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

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[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).

20 are often present in human-versus-physical approaches to disasters (e.g. Gaillard and Mercer, 2013;

21 Hewitt, 1983, 2013). Furthermore, the increased emphasis on scientific advice in the Sendai

22 Framework for DRR 2015-2030 provides an important opportunity for geographers to interrogate

23 the interface between science and policy in disasters, alongside human geographical approaches to

24 vulnerability and transformation (e.g. Pelling, 2003, 2010; Cutter, 2003).

25 This paper is highly interdisciplinary and is necessarily broad as a result. It does not aim to explore in

26 detail all of the issues that it raises, but to provide an overview of emerging themes across a range of

27 geographical literature. It is necessarily synoptic and theoretical in its approach. Initially, the paper

28 discusses recent debates in DRR research and places them in a critical geographical context related

29 to broad ideas of risk, knowledge and power. The following sections establish the theoretical

30 framework within which the paper works, elucidating first assemblage theory and then geopower.

31 Finally, six interlocking dimensions of the DRR assemblage are examined, to illustrate the human-

32 natural flows of power and knowledge (geopower) that reverberate through the DRR assemblage,

33 and to provide a broad framework for future research.

II Challenges, controversies and categories in DRR

35 Disaster risk reduction (DRR) research has explicitly distanced itself from a "technical-rational"

36 model of disasters (White, 1945; Hewitt, 1983; Wisner et al., 2004, 2012). It has applied the concepts

37 of vulnerability, adaptation and resilience to provide insights into the process of disaster risk

38 reduction – and produced many critiques of these concepts (e.g. Alexander, 2013; Weichselgartner

39 and Kelman, 2014; Cannon and Muller-Mahn, 2010; Adger, 2006; Cutter, 1996, 2003; Manyena

40 2006; Lewis and Kelman, 2010; Sudmeier-Rieux, 2014; Bankoff 2001). This separation of the "hazard

41 paradigm" from the "vulnerability paradigm" (e.g. documented by Gaillard and Mercer, 2013) has

42 been extremely productive for human geographical understanding of disasters, but is still not as

43 effective as it might be in many practical applications (e.g. as noted by Manyena et al. 2013; Gaillard

44   and Mercer, 2013; Weichselgartner and Kelman, 2014; Hewitt, 2015): the hazard paradigm often

45   dominates in governments and in the physical sciences – and often retains a positivistic

46   epistemology (Gaillard and Mercer, 2013; Hewitt, 2000, 2013; Porter and Davoudi, 2012). Human

47   geography has tended to focus on "bottom-up" approaches, and linking these with governmental

48   "top-down" approaches has proved challenging (e.g. Wisner, 2003; Gaillard and Mercer, 2013).

49   However, there is scope for moving beyond this vertical representation to examine the spaces

50   between the vulnerability and hazard paradigms, without compromising commitment to reducing

51   social vulnerability through transformative practical action (Pelling, 2010; Pelling and Wisner 2012).

52   This section charts some broad theoretical debates within and around DRR research, and some

53   emerging ideas about its future directions (e.g. Gaillard and Mercer, 2013; Weichselgartner and

54   Kelman, 2014; Grove and Pugh, 2015). It initially focusses on two related aspects of expert advice in

55   disasters that have received relatively little attention in the literature – the latent, multiscalar power

56   dynamics that exist behind the language of DRR (e.g. Pelling and Dill, 2010; Bankoff and Hilhorst

57   2009), and the problem of different epistemologies underlying scientific advisory practice (e.g.

58   Donovan and Oppenheimer, 2015a). These issues open up broader questions about the

59   epistemology and ontology of DRR research, which are discussed in the following section and lead

60   into the argument that assemblage theory may provide a lens through which both DRR and disasters

61   can be profitably studied.

62   1 Knowledge topologies between the 'paradigms'

63   Several authors have called for a greater interest in the politics of disaster management (e.g. Pelling

64   and Dill, 2010; Weichselgartner and Kelman, 2014). Bankoff and Hilhorst (2009) point out that the

65   "different political interpretations of risk reduction often remain concealed behind the facade of a

66   shared language of disaster response". They show differences between NGO approaches to disasters

67   in the Philippines and those of the government, and suggest that meaningful collaboration between

68   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

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

93   represent different degrees of political empowerment (Cox, 1998; see also Mercer et al., 2010).

94   Vulnerability and local knowledge are often associated with each other: as Gaillard and Mercer note,

95   vulnerability is often the result of uneven distributions of power between decisionmakers and

96   communities that are closely tied to emphasis on scientific knowledge by the former. For local

97   knowledge to be incorporated into decision-making could be perceived as a threat both to scientific

98   authority and to government, and as practically challenging – which perhaps explains in part why the

99   vulnerability paradigm has had limited success at national levels despite its acceptance at

100   international levels (Gaillard and Mercer, 2013).

101   Expert identification of particular groups as "vulnerable" can also result in the reduction of civil

102   liberties and the introduction of new bureaucratic requirements that ultimately inhibit freedom, as it

103   does in the case of terrorism and other anthropogenic threats (Collier and Lakoff, 2008, 2014). This

104   can also be a form of biopower: the management of human beings in the context of threats to life

105   and the implicit responsibility of the individual to help the state protect them is a "form of power

106   that regulates social life from its interior" (Hardt and Negri, 2000). Furthermore it is a form of power

107   that can make use of the natural system – and knowledge or uncertainty about the natural system –

108   for its own ends (e.g. Nelson, 2010; Grove, 2010, 2013, 2014a; Yusoff, 2010; Oels, 2013; Cupples,

109   2012; Mahony 2014). Lövbrand et al (2009) discuss the concept of "Earth System Governmentality",

110   which involves the coupling of human and natural systems in the climate change discourse. For

111   Lövbrand et al., "the governmentality concept helps us to think of science as a socially embedded

112   practice interwoven into the fabric of rule and authority" (Lövbrand et al., 2009:8; see also Platt,

113   1999 and Glantz, 1976). Critiques of the IPCC and other scientific advisory institutions have included

114   a rich analysis of the roles, power and rationalities of (physical) science (Hulme, 2009; Lövbrand et al,

115   2009; Hulme and Mahony, 2010; O'Brien, 2010; Davoudi, 2012; Bulkeley, 2005). Moving towards an

116   international advisory system for disasters – as called for by Wisner (2003) and more recently by

117   Cutter et al (2015) – requires that critical social scientists work with physical scientists, and that the

118   power dynamics of expert bodies are reflexively managed.

