011).
257 The changes to the physical and human landscape tend to be permanent (on human timescales), and
258 require the redrawing of maps and even boundaries when new crust is formed. There may be links
259 between a city on a volcano and the volcano itself – for example, through the use of geothermal
260 power or dependence on volcano tourism, which is increasing around the world (e.g. Kelman and
261 Mather, 2008; Benediktsson et al., 2011). Ultimately, the volcano itself has agency within the
262 human-physical environment to transform such links and to continue transforming them long after
263 the physical eruption has ended.

264 Shaw (2012) argues the case for “geo-events”: transformations of the world that occur due to
265 forcing from objects. Volcanoes, eruptions, faultlines and earthquakes fit into this category: their
266 distinction from the human is also the source of their forcefulness as objects, and paradoxically

267 defines their relationship with the human, not least because of the complexity they pose in time and
268 space and its impact on human imagination and identity. Gaston Bachelard, in his Poetics of Space,
269 notes that:

270 *Space that has been seized upon by the imagination cannot remain indifferent space subject to the*
271 *measures and estimates of the surveyor. It has been lived in... with all the partiality of the*
272 *imagination.*

273 The act of being imagined changes the nature of space and the ways in which it is valued. Thus,
274 "future geographies" are created and defended against disaster (Anderson, 2010), and the
275 unimaginable becomes deeply problematic. One characteristic of geophysical disasters is that they
276 force a new future upon a population. Bachelard opposes causality to *reverberation*. He is interested
277 in the reverberations that define the poetic image; however, there is something attractive in the
278 concept of reverberation as opposed to causality: disasters are characterised by reverberations of
279 shifting identities, power dynamics and spatialities. This paper builds on this through the concept of
280 "geopower": the reverberating impact of such events on the economies and topologies that
281 surround them.

282 The term "geopower" has been used intermittently in the literature to describe interactions
283 between the forces and networks of life, and the forces of the earth itself (e.g. Luke, 1999; Grosz,
284 2008; Yusoff et al., 2012). In this paper, it provides a means of analysing disasters through the
285 reverberations in assemblages that include both human and physical components. When an external
286 forcing occurs for example, biopower may employ that "geo-event" as a means of control and an
287 instrument of governmentality, while social and economic relationships are also re-ordered and
288 scientific interpretations are imposed. The event itself is thus transformed as it encounters the
289 human, and the relationship between the human and the natural shifts in ways that are affected by
290 the presence of particular topologies – including expert knowledge structures, power structures,
291 value systems and governmentality – as a disaster is assembled. Aspects of the ways in which these

systems are affected may be described by resilience or as vulnerability. Disaster assemblages are characterised by complex ideas, physical processes, physical-human interactions (e.g. via affect and imagination), human cultures and technologies that experience a varying power distribution in time. The unpredictable shifts in the distribution of power, which reverberate through the assemblage, are conceptualised here as "geopower".

2 Disaster assemblages and assembling DRR

Assemblage theory opens up forensic spaces for geographers to reconceptualise disasters as gatherings of components that interact with one another and with other assemblages of which they are a part (such as cities and cultures). It also provides a space in which the complex landscape of DRR itself can be examined – looking at how vulnerability, resilience and other key concepts are used, how cultural values feed into them, the ways in which the ontological differences between the social and physical sciences are worked out in DRR, the role of institutions that function at different (often overlapping) scales, and the differences in the physical geography and impacts of hazards. For example, Grove (2014c) used "adaptation machines" to describe "neoliberal disaster resilience". He argued that in Jamaica, adaptation machines provided a means for appropriating the community's "inherent adaptive capacity" for particular ends: disaster management can itself be a form of "power by stealth". The means by which it does this vary in space and time, and Greg Bankoff's extensive work in the Philippines has demonstrated the value of historical approaches to understanding disasters (Bankoff, 1999, 2003). Not only do disasters depend on historical factors (such as land use), but institutional and even expert histories and narratives are also important. Taking a relational approach to this can combine insights from vulnerability, science studies and physical science itself through understanding the ways in which disasters are assembled from pre-existing social networks, power relations and knowledge topologies, producing a hybridisation of 'causes' and contributing factors.