119 Physical science can make significant advances in both warning systems and in mitigation

120 technologies, and therefore has an important role in reducing the risk from natural hazards. In doing

121 so, though, it does not act in isolation, but forms an integral part of the social system: science and

122 social order are co-produced (Jasanoff, 2004) and science cannot be separated from its social

123 context. However, many authors note the continued persistence of positivism in the physical

124 scientific approaches to hazards (Weichselgartner and Kelman 2014; Porter and Davoudi, 2012): this

125 remains the primary challenge in interdisciplinary approaches, and is a key challenge in

126 implementing the Sendai Framework for DRR with a broad view of 'science'. Human geographical

127 input into risk assessment can be greatly beneficial (e.g. Lane et al., 2011; Demeritt et al, 2010,

128 2013), and can increase the confidence of local people in the scientific process. A major challenge of

129 recent disasters has been the justification and communication of decisions made under uncertainty

130 – the most striking example perhaps being the court case surrounding the L'Aquila earthquake

131 (Alexander, 2010, 2014) – and this is exacerbated by advisory groups that are composed purely of

132 physical scientists. That disasters are "largely acts of man" (White, 1945) is an accepted doctrine, but

133 it has to incorporate human geographical understandings of the power dynamics, reputational fears,

134 disciplinary limits and uncertainties *of scientists* in the risk assessment process (e.g. Mahony, 2014;

135 Donovan and Oppenheimer 2015b; Hulme, 2009): the topology of knowledge is more complex than

136 human-versus-physical. It also requires engagement with the nature of causality in disasters: this is

137 at the root of the separation between the "hazard" and "vulnerability" paradigms.

2 Complexity and the attribution of causality

139 The complexity of a disaster undermines abilities to model or explain it, and clearly renders

140 deterministic approaches overly simplistic, yet deterministic thinking is very pervasive. To give an

141 example, human geographers have argued persuasively that the term "natural disaster" is a

142 misnomer, and this has been accepted by many practitioners (O'Keefe et al., 1976; Cannon, 1994;

143 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

170   international interventions, the particular combination of legislation and a range of dysfunctional

171   relationships between institutions and agencies fed into the "precariousness" that contributed to

172   the impacts of the 2010 Haitian earthquake. O'Connor et al (2014) read the aftermath of the

173   earthquake through the lens of biopolitics, demonstrating the use of aid as a mechanism for

174   governing the failed state: "liberalism invents strategies to govern at a distance". The problems

175   encountered by the Haitian state are framed as failures of democracy, and failures of democracy

176   allow the UN and associated bodies the power to make aid conditional upon aspects of democratic

177   reform (O'Connor et al., 2014). The earthquake, however, as a physical phenomenon, compounded

178   this not only in the involvement of the physical environment in exacerbating the social problems, but

179   also in the lack of knowledge it revealed. The faultline on which the earthquake occurred was

180   unmapped (Calais et al., 2010), but the presence of seismic hazard in the region should not have

181   been a surprise (e.g. Taber, 1922). This demonstrates the oft-ignored importance of knowledge

182   topologies in the context of disasters: lack of knowledge may be part of the challenge, but the

183   placing of knowledge is also non-trivial – the translation of knowledge across boundaries may be

184   closely tied with the topologies of power and geopolitical representations.

185   This paper suggests that assemblage thinking can "open up" a relational approach to disasters that

186   integrates the critical thinking within the vulnerability paradigm with a broader range of ideas from

187   human geography that extend DRR into geopolitics and geography of science[3], and draws on the

188   materiality of physical science. The physical sciences will always be needed by governments in the

189   context of hazards – and there are human processes within the physical sciences that deserve

190   serious scrutiny (e.g. Morss et al., 2005; Demeritt et al., 2010, 2013; Hulme 2009). The conclusion

191   that governments can reduce disasters through better governance (Hewitt, 2013) can also actually

192   empower governmentality (Reid, 2012; see also discussions of the "emergency state" in Adey and

193   Anderson, 2011; Anderson and Adey, 2012). Furthermore, DRR has a tendency to encode its

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

194   methods into what Grove and Pugh (2015) refer to as "a modernist imaginary" – concepts that seek

195   to render a situation governable, such as adaptive capacity. As Grove and Pugh (2015) argue

196   regarding participatory research, the challenge is to "work against the categorical closures of a

197   liberal will to truth". Assemblage theory allows a nuanced approach that can focus DRR around its

198   inherent transdisciplinarity. In the next section, this is explored in more detail.

III Assemblage, knowledge and power

200   This section first defines and explains the use of assemblage theory in this paper. It then

201   contextualises this discussion in the broader history of social thinking about disasters to show the

202   emergence of the DRR assemblage.

1 Assemblage and Geopower

204   *We will call an assemblage every constellation of singularities and traits deducted from the flow—*

205   *selected, organized, stratified—in such a way as to converge (consistency) artificially and naturally; …*

206   *Assemblages may group themselves into extremely vast constellations constituting "cultures," or*

207   *even "ages"...*

208   Deleuze and Guattori, 1987, p.406.

209   *Social assemblages... contain mechanisms which, in addition to causal interactions, involve reasons*

210   *and motives... assemblage theory, in which assemblages can be component parts of other*

211   *assemblages.... can accommodate these complex forms of causal productivity.*

212   DeLanda, 2006, pp.19-20.

213   Assemblage has been variously defined in the geographical literature (e.g. overviews in Robbins and

214   Mark, 2009; Anderson and Mcfarlane, 2011). An assemblage is an entity that is composed of

215   heterogeneous components that may be material or expressive and may be multi-scalar. The

216   components of an assemblage may also be components of other assemblages, and the interactions