316 The DRR assemblage is composed not only of histories of disasters, but its own historical foundations
317 elucidate its assembled nature. The vulnerability paradigm has its roots in a debate between Voltaire
318 and Rousseau in the aftermath of the Lisbon earthquake of 1755 (e.g. Chester, 2001; Dynes, 2000).
319 While Voltaire took the view that the disaster affirmed that God was not concerned about suffering,
320 Rousseau offered what Dynes (2000) refers to as "the first truly social scientific view of disaster":

321 *It was hardly nature who assembled there twenty-thousand houses of six or seven stories. If the*
322 *residents of this large city had been more evenly dispersed and less densely housed, the losses would*
323 *have been fewer... But we have to stay... because what we would have to leave behind is worth more*
324 *than what we could carry away.* Rousseau to Voltaire, 18 August 1756

325 Rousseau focusses on the ways in which humanity exacerbates disasters in order to emphasise that
326 disasters are not the result of God's cruelty (as suggested by Voltaire). He further asks, "Will we say
327 that the order of the world must change to suit our whims, that nature must be subject to our laws,
328 that in order to prevent an earthquake in a certain spot, all we have to do is build a city there?"
329 These quotations are interesting for two reasons: first, they demonstrate that the vulnerability
330 paradigm has roots in a moral philosophical debate about the nature of being; second, they show
331 the complexity of interpreting the human-natural relations of disasters.

332 Immanuel Kant followed Rousseau in ascribing the effects of the earthquake to human action, and
333 he also sought to identify its physical characteristics. Kant's work is critical because of his strong links
334 with the eighteenth century aesthetic of the sublime (which sought to understand the close
335 relationships between beauty and fear in nature), and also because his work was scientifically rather
336 than theologically driven: he saw the earthquake as a challenge to natural philosophy, and sought to
337 explain the physical processes involved. He also noted the benefits to humanity of geological
338 phenomena, such as hot springs and metal ores, in a manner not dissimilar to the literature on
339 sustainable livelihoods (see Reinhardt and Oldroyd, 1983). These attempts to reconcile issues of
340 morality with ideas about nature, causality and society fed into the development of the geological

sciences in the nineteenth century, and the establishment of institutions tasked with the surveillance of natural phenomena (such as the Vesuvius Observatory). Kant's "scientific turn" (Larsen, 2006) was characterised by its material approach. Indeed, Larsen (2006) argues that the risk society (Beck, 1992) "is born in Kant's writings after the Lisbon earthquake" and the earthquake's "overwhelmingly powerful materiality": it brought into focus the human responsibility for the future that pervades modern discourse about disasters alongside the physical scientific challenges. The earthquake contributed to the reordering of natural scientific and philosophical approaches to disaster – a manifestation of geopower.

The recent history of DRR research highlights the shift from technical-rational approaches that highlighted knowledge-deficit methods for "education" and the increase of technological methods (evidenced in the documentation that accompanied the International Decade for Natural Disaster Reduction 1990-1999, for example) to vulnerability-dominated approaches (e.g. the Hyogo Framework for Action, 2005-2015, and the Sendai Framework for DRR, 2015-2030; see also Furedi, 2007). This shift is partially driven by the recent history of disasters and their epidemiology, but also by the significant work of geographers in the 1960s and 1970s, advocating a human ecological approach to DRR (e.g. Burton and Kates, 1963; Burton et al., 1968; O'Keefe and Wisner, 1977). Understanding history is thus not only important for understanding the nature and value of local knowledge (Bankoff, 2012; Gaillard and Mercer, 2013; Oliver-Smith, 1999), but also in framing academic and policy discourses of DRR. Discourses within DRR are historically and culturally grounded, even where they are cross-culturally applied. DRR is an assembled product of ontological and epistemological reasoning regarding human societies and their relationship with the earth system, often focussed on Western thought (see also Bankoff, 2001, 2004). It is also strongly determined by the history of that relationship, including the assembling of individual disasters. This perspective opens up opportunities for understanding DRR in its historical context as a collection of relationships between institutions, concepts, ideas, morality, ideology, scales, events, ontologies and knowledges.