217   between the components can be difficult to assess or quantify – thus incorporating complexity and

218   non-linearity. Assemblage theory has been applied to cities, social action groups, mosquito

219   management, energy policy, participation in disaster management, and geopolitics, to give a few

220   examples (e.g. Mcfarlane, 2009, 2011; Davies, 2012; Grove, 2014b; Grove and Pugh, 2015; Sassen,

221   2006; Harrison and Popke, 2011; Shaw et al., 2010). Its appeal was discussed by Dewsbury (2011) as

222   arising out of the turn towards relational thinking and the limitations of networks as a means of

223   interrogating socio-spatial entities. Assemblage implies a level of activity that is not adequately

224   represented through network thinking. Thus, a city may be an assemblage of networks, resources,

225   technologies and groups (Mcfarlane, 2011). A volcano might also be an assemblage of human-nature

226   constituents, including the livelihoods, identities, cultures and imaginations of populations,

227   alongside the physical movement of magma in the earth and the scientific interpretation of the

228   signals it provokes.

229   Disasters and DRR can be viewed as assemblages. They incorporate networks, groups, concepts,

230   power dynamics and physical/environmental/hybrid factors. They rarely exhibit any predictable

231   linearity, but they can be represented on what DeLanda (2006) refers to as the axes that define

232   assemblage: the roles that each component may play (ranging from material to expressive), and the

233   processes in which they are involved, which either reinforce the identity of the assemblage

234   (territorialisation) or undermine it (deterritorialisation). To these, DeLanda adds a third dimension,

235   that of coding and decoding, which represents processes that involve particular expressive devices

236   to either stabilise identity or to make it more flexible. This might include concepts such as

237   "vulnerability" and "resilience", for example, which are often employed to stabilise the identity of

238   DRR, but can also destabilise it. Equally important is that assemblage components are characterised

239   by 'relations of exteriority': the components of an assemblage, and indeed the assemblage itself, can

240   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

292 systems are affected may be described by resilience or as vulnerability. Disaster assemblages are

293 characterised by complex ideas, physical processes, physical-human interactions (e.g. via affect and

294 imagination), human cultures and technologies that experience a varying power distribution in time.

295 The unpredictable shifts in the distribution of power, which reverberate through the assemblage, are

296 conceptualised here as "geopower".

2 Disaster assemblages and assembling DRR

298 Assemblage theory opens up forensic spaces for geographers to reconceptualise disasters as

299 gatherings of components that interact with one another and with other assemblages of which they

300 are a part (such as cities and cultures). It also provides a space in which the complex landscape of

301 DRR itself can be examined – looking at how vulnerability, resilience and other key concepts are

302 used, how cultural values feed into them, the ways in which the ontological differences between the

303 social and physical sciences are worked out in DRR, the role of institutions that function at different

304 (often overlapping) scales, and the differences in the physical geography and impacts of hazards. For

305 example, Grove (2014c) used "adaptation machines" to describe "neoliberal disaster resilience". He

306 argued that in Jamaica, adaptation machines provided a means for appropriating the community's

307 "inherent adaptive capacity" for particular ends: disaster management can itself be a form of

308 "power by stealth". The means by which it does this vary in space and time, and Greg Bankoff's

309 extensive work in the Philippines has demonstrated the value of historical approaches to

310 understanding disasters (Bankoff, 1999, 2003). Not only do disasters depend on historical factors

311 (such as land use), but institutional and even expert histories and narratives are also important.

312 Taking a relational approach to this can combine insights from vulnerability, science studies and

313 physical science itself through understanding the ways in which disasters are assembled from pre-

314 existing social networks, power relations and knowledge topologies, producing a hybridisation of

315 '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

341 sciences in the nineteenth century, and the establishment of institutions tasked with the surveillance

342 of natural phenomena (such as the Vesuvius Observatory). Kant's "scientific turn" (Larsen, 2006) was

343 characterised by its material approach. Indeed, Larsen (2006) argues that the risk society (Beck,

344 1992) "is born in Kant's writings after the Lisbon earthquake" and the earthquake's "overwhelmingly

345 powerful materiality": it brought into focus the human responsibility for the future that pervades

346 modern discourse about disasters alongside the physical scientific challenges. The earthquake

347 contributed to the reordering of natural scientific and philosophical approaches to disaster – a

348 manifestation of geopower.

349 The recent history of DRR research highlights the shift from technical-rational approaches that

350 highlighted knowledge-deficit methods for "education" and the increase of technological methods

351 (evidenced in the documentation that accompanied the International Decade for Natural Disaster

352 Reduction 1990-1999, for example) to vulnerability-dominated approaches (e.g. the Hyogo

353 Framework for Action, 2005-2015, and the Sendai Framework for DRR, 2015-2030; see also Furedi,

354 2007). This shift is partially driven by the recent history of disasters and their epidemiology, but also

355 by the significant work of geographers in the 1960s and 1970s, advocating a human ecological

356 approach to DRR (e.g. Burton and Kates, 1963; Burton et al., 1968; O'Keefe and Wisner, 1977).

357 Understanding history is thus not only important for understanding the nature and value of local

358 knowledge (Bankoff, 2012; Gaillard and Mercer, 2013; Oliver-Smith, 1999), but also in framing

359 academic and policy discourses of DRR. Discourses within DRR are historically and culturally

360 grounded, even where they are cross-culturally applied. DRR is an assembled product of ontological

361 and epistemological reasoning regarding human societies and their relationship with the earth

362 system, often focussed on Western thought (see also Bankoff, 2001, 2004). It is also strongly

363 determined by the history of that relationship, including the assembling of individual disasters. This

364 perspective opens up opportunities for understanding DRR in its historical context as a collection of

365 relationships between institutions, concepts, ideas, morality, ideology, scales, events, ontologies and

366 knowledges.

367   In thinking about disasters and about DRR as assemblages, the distinctions between macro-micro,

368   physical-human, subject-object cease to be the focus of attention. Disasters themselves are

369   assemblages of institutional practices, communities, NGOs, technologies, knowledges, volcanoes –

370   but they are also themselves part of the DRR assemblage (DeLanda, 2006): they can be viewed as

371   nested, for example, through processes of forensic investigation and the narratives that result. DRR

372   combines particular expressive encodings (adaptive capacity, participation, resilience, vulnerability,

373   hazard), material features, institutions and practices, all of which it deploys as a means of clarifying

374   its own identity – a process that is exemplified through the machinations of the UN noted above but

375   that also derives from the deeper philosophical history and geography of disasters and human-

376   nature relations. Assemblage also accounts for the complex relations that define DRR through time

377   and space, and for the instabilities in DRR that arise from the potentialities within it. For example,

378   the Sendai Framework for DRR 2015-2030 systematically distinguishes between two scales – "local

379   and national" and "regional and global". Such a separation is arguably a practical necessity because

380   the Framework is an international document that requires particular responses from governments

381   (see also Macfarlane, 2009, for a discussion of the relationship between order and hierarchy).

382   Gaillard and Mercer (2013) note that "there is an important need to address power relations within

383   and across scales in order to reduce the manifestations of hierarchies of scale"; they call for greater

384   emphasis on national and local rather than global. Assemblage reframes spatial concepts as

385   relational – "near and far", based on proximity and distance rather than scale. Its focus on the

386   assembling of the "social" also allows us to reclaim DRR – including the physical scientific aspects

387   (hazard forecasting, monitoring) – as a part of the social, whilst allowing a realist perspective that

388   resonates with physical scientists (e.g. Anderson et al., 2012).

IV Geopower and disaster risk reduction

390   This part of the paper discusses six areas in which the complex dynamics of DRR are manifest, and

391   which might provide useful perspectives. These areas are characterised by topological flows of ideas,

392   objects and actors, and they are linked together in the DRR assemblage: they could be viewed as

393   lenses through which its parts may be envisioned, and through this, the assemblages of individual

394   disasters. The purpose of this section is to elucidate the relational dynamics of the DRR assemblage

395   in a practical way: assemblage theory can be presented as an interesting way of describing a socio-

396   spatial phenomenon, but it is sometimes insufficiently practically applied.

1 Governance and governmentality in disasters

398   Complex power dynamics come into play when human systems and the earth system interact. The

399   behaviour of the natural system can affect the rights that citizens hold. In 1996, the Governor of

400   Montserrat gained the right to order mandatory evacuations, under the Emergency Powers Act. This

401   continued to be a controversial legal matter (e.g. Aspinall and Sparks, 2004; Donovan et al., 2012a),

402   as the felt rights of citizens to remain in their homes came into conflict with the protective power of

403   the state. This has occurred in other situations, notably during Hurricane Katrina, where many

404   citizens of New Orleans did not obey mandatory evacuation orders due to health issues, mobility

405   problems and fear of looting (e.g. Nigg et al., 2006). In some areas, mandatory evacuations have had

406   success – in the 2010 eruption of Merapi volcano in Indonesia, for example, evacuations saved

407   10,000 to 20,000 lives (Surono et al., 2012). Others have documented the ways in which the closing

408   down of facilities and even islands during "Superstorm Sandy" led to power struggles between

409   government and residents, who had different views about what it means to be resilient and whether

410   resilience was being used to promote active citizenship at the expense of governmental

411   responsibility to help (see for example Evans and Reid, 2014). In each of these cases, the idea of

412   resilience is dependent on the experience of different actors (see also the detailed discussion in

413   Weichselgartner and Kelman, 2014).

414   Governments in disasters tread a difficult line between protecting people and encroaching upon

415   their freedom. In some respects, this is similar to the findings of recent research in CCA (e.g. Grove,

416   2010, 2013, 2014a,b). Davoudi (2014) argues against the "dominant discourses" of climate change in

417 presenting nature as a threat rather than a resource. Not only that, but nature has also been re-

418 formed by human intervention in the "anthropocene" (Crutzen, 2000). Critically, this has allowed

419 paradigms of risk management to be produced that use the 'empowerment' of citizens to neutralise

420 them as a threat as they become "governable" (Pugh, 2014; Grove, 2013), sometimes through

421 insurance (e.g. Collier, 2014). Governmentality is therefore an important component of DRR, but it is

422 also one that has to remain connected to broader ideas about human and nonhuman natures:

423 power reverberates between human attempts to govern other humans and thereby manage a

424 disaster, and the rages of the non-human nature as humans attempt to understand it and limit it.

425 The becoming of a disaster can be mitigated through effective governance (Hewitt, 2013; see also

426 Wisner, 2003 and Pelling and Wisner, 2012), but the use of warning systems, expert advice, and DRR

427 terms, for example, demonstrates that disasters are not so much "unnatural" as "more-than-

428 natural": they involve complicated interactions between humans and nature that require

429 interpretation and analysis. Governance – whether effective or ineffective – is crucial in the

430 assembling of a disaster, and it is also highly nuanced and ambiguous through the flows of power

431 and knowledge that are ensconced within it as it interacts with nature and interpretations of nature

432 (Bankoff and Hilhorst, 2009; Pelling and Dill, 2010).

2 Expert advice, power and uncertainty

434 Geographers and sociologists of science have highlighted the potential power that expert bodies

435 may have in governance, and the threat it poses to democracy (e.g. Beck, 1992; Jasanoff, 1990,

436 2004, 2005; Wynne, 1989, 1992). In current terminology, that power is often ineffectively

437 characterised through the terminology of "evidence-basing": power is attributed to the "evidence"

438 to avoid the impression that human agency has a role in policy-formation. This rhetoric is found in

439 scientific reports from the volcanic eruptions on Montserrat, for example (Donovan et al., 2014).

440 This terminology is problematic for several reasons, not least that the "evidence" is frequently

441 uncertain – and policy is most likely to be based on inference from the (uncertain) evidence.