In thinking about disasters and about DRR as assemblages, the distinctions between macro-micro, physical-human, subject-object cease to be the focus of attention. Disasters themselves are assemblages of institutional practices, communities, NGOs, technologies, knowledges, volcanoes – but they are also themselves part of the DRR assemblage (DeLanda, 2006): they can be viewed as nested, for example, through processes of forensic investigation and the narratives that result. DRR combines particular expressive encodings (adaptive capacity, participation, resilience, vulnerability, hazard), material features, institutions and practices, all of which it deploys as a means of clarifying its own identity – a process that is exemplified through the machinations of the UN noted above but that also derives from the deeper philosophical history and geography of disasters and human-nature relations. Assemblage also accounts for the complex relations that define DRR through time and space, and for the instabilities in DRR that arise from the potentialities within it. For example, the Sendai Framework for DRR 2015-2030 systematically distinguishes between two scales – "local and national" and "regional and global". Such a separation is arguably a practical necessity because the Framework is an international document that requires particular responses from governments (see also Macfarlane, 2009, for a discussion of the relationship between order and hierarchy). Gaillard and Mercer (2013) note that "there is an important need to address power relations within and across scales in order to reduce the manifestations of hierarchies of scale"; they call for greater emphasis on national and local rather than global. Assemblage reframes spatial concepts as relational – "near and far", based on proximity and distance rather than scale. Its focus on the assembling of the "social" also allows us to reclaim DRR – including the physical scientific aspects (hazard forecasting, monitoring) – as a part of the social, whilst allowing a realist perspective that resonates with physical scientists (e.g. Anderson et al., 2012).

IV Geopower and disaster risk reduction

This part of the paper discusses six areas in which the complex dynamics of DRR are manifest, and which might provide useful perspectives. These areas are characterised by topological flows of ideas,

objects and actors, and they are linked together in the DRR assemblage: they could be viewed as lenses through which its parts may be envisioned, and through this, the assemblages of individual disasters. The purpose of this section is to elucidate the relational dynamics of the DRR assemblage in a practical way: assemblage theory can be presented as an interesting way of describing a socio-spatial phenomenon, but it is sometimes insufficiently practically applied.

1 Governance and governmentality in disasters

Complex power dynamics come into play when human systems and the earth system interact. The behaviour of the natural system can affect the rights that citizens hold. In 1996, the Governor of Montserrat gained the right to order mandatory evacuations, under the Emergency Powers Act. This continued to be a controversial legal matter (e.g. Aspinall and Sparks, 2004; Donovan et al., 2012a), as the felt rights of citizens to remain in their homes came into conflict with the protective power of the state. This has occurred in other situations, notably during Hurricane Katrina, where many citizens of New Orleans did not obey mandatory evacuation orders due to health issues, mobility problems and fear of looting (e.g. Nigg et al., 2006). In some areas, mandatory evacuations have had success – in the 2010 eruption of Merapi volcano in Indonesia, for example, evacuations saved 10,000 to 20,000 lives (Surono et al., 2012). Others have documented the ways in which the closing down of facilities and even islands during “Superstorm Sandy” led to power struggles between government and residents, who had different views about what it means to be resilient and whether resilience was being used to promote active citizenship at the expense of governmental responsibility to help (see for example Evans and Reid, 2014). In each of these cases, the idea of resilience is dependent on the experience of different actors (see also the detailed discussion in Weichselgartner and Kelman, 2014).

Governments in disasters tread a difficult line between protecting people and encroaching upon their freedom. In some respects, this is similar to the findings of recent research in CCA (e.g. Grove, 2010, 2013, 2014a,b). Davoudi (2014) argues against the “dominant discourses” of climate change in

presenting nature as a threat rather than a resource. Not only that, but nature has also been re-formed by human intervention in the "anthropocene" (Crutzen, 2000). Critically, this has allowed paradigms of risk management to be produced that use the 'empowerment' of citizens to neutralise them as a threat as they become "governable" (Pugh, 2014; Grove, 2013), sometimes through insurance (e.g. Collier, 2014). Governmentality is therefore an important component of DRR, but it is also one that has to remain connected to broader ideas about human and nonhuman natures: power reverberates between human attempts to govern other humans and thereby manage a disaster, and the rages of the non-human nature as humans attempt to understand it and limit it. The becoming of a disaster can be mitigated through effective governance (Hewitt, 2013; see also Wisner, 2003 and Pelling and Wisner, 2012), but the use of warning systems, expert advice, and DRR terms, for example, demonstrates that disasters are not so much "unnatural" as "more-than-natural": they involve complicated interactions between humans and nature that require interpretation and analysis. Governance – whether effective or ineffective – is crucial in the assembling of a disaster, and it is also highly nuanced and ambiguous through the flows of power and knowledge that are ensconced within it as it interacts with nature and interpretations of nature (Bankoff and Hilhorst, 2009; Pelling and Dill, 2010).

2 Expert advice, power and uncertainty

Geographers and sociologists of science have highlighted the potential power that expert bodies may have in governance, and the threat it poses to democracy (e.g. Beck, 1992; Jasanoff, 1990, 2004, 2005; Wynne, 1989, 1992). In current terminology, that power is often ineffectively characterised through the terminology of "evidence-basing": power is attributed to the "evidence" to avoid the impression that human agency has a role in policy-formation. This rhetoric is found in scientific reports from the volcanic eruptions on Montserrat, for example (Donovan et al., 2014). This terminology is problematic for several reasons, not least that the "evidence" is frequently uncertain – and policy is most likely to be based on inference from the (uncertain) evidence.

Expert bodies may also be vulnerable, however: scientists on Montserrat were sometimes blamed for unpopular political decisions (Donovan et al., 2012a) and six seismologists from Italy were sentenced to six years in jail as a result of their recommendations as part of an advisory panel (Alexander, 2014) – though they were subsequently acquitted at appeal, again showing the volatility of expert positions. The position of expert advisors varies between governments, but remains sub-politically ambiguous. Expert groups generally do not make decisions, but in crisis situations may be effectively making them: in some cases, for example, the increase of a volcanic alert level might automatically provoke an evacuation (e.g. Donovan and Oppenheimer, 2015a). Experts may thus be regarded as wielding power themselves, or as subject to abuse by power. Uncertainty, too, can be manipulated and used as a reason for decisions that are controversial (Power, 2004; O'Malley, 2011; see also Rothstein et al, 2006) – linking back to governmentality.

These examples demonstrate several key aspects of expert advice and the way that it is used in disaster management: it can be used for political ends, and it can assume knowledge-power itself as experts seek to "educate" the public (often an important part of a volcano observatory's work). The machines of expert advice are very varied between governments (e.g. Jasanoff, 2005), but they invariably have agency within the structures of disaster governance. Disasters can produce significant redistributions of powers through knowledge topologies (with associated uncertainties), as scientific institutions compete for visibility, funding and field time; political institutions seek to manage land use in dependence on scientific advice; social groups object to evacuations. All of these activities cause ripples in the DRR assemblage, as groups seek to increase or decrease their involvement, and are ultimately manifestations of geopower.

3 Vulnerability and imbalances of wealth, resources and scale

Vulnerability to disasters has been conceptualised in many ways, with some authors distinguishing between social and physical vulnerability, for example (Adger, 2006; Cutter, 1996). Vulnerability assessment has become a critical aspect of DRR (Pelling, 2007; Smit and Wandel, 2006). Often,

vulnerability is taken as more or less the polar opposite of resilience, though this has been critiqued by several authors (e.g. Gallopin, 2006). Some authors (e.g. Cutter, 2003; Birkmann 2006) have sought to quantify vulnerability using multiple measures. This is strongly dependent upon the availability of data, however, and tends to be limited to countries for which this data exists, such as the US. Vulnerability has proved to be an extremely valuable concept in DRR, in spite of shortcomings (e.g. Bankoff, 2001; Lewis and Kelman, 2010). It also functions as an organising idea for a large range of social factors that combine in the assembling of disasters, including poverty, education, healthcare, housing, gender and political stability. O'Brien et al (2004) conceive a spectrum from "vulnerable" to "resilient". They also note the important influence of scale on vulnerability and the ways in which it is conceived (see also Fekete et al., 2010; Wisner 1993). Small-scale resilience might translate to large-scale vulnerability, for example. The links that have been made in the literature between "vulnerability" and certain types of "other" or certain places can also be a form of geopolitical conceit (e.g. Bankoff, 2001), a way of dividing up the world. More usually, however, vulnerability is a characteristic of a world already divided (Wisner et al., 2012).