442 Expert bodies may also be vulnerable, however: scientists on Montserrat were sometimes blamed

443 for unpopular political decisions (Donovan et al., 2012a) and six seismologists from Italy were

444 sentenced to six years in jail as a result of their recommendations as part of an advisory panel

445 (Alexander, 2014) – though they were subsequently acquitted at appeal, again showing the volatility

446 of expert positions. The position of expert advisors varies between governments, but remains sub-

447 politically ambiguous. Expert groups generally do not make decisions, but in crisis situations may be

448 effectively making them: in some cases, for example, the increase of a volcanic alert level might

449 automatically provoke an evacuation (e.g. Donovan and Oppenheimer, 2015a). Experts may thus be

450 regarded as wielding power themselves, or as subject to abuse by power. Uncertainty, too, can be

451 manipulated and used as a reason for decisions that are controversial (Power, 2004; O'Malley, 2011;

452 see also Rothstein et al, 2006) – linking back to governmentality.

453 These examples demonstrate several key aspects of expert advice and the way that it is used in

454 disaster management: it can be used for political ends, and it can assume knowledge-power itself as

455 experts seek to "educate" the public (often an important part of a volcano observatory's work). The

456 machines of expert advice are very varied between governments (e.g. Jasanoff, 2005), but they

457 invariably have agency within the structures of disaster governance. Disasters can produce

458 significant redistributions of powers through knowledge topologies (with associated uncertainties),

459 as scientific institutions compete for visibility, funding and field time; political institutions seek to

460 manage land use in dependence on scientific advice; social groups object to evacuations. All of these

461 activities cause ripples in the DRR assemblage, as groups seek to increase or decrease their

462 involvement, and are ultimately manifestations of geopower.

463 ## 3 Vulnerability and imbalances of wealth, resources and scale

464 Vulnerability to disasters has been conceptualised in many ways, with some authors distinguishing

465 between social and physical vulnerability, for example (Adger, 2006; Cutter, 1996). Vulnerability

466 assessment has become a critical aspect of DRR (Pelling, 2007; Smit and Wandel, 2006). Often,

467   vulnerability is taken as more or less the polar opposite of resilience, though this has been critiqued

468   by several authors (e.g. Gallopin, 2006). Some authors (e.g. Cutter, 2003; Birkmann 2006) have

469   sought to quantify vulnerability using multiple measures. This is strongly dependent upon the

470   availability of data, however, and tends to be limited to countries for which this data exists, such as

471   the US. Vulnerability has proved to be an extremely valuable concept in DRR, in spite of

472   shortcomings (e.g. Bankoff, 2001; Lewis and Kelman, 2010). It also functions as an organising idea for

473   a large range of social factors that combine in the assembling of disasters, including poverty,

474   education, healthcare, housing, gender and political stability. O'Brien et al (2004) conceive a

475   spectrum from "vulnerable" to "resilient". They also note the important influence of scale on

476   vulnerability and the ways in which it is conceived (see also Fekete et al., 2010; Wisner 1993). Small-

477   scale resilience might translate to large-scale vulnerability, for example. The links that have been

478   made in the literature between "vulnerability" and certain types of "other" or certain places can also

479   be a form of geopolitical conceit (e.g. Bankoff, 2001), a way of dividing up the world. More usually,

480   however, vulnerability is a characteristic of a world already divided (Wisner et al., 2012).

481   Adger (2006) notes that there are a range of approaches to vulnerability research, which have

482   different epistemological foundations. He separates vulnerability of socio-ecological systems (SES),

483   and vulnerability resulting from poverty (e.g. the sustainable livelihoods approach). Both of these

484   theoretical approaches have significantly advanced the understanding of disasters, evidenced by

485   their continuing application by researchers (e.g. Kelman and Mather, 2008; Gaillard 2010; Turner et

486   al., 2003; Watts and Bohle, 1993; Wisner et al., 2004, 2012). The former approach highlights the

487   ability of SES to adapt, while the latter suggests that vulnerability is related to powerlessness. The

488   different readings in the literature on both vulnerability and resilience have sometimes led to

489   confusion, but there is considerable merit in juxtaposing them and observing their impact on one

490   another (see for example Romieu et al, 2010 on differences between climate change and DRR).

491   Multiple meanings can co-exist. Adger (2006) concludes that the diversity of meanings may be a

492   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:

518 *Through such exhortations, the uncertain future is rendered a shared societal problem, an*

519 *opportunity to temper the furies of fate through individual and collective empowerment. Any*

520 *inconsistency between narrating the turbulent future as governable and ungovernable, or*

521 *opportunity and threat, tends to be smoothed over by a new lexicon of words with ambiguous*

522 *meanings. P141*

523 The ambiguity of resilience as a term is both a strength and a weakness in DRR (e.g. Weichselgartner

524 and Kelman, 2014), and may be behind Manyena's (2006) argument that it is not quite a paradigm: it

525 has usefulness, but is not flawless. Even the rhetoric of social empowerment is an exercise of power

526 that betrays values and philosophies. As Bankoff and Hilhorst (2009) argue, vulnerability depends to

527 some extent on positionality. They make the further point that the language of disaster response can

528 hide political aims. In the example that they give – the eruption of Mount Mayon in 1999-2000 – the

529 government ultimately decided to resettle over a thousand families permanently. The cost of

530 relocation was viewed as less significant than the risk of leaving people living close to the volcano.

531 Similar discussions surrounded the Chaitén eruption in Chile in 2008.

532 Alexander (2007) writes:

533 *Governments have a moral duty, and usually also a legal and constitutional one, to protect their*

534 *citizens against foreseeable sources of harm (50).*

535 He goes on to show some of the differences in the civil management of emergencies, particularly in

536 terms of organisational structures between governments, and relates media portrayals of Hurricane

537 Katrina to discrimination in aid management. He concludes by arguing that disaster management

538 would benefit from being "more participatory and more democratic" (56). This echoes other DRR

539 researchers (e.g. Batterbury et al., 1997; Pelling, 2007; Hewitt, 2013). In linking value with

540 adaptation in this section, this paper seeks to highlight the moral aspects of this debate, which are

541 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).

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.

References

690

691 Adey, P., & Anderson, B. (2011). Event and anticipation: UK Civil Contingencies and the space–times

692 of decision. Environment and Planning-Part A, 43(12), 2878.