Adger (2006) notes that there are a range of approaches to vulnerability research, which have different epistemological foundations. He separates vulnerability of socio-ecological systems (SES), and vulnerability resulting from poverty (e.g. the sustainable livelihoods approach). Both of these theoretical approaches have significantly advanced the understanding of disasters, evidenced by their continuing application by researchers (e.g. Kelman and Mather, 2008; Gaillard 2010; Turner et al., 2003; Watts and Bohle, 1993; Wisner et al., 2004, 2012). The former approach highlights the ability of SES to adapt, while the latter suggests that vulnerability is related to powerlessness. The different readings in the literature on both vulnerability and resilience have sometimes led to confusion, but there is considerable merit in juxtaposing them and observing their impact on one another (see for example Romieu et al, 2010 on differences between climate change and DRR). Multiple meanings can co-exist. Adger (2006) concludes that the diversity of meanings may be a strength not a weakness and that a major challenge is the "interlocking of explanations of cause and

493 effect between disciplines". However, the language of cause and effect is overly simple in this
494 context: influences and relationships between different factors and ideas are involved. Vulnerability
495 is a conceptual and dynamic landscape of connections in which the separation of human and natural
496 is not straightforward, and it is reconfigured by geopower. In this theme, it is envisioned through
497 resource imbalances and scale, but the next theme also brings important perspectives on
498 vulnerability, particularly in terms of its use in different ideological contexts.

499 4 Values, ideologies and social empowerment

500 Vulnerability and resilience are both concepts with considerable analytical ability in the context of
501 DRR, evidenced by the range of studies that apply them (e.g. Gaillard, 2007; Manyena, 2006;
502 Alexander, 2013; Folke, 2006), but they also require reflexive assessment. Bankoff (2001) critiques
503 vulnerability as a "Western discourse", and notes that it holds within it the risk of writing off large
504 sections of the world as "disease-ridden, poverty-stricken and disaster-prone" (p19). He links this
505 with historical Western views of the world, drawing on the world of Edward Said and others, and
506 highlights the dangers of this in terms of Western interference. Bankoff brings a historical
507 perspective to bear on the idea of vulnerability (2001, 2003, 2004). Chester et al (2008) argued that
508 the prevalence of often secular Western researchers in DRR has led to underestimation of the
509 importance of religious worldviews in disasters. Vulnerability is the result of a connected thread
510 through time and space, and is dynamic (Lewis and Kelman, 2010), both in its meaning and in its
511 purpose as a term. This suggests that DRR research can play a key role not only in understanding
512 vulnerability and the resilience of a community, but also in interrogating the political and cultural
513 networks and ideologies behind and induced by "resilience" and "vulnerability". These topologies
514 include NGOs, governments, scientific academies and the insurance industry, as well as local
515 networks of disaster managers and social groups (Walker and Cooper, 2011). These groups have
516 different levels of influence in the disaster process, and the ways in which they exercise that
517 influence may employ concepts like "vulnerability" and "resilience". Amin (2013) notes:

Through such exhortations, the uncertain future is rendered a shared societal problem, an opportunity to temper the furies of fate through individual and collective empowerment. Any inconsistency between narrating the turbulent future as governable and ungovernable, or opportunity and threat, tends to be smoothed over by a new lexicon of words with ambiguous meanings. P141

The ambiguity of resilience as a term is both a strength and a weakness in DRR (e.g. Weichselgartner and Kelman, 2014), and may be behind Manyena's (2006) argument that it is not quite a paradigm: it has usefulness, but is not flawless. Even the rhetoric of social empowerment is an exercise of power that betrays values and philosophies. As Bankoff and Hilhorst (2009) argue, vulnerability depends to some extent on positionality. They make the further point that the language of disaster response can hide political aims. In the example that they give – the eruption of Mount Mayon in 1999-2000 – the government ultimately decided to resettle over a thousand families permanently. The cost of relocation was viewed as less significant than the risk of leaving people living close to the volcano. Similar discussions surrounded the Chaitén eruption in Chile in 2008.