693

694

695 Adey, P., Anderson, B., & Guerrero, L. L. (2011). An ash cloud, airspace and environmental threat.

696 Transactions of the Institute of British Geographers 36(3), 338-343.

697

698 Adger, W.N. (2006). Vulnerability. Global Environmental Change 16(3) 268-281

699

700 Agrawal, A. (1995). Dismantling the divide between indigenous and scientific knowledge.

701 Development and Change 26(3), 413-439.

702

703 Alexander, D. (2007). Disaster management: from theory to implementation. Journal of Seismology

704 and Earthquake Engineering, 9(1), 39-49.

705

706 Alexander, D. (2010). The L'Aquila earthquake of 6 April 2009 and Italian Government policy on

707 disaster response. Journal of Natural Resources Policy Research 2 325-342

708

709 Alexander, D. (2013). Resilience and disaster risk reduction: an etymological journey. Natural

710 Hazards and Earth System Sciences Discussions 1 1257-1284

711

712 Alexander, D. (2014). Communicating earthquake risk to the public: the trial of the "L'Aquila Seven".

713 Natural Hazards, 72(2), 1159-1173.

714

715 Allen, J. (2012). A more than relational geography? Dialogues in Human Geography, 2(2), 190-193.

716

717   Amin, A. (2004). Regions unbound: towards a new politics of place. Geografiska Annaler: Series B,

718   Human Geography, 86(1), 33-44.

719

720   Amin, A. (2013). Surviving the turbulent future. Environment and Planning D: Society and space,

721   31(1), 140-56.

722

723   Anderson, B. (2010). Preemption, precaution, preparedness: anticipatory action and future

724   geographies. Progress in Human Geography 34 (6), pp. 777–798.

725

726   Anderson, B., & Adey, P. (2012). Governing events and life:'Emergency'in UK Civil Contingencies.

727   Political Geography 31(1), 24-33.

728

729   Anderson, B., & McFarlane, C. (2011). Assemblage and geography. Area, 43(2), 124-127.

730

731   Anderson, B., Kearnes, M., McFarlane, C., & Swanton, D. (2012). On assemblages and geography.

732   Dialogues in Human Geography, 2(2), 171-189.

733

734   Aspinall, W., & Sparks, R. S. J. (2004). Volcanology and the law. IAVCEI News, 1(4).

735

736   Aspinall, W. P. (2012). Comment on "Social studies of volcanology: knowledge generation and expert

737   advice on active volcanoes" by Amy Donovan, Clive Oppenheimer and Michael Bravo [Bull Volcanol

738   (2012) 74: 677-689]. Bulletin of volcanology, 1-2.

739

740   Bachelard, G. (1994). The poetics of space (Vol. 330). Beacon Press.

741

742 Bankoff, G. (1999). A history of poverty: the politics of natural disasters in the Philippines, 1985–95.

743 The Pacific Review, 12(3), 381-420.

744

745 Bankoff, G. (2001). Rendering the world unsafe:'vulnerability'as western discourse. Disasters, 25(1),

746 19-35.

747

748 Bankoff, G. (2003). Constructing vulnerability: the historical, natural and social generation of

749 flooding in metropolitan Manila. Disasters, 27(3), 224-238.

750

751 Bankoff, G. (2004). Time is of the essence: disasters, vulnerability and history. International Journal

752 of Mass Emergencies and Disasters, 22(3), 23-42.

753

754 Bankoff, G. (2012). Storm over San Isidro:"Civic community" and disaster risk reduction in the

755 nineteenth century Philippines. Journal of Historical Sociology, 25(3), 331-351.

756

757 Bankoff, G., & Hilhorst, D. (2009). The politics of risk in the Philippines: comparing state and NGO

758 perceptions of disaster management. Disasters, 33(4), 686-704.

759

760 Barzeger, K. (2012). The Arab Spring and the balance of power in the Middle East. Power and Policy.

761 Harvard.

762

763 Batterbury, S., Forsyth, T., & Thomson, K. (1997). Environmental transformations in developing

764 countries: hybrid research and democratic policy. Geographical Journal, 163(2), 126-132.

765

766 Beck U 1992; German original 1986 Risk Society Towards a New Modernity New Delhi Sage

767

768   Benediktsson, K., Lund, K. A., & Huijbens, E. (2011). Inspired by eruptions? Eyjafjallajökull and

769   Icelandic tourism. Mobilities, 6(1), 77-84.

770

771   Billon, P. L., & Waizenegger, A. (2007). Peace in the wake of disaster? Secessionist conflicts and the

772   2004 Indian Ocean tsunami. Transactions of the Institute of British Geographers, 32(3), 411-427.

773

774   Birkmann, J. (2006). Measuring vulnerability to promote disaster-resilient societies: Conceptual

775   frameworks and definitions. Measuring vulnerability to natural hazards: Towards disaster resilient

776   societies, 9-54.

777

778   Bulkeley, H. (2005). Reconfiguring environmental governance: towards a politics of scales and

779   networks. Political geography, 24(8), 875-902.

780

781   Burton, I., Kates, R. W., & White, G. F. (1968). The human ecology of extreme geophysical events.

782   FHMI Publications 78.

783

784   Burton, I., & Kates, R. W. (1963). Perception of Natural Hazards in Resource Management, The. Nat.

785   Resources J., 3, 412.

786

787   Cadag, J.R.D. and Gaillard, J.C. (2012). Integrating knowledge and actions in disaster risk reduction:

788   the contribution of participatory mapping Area 44(1):100-109

789

790   Calais, E., Freed, A., Mattioli, G., Amelung, F., Jónsson, S., Jansma, P., et al. (2010). Transpressional

791   rupture of an unmapped fault during the 2010 Haiti earthquake. Nature Geoscience, 3(11), 794-799.

792

793   Cannon, T. (1994). Vulnerability analysis and the explanation of 'natural'disasters. Disasters,

794   development and environment, 13-30.

795

796   Cannon, T. and Mueller-Mann, D. (2010). Vulnerability, resilience and development discourses in

797   context of climate change. Natural Hazards 55, pp. 621–635.