Alexander (2007) writes:

Governments have a moral duty, and usually also a legal and constitutional one, to protect their citizens against foreseeable sources of harm (50).

He goes on to show some of the differences in the civil management of emergencies, particularly in terms of organisational structures between governments, and relates media portrayals of Hurricane Katrina to discrimination in aid management. He concludes by arguing that disaster management would benefit from being "more participatory and more democratic" (56). This echoes other DRR researchers (e.g. Batterbury et al., 1997; Pelling, 2007; Hewitt, 2013). In linking value with adaptation in this section, this paper seeks to highlight the moral aspects of this debate, which are relatively rarely discussed yet underlie normative approaches to DRR. Adaptation is hinged on

542 improving lives and livelihoods, as are the reduction of vulnerability and the building of resilience.
543 Yet the choices and decisions that are made are dependent on a range of motivations in individual
544 components of the disaster assemblage.

545 Understanding these relationships – the messy and challenging impacts of ideology, values, political
546 perspectives and hidden motives of individuals and institutions – is important because it aids the
547 negotiation of multiple scales in the previous theme. DRR has tended to be ensconced in a broad
548 international language that expresses a Western worldview (e.g. as discussed in Bankoff and
549 Hilhorst, 2009; Grove and Pugh, 2015). If these signifiers are viewed as part of an assemblage, they
550 become single components among many. They do not lose their importance, but their
551 (de)territorialising role becomes clearer and can be critiqued. Furthermore, the complex local and
552 cultural processes that affect DRR such as the relationships between individuals, place and identity,
553 can be examined alongside the discourses of power and knowledge between governments (see also
554 Oliver-Smith, 2015). This is part of the complex negotiation of scale that assemblage allows: while
555 DRR practice distinguishes local, national, regional, global scales in theory, in practice many of the
556 institutions and agencies are multiscalar in their scope and activities. The separation of scale is not
557 simple, and is often politically driven (e.g. Adger, 2006; Marston et al., 2005; Marston, 2000; Yates,
558 2012; Neumann, 2009). Bulkeley (2005) explored this issue in environmental governance, noting the
559 difficulty of untangling scale and authority, and suggesting that a more productive approach might
560 “move beyond nested hierarchies, the separation of levels of decisionmaking, and the divisions
561 between territorially bound states and the fluid relations of non-state actors”. Assemblage aids this
562 because it looks at the relationships between components rather than their scale. The issue of scale
563 becomes even less readily managed in the context of different and conflicting value systems,
564 ideologies and ambitions, such as those imposed by geopolitical imaginations.

5 Disasters and Geopolitical risk

Geopolitical risk is most often characterised as risk that emerges from conflicts and instability. It is difficult to quantify or assess, because it is dependent on imagination and emotion (Pain, 2009). Ultimately, it is created by an unstable balance of power between governments, and the potential for shifts in that balance to create economic, social and political upheaval. The assessment of geopolitical risks is of interest to the banking and insurance sector, and to governments. In the context of DRR research, geopolitical risk can be also increased if a major event disrupts economic, political and/or social networks at a regional scale (e.g. Nelson, 2012; Drury et al., 2005; Middleton and O'Keefe, 1997; Barzeger, 2012; Salloukh, 2013). There are a number of recent examples, notably the 2011 Great East Japan Earthquake and Tsunami (GEJET). GEJET refocused the attention of the Japanese government towards internal problems and away from, for example, Chinese territorial ambitions in the East China Sea (Hirano, 2014). There are several dimensions in this picture of geopolitical risk, however. For example, the size of the Japanese economy led to increased risk, as did its dependence on imports and on nuclear power.

Disaster geopolitics is emerging as an important field for research, and several authors have noted the potential for disasters to be "used" for states to excuse conflict, for example (e.g. Kreutz, 2012; Nelson, 2010; Billon and Waizenegger, 2007), or to affect international relations through disaster diplomacy (e.g. Gaillard et al., 2008; Kelman, 2006, 2007; Gaillard and Kelman, 2009; Kelman et al., 2006; Kelman and Gaillard, 2007). Aid, too, has been associated with geopolitical ambition (e.g. Nelson, 2012; Duffield, 2002, 2012). Pelling and Dill (2010) called for a new research programme on disaster politics, arguing using a range of case studies that disaster politics are multi-layered and complex, and operate at a range of scales:

Disaster shocks open political space for the contestation or concentration of political power and the underlying distributions of rights between citizens and citizens and the state (p14).

589 Disaster also reverberates through networks and globalisation: it can affect the balance of power
590 between states. It links to knowledge topologies as DRR practitioners learn from disasters, and it
591 affects preparation for future disasters at the state level and internationally (e.g. the complex
592 impacts of the Fukushima nuclear disaster on global energy security – which required the
593 mobilisation of experts at many levels to inform governments with different agendas; for example,
594 Hayashi and Hughes, 2013; Wittneben, 2012). Disasters relay geopower: they change the power
595 relationships between the components of which they are composed, whether human, physical or
596 hybrid. This can include the power relationships between different groups of experts, such as
597 physical scientists, medical doctors, or social scientists (Kuus 2013).

598 ## 6 Hazard and risk assessment under uncertainty

599 This theme is concerned with the production of physical scientific models for hazard and for risk. The
600 process of hazard assessment might appear at first sight to be relatively straightforward, at least
601 theoretically. However, there are considerable variations in the philosophies, methodologies and
602 observational datasets available for assessing different hazards. Seismological hazard assessment
603 (SHA) has been undertaken around the world for decades, dominantly using probabilistic methods
604 (PSHA; Cornell, 1968). More recently, deterministic methods – and "neo-deterministic" methods –
605 have challenged PSHA as underestimating the risk and failing to take into account all available
606 information (e.g. Castanos and Lomnitz, 2002). Following the L'Aquila earthquake in 2009, for
607 example, determinists argued that probabilists were negligent because a deterministic assessment
608 would have shown elevated ground shaking in the region.

609 Volcanic hazard assessment is very different from seismic assessment – there are frequently
610 observable precursors to volcanic eruptions. Nevertheless, there are disagreements on the most
611 reliable means of analysing data and converting observables to quantitative hazard and risk
612 assessments, with some scientists advocating subjective probabilistic methods (e.g. Aspinall, 2010).
613 In both volcanology and seismology, the debates hinge around the nature and achievement of

614 "objectivity" (Aspinall, 2012; Donovan et al., 2012b) – a practice that has been highlighted in other
615 fields by sociologists of science (e.g. Jasanoff, 1990, 2005; Shackley and Wynne, 1995, 1996 – see
616 also Demeritt et al., 2010, 2013 on flood risk). It is in this aspect of DRR – the assessment of hazard –
617 that the epistemologies of social and physical sciences become problematic. Hazard assessment
618 tends to be predicated on representing the natural system as reliably as possible. Whether it is
619 "real", a "representation" or a subjectively and socially constructed artefact depends upon
620 epistemology. In assemblage, however, these interpretations can draw on each other without being
621 mutually exclusive. Hazard and risk assessment is often undertaken in isolation from human
622 geographical approaches to vulnerability – in part because the latter have explicitly distanced
623 themselves from "naturalising" disaster (Hewitt, 2013) – but it is an important form of human-
624 nature interaction through interpretation, maps, models and observation. The DRR assemblage
625 draws out the connections between epistemology, institutional approaches to risk, knowledge
626 topologies (including the relationship between local and scientific knowledge), scientific uncertainty
627 and the expert advisory process. These connections may include concerns about reputation,
628 disciplinary background, ontological assumptions, underlying values and political factors, for
629 example. Understanding the social, political and philosophical context of scientific assessments of
630 risk is thus an aspect of reducing vulnerability.

631 ## V Conclusions

632 Disaster risk reduction is an assemblage of actors, associations, triggers and concepts. This paper
633 suggests that, as argued by Gaillard and Mercer (2013), DRR should be inclusive, not only in the
634 inclusion of both scientific and local knowledge, but also in assessing the relationships between
635 different components of disasters. Both DRR and disasters themselves can be envisioned as
636 assemblages: they are made up of components that are not reducible to function but that overlap
637 and are influenced by one another, and that may experience reverberations of knowledge and
638 (geo)power that transform their relations. They are historically contingent. The six themes

639 elucidated in the previous section show the complexity of the assemblage, and the connectivities
640 that are inherent in disaster and that undermine a deterministic approach. In taking DRR forwards,
641 therefore, a research programme would incorporate the full range of social, political, physical and
642 medical sciences in collaboration with one another, recognising their diverse epistemological
643 approaches and the differing dynamics of power and knowledge through the DRR assemblage.