798

799   Castanos, H. and Lomnitz, C., (2002). PSHA: is it science? Engineering Geology 66 315-317

800

801   Chen, C. W., Tseng, C. P., Hsu, W. K., & Chiang, W. L. (2012). A novel strategy to determine the

802   insurance and risk control plan for natural disaster risk management. Natural hazards, 64(2), 1391-

803   1403.

804

805   Chester, D. K. (2001). The 1755 Lisbon earthquake. Progress in Physical Geography, 25(3), 363-383.

806

807   Chester, D. K., Duncan, A. M., & Dibben, C. J. (2008). The importance of religion in shaping volcanic

808   risk perception in Italy, with special reference to Vesuvius and Etna. Journal of Volcanology and

809   Geothermal Research, 172(3), 216-228.

810

811   Collier, S. J. (2014). Neoliberalism and natural disaster: Insurance as political technology of

812   catastrophe. Journal of Cultural Economy, 7(3), 273-290.

813

814   Collier, S. and Lakoff, A. (2008). The vulnerability of vital systems: how "critical infrastructure"

815   became a security problem. In: Dunn, M., and Kristensen, K. (eds) Securing the homeland: critical

816   infrastructure, risk and (in)security. London and New York: Routledge, pp. 17–39.

817

818   Collier, S. J., & Lakoff, A. (2014). Vital systems security: Reflexive biopolitics and the government of

819   emergency. Theory, Culture & Society, 0263276413510050.

820

821   Cornell, C. A. (1968). Engineering seismic risk analysis. Bulletin of the Seismological Society of

822   America, 58(5), 1583-1606.

823

824   Cox, K. R. (1998). Spaces of dependence, spaces of engagement and the politics of scale, or: looking

825   for local politics. Political geography, 17(1), 1-23.

826

827   Crutzen, P. J. (2002). Geology of mankind. Nature, 415(6867), 23-23.

828

829   Cupples, J. (2012). Wild globalization: the biopolitics of climate change and global capitalism on

830   Nicaragua's Mosquito Coast. Antipode, 44(1), 10-30.

831

832   Cutter, S.L. (2003). The vulnerability of science and the science of vulnerability Annals of the

833   Association of American Geographers 93 (1)1-12

834

835   Cutter, S. L. (1996). Vulnerability to environmental hazards. Progress in human geography, 20, 529-

836   539.

837

838   Cutter, S. L., Ismail-Zadeh, A., Alcantara-Ayala, I., Altan, O., Baker, D. N., Briceno, S., Gupta, H.,

839   Holloway, A., Johnston, D., McBean, G. A., Ogawa, Y., Paton, D., Porio,E., Silbereisen, R. K., Takeuchi,

840   K., Valsecchi, G. B., Vogel, C., Wu, G. (2015). Global risks: pool knowledge to stem losses from

841   disasters. Nature, 522, 277-279.

842

843   Dalby, S. (2009). Security and environmental change. Cambridge: Polity.

844

845 Dalby, S. (2013). Biopolitics and climate security in the Anthropocene. Geoforum, 49, 184-192.

846

847 Davies, A. D. (2012). Assemblage and social movements: Tibet Support Groups and the spatialities of

848 political organisation. Transactions of the Institute of British Geographers, 37(2), 273-286.

849

850 Davoudi, S. (2012). Resilience: A bridging concept or a dead end? Planning theory and practice

851 13(2):299-333.

852

853 Davoudi, S. (2014). Climate change, securitisation of nature, and resilient urbanism. Environment

854 and Planning C: Government and Policy, 32(2), 360-375.

855

856 DeLanda, M. (2006). A new philosophy of society: Assemblage theory and social complexity. A&C

857 Black.

858

859 Deleuze, G., & Guattari, F. (1988). A thousand plateaus: Capitalism and schizophrenia. Bloomsbury

860 Publishing.

861

862 Demeritt, D., Nobert, S., Cloke, H., & Pappenberger, F., (2010). Challenges in communicating and

863 using ensembles in operational flood forecasting Meteorological applications 17(2) 209-222

864

865 Demeritt, D., Nobert, S., Cloke, H. L., & Pappenberger, F. (2013). The European Flood Alert System

866 and the communication, perception, and use of ensemble predictions for operational flood risk

867 management. Hydrological Processes, 27(1), 147-157.

868

869 Dewsbury, J. D. (2011). The Deleuze-Guattarian assemblage: plastic habits. Area, 43(2), 148-153.

870

871   Dittmer, J. (2014). Geopolitical assemblages and complexity. Progress in Human Geography,

872   0309132513501405.

873

874   Donovan, A. R., Oppenheimer, C. (2011). The 2010 Eyjafjallajökull eruption and the reconstruction

875   of geography. The Geographical Journal, 177(1), 4-11.

876

877   Donovan, A., Oppenheimer, C., Bravo, M (2012a) Contested boundaries: Delineating the safe zone

878   on Montserrat Applied Geography 35(1) 508-514

879   Donovan, A., Oppenheimer, C., & Bravo, M. (2012b). Reply to comment from WP Aspinall on "Social

880   studies of volcanology: knowledge generation and expert advice on active volcanoes" by Amy

881   Donovan, Clive Oppenheimer and Michael Bravo [Bull Volcanol (2012) 74: 677-689]. Bulletin of

882   volcanology, 1-4.

883   Donovan, A., Oppenheimer, C., Bravo, M (2014). Reflexive volcanology: Fifteen years of

884   communicating risk and uncertainty in scientific advice on Montserrat. In Wadge, G., Robertson, R.,

885   Voight, B., eds. The eruption of the Soufriere Hills Volcano, Montserrat, from 2000-2010. Geological

886   Society, London, Memoirs 2014, v.39; p457-470.

887   Donovan, A.R., Oppenheimer, C. (2015a). Modelling risk and risking models: The diffusive boundary

888   between science and policy in volcanic risk management. Geoforum, 58, 153-165.

889   Donovan, A., & Oppenheimer, C. (2015b). At the mercy of the mountain? Field stations and the

890   culture of volcanology. Environment and Planning A, 47(1), 156-171.

891   Drury, A. C., Olson, R. S., & Belle, D. A. V. (2005). The politics of humanitarian aid: US foreign disaster

892   assistance, 1964–1995. Journal of Politics, 67(2), 454-473.

893

894   Duffield, M. (2002). Social reconstruction and the radicalization of development: aid as a relation of

895   global liberal governance. Development and change, 33(5), 1049-1071.

896

897   Duffield, M. (2012). Challenging environments: Danger, resilience and the aid industry. Security

898   Dialogue, 43(5), 475-492.

899

900   Dynes, R. R. (2000). The Dialogue between Voltaire and Rousseau on the Lisbon Earthquake: The

901   Emergence of a Social Science View. International Journal of Mass Emergencies and Disasters 18:97–

902   115.

903   Eiser, J.R., Donovan, A.R., Sparks, R.S.J (2014). Risk perceptions following the 2010 and 2011

904   Icelandic volcanic ash crises. Risk Analysis

905   Evans, B., & Reid, J. (2014). Resilient life: the art of living dangerously. John Wiley & Sons.

906   Fekete, A., Damm, M., & Birkmann, J. (2010). Scales as a challenge for vulnerability assessment.

907   Natural Hazards, 55(3), 729-747.

908   Ferreira, M. (2011). Bodies do matter! The rule of precariousness in Haiti. International Social

909   Science Journal, 62(205-206), 339-350.

910

911   Folke, C. (2006). Resilience: The emergence of a perspective for social–ecological systems analyses.

912   Global environmental change, 16(3), 253-267.

913   Furedi, F. (2007). The changing meaning of disaster. Area, 39(4), 482-489.

914   Gaillard, J. C. (2010). Vulnerability, capacity and resilience: perspectives for climate and development

915   policy. Journal of International Development 22, pp. 218–232.

916   Gaillard, J.C. (2007) Resilience of traditional societies in facing natural hazards Disaster Prevention

917   and Management 16(4):522-544

918

919   Gaillard, J.C. and Mercer, J. (2013). From knowledge to action Bridging gaps in disaster risk reduction

920   Progress in Human Geography 37(1): 93-114.

921

922   Gaillard, J. C., & Kelman, I. (2009). US-Philippines Military Relations After the Mt Pinatubo Eruption

923   in I99I: A Disaster Diplomacy Perspective. European journal of east Asian studies, 8(2), 301-330.

924

925   Gaillard, J. C., Clavé, E., & Kelman, I. (2008). Wave of peace? Tsunami disaster diplomacy in Aceh,

926   Indonesia. Geoforum, 39(1), 511-526.

927

928   Gallopín, G.C. (2006). Linkages between vulnerability resilience and adaptive capacity Global

929   Environmental Change 16(3):293-303

930

931   Giroux, H. A. (2007). Reading Hurricane Katrina: Race, class, and the biopolitics of disposability.

932   College Literature, 33(3), 171-196.

933

934   Glantz, M. H. (2003). Usable science 8: early warning systems: do's and don'ts. Report of workshop.

935

936   Glantz, M. H. (1976). The politics of natural disaster: The case of the Sahel drought. New York:

937   Praeger.

938

939   Grosz, E. A. (2008). Chaos, territory, art: Deleuze and the framing of the earth. Columbia University

940   Press.

941

942   Grove, K. J. (2010). Insuring "our common future?" Dangerous climate change and the biopolitics of

943   environmental security. Geopolitics, 15(3), 536-563.

944

945   Grove, K. (2013). Hidden transcripts of resilience: power and politics in Jamaican disaster

946   management. Resilience, 1(3), 193-209.

947

948   Grove, K. (2014a). Biopolitics and Adaptation: Governing Socio-Ecological Contingency Through

949   Climate Change and Disaster Studies. Geography Compass, 8(3), 198-210.

950

951   Grove, K. (2014b). Agency, affect, and the immunological politics of disaster resilience. Environment

952   and Planning D: Society and Space, 32(2), 240-256.

953   Grove, K. J. (2014c). Adaptation machines and the parasitic politics of life in Jamaican disaster

954   resilience. Antipode, 46(3), 611-628.

955   Grove, K., & Pugh, J. (2015). Assemblage Thinking and Participatory Development: Potentiality,

956   Ethics, Biopolitics. Geography Compass 9(1):1-15.

957   Hardt, M. And Negri, A. (2000). Empire. Cambridge, MA: Harvard University Press.

958   Harrison, C., & Popke, J. (2011). "Because you got to have heat": the networked assemblage of

959   energy poverty in Eastern North Carolina. Annals of the Association of American Geographers,

960   101(4), 949-961.

961   Hayashi, M., & Hughes, L. (2013). The Fukushima nuclear accident and its effect on global energy

962   security. Energy Policy, 59, 102-111.

963

964   Hewitt, K. (1983). The idea of calamity in a technocratic age. In: Hewitt, K. (ed.) Interpretations of

965   calamity from the viewpoint of human ecology. Boston: Allen & Unwin, pp. 3–32.

966

967 Hewitt, K. (2000). Safe place or 'catastrophic society'? Perspectives on hazards and disasters in

968 Canada. The Canadian Geographer/Le Géographe canadien, 44(4), 325-341.

969

970 Hewitt K (2007) Preventable disasters: Addressing social vulnerability, institutional risk, and civil

971 ethics. Geographische Rundschau, International Edition 3: 43–52.

972

973 Hewitt, K. (2013). Environmental disasters in social context: toward a preventive and precautionary

974 approach. Natural hazards, 66(1), 3-14.

975

976 Hewitt, K. (2015). Framing disaster in the 'global village': cultures of rationality in risk, security and

977 news. In Krüger, F., Bankoff, G., Cannon, T., Orlowski, B., & Schipper, E. L. F. (Eds.). (2015). Cultures

978 and disasters: understanding cultural framings in disaster risk reduction. London: Routledge, pp.19-

979 36.

980

981 Hirano, M. (2014). The Maritime Dispute in Sino-Japanese Relations: Domestic