644 This paper uses the concept of "geopower" (Grosz, 2008; Yusoff et al., 2012) to unpack the
645 connections between different aspects of DRR. Geopower allows the agency in disasters – and in
646 DRR – to be complex and to include earth system forces as well as human and human-natural
647 interactions. . In a disaster, a hybrid of earth system forces and human factors is drawn together.
648 The relationships between landscapes, governments, institutions, knowledges and population
649 groups are transformed. DRR research has made significant inroads in studying this through the
650 work of key geographers in the last forty years (e.g. Hewitt, 1983; Wisner et al., 2004, 2012; Gaillard
651 and Mercer, 2013; Pelling, 2003, 2010). It has, crucially, put the social sciences at the centre of
652 international disaster management. However, many authors have noted that DRR still struggles to
653 be influential in many situations – especially at the national level where the hazard paradigm often
654 dominates – and that it can be limited by the implicit assumptions behind its terms (Bankoff and
655 Hilhorst, 2009; Grove, 2010, 2013, 2014a; Grove and Pugh, 2015; Oliver-Smith, 2015). This may
656 partly be because of a relative lack of cultural studies of disasters (e.g. noted by Kruger et al., 2015;
657 Oliver-Smith, 2015; Hewitt, 2015) that involve analysis of diversity that is lost at the international
658 level of management (see also Gaillard and Mercer, 2013) but that is important in the assembling of
659 a disaster. There is also a need for greater critical human geographical engagement with the
660 complex relationships between power, knowledge and risk: the spatialities of disasters are not
661 purely confined to their physical geography, but also reverberate through the complex assemblage
662 of "more-than-human" components that have agency in the disaster process. Geo- and bio-political
663 readings as well as science studies approaches to understanding how disasters are assembled can
664 produce significant insights that ultimately reduce vulnerability and ensure that scientific knowledge

665 is accountable (e.g. Grove, 2013; Pelling and Dill, 2010; Bankoff and Hilhorst, 2009; Donovan and
666 Oppenheimer, 2015a). Thinking through disasters in terms of assemblages and topologies allows a
667 broadening of critical geographical approaches to this end. This might arguably add a third "meta"
668 dimension to the road-map of Gaillard and Mercer (2013): an additional means of interrogating the
669 procedures of governments, NGOs and international institutions, as well as scientists, in terms of
670 their connectivities and power dynamics, and the histories of their discourses.

671 Recent work suggests that power and geopolitics are important aspects of disasters and indeed
672 preparation (Grove, 2010, 2013, 2014; Kelman, 2006; Giroux, 2007): the geopolitical imaginations of
673 key actors, the links between and within institutions (including NGOs) and the links between
674 scientists, for example, can all affect DRR. The connections between different parts of DRR are not
675 linear, nor are they constant in space-time: they are characterised by reverberations of knowledge
676 and power through topologies of actors, objects and ideas. Furthermore, in treating disasters
677 themselves as assemblages, the focus shifts to connections between human and physical entities
678 and allows for different, co-existing perceptions of disaster to work together. It recognises that
679 values, imaginations and cultural factors are important not only in local knowledge but also in
680 scientific knowledge; allows critical engagement with the human-and-physical aspects of disasters;
681 and also provokes a deeper understanding of the ways in which these connections are affected in
682 time and space – which can feed into DRR. There are many examples of this emerging in the
683 geographical literature that demonstrate its importance (e.g. Grove 2013, 2014; Bankoff and
684 Hilhorst, 2009; Grove and Pugh, 2015), particularly in tackling the potential use of scientific
685 knowledge about vulnerability and resilience as mechanisms for the exercise of biopower and
686 governmentality. This paper suggests six strongly linked themes around which such work might be
687 framed, emphasising relationships between the components of disaster rather than a search for a
688 "root cause". Focussing on the nature of the connections, as well as on the components of the DRR
689 assemblage, opens up new and exciting questions for critical geographies of disasters.

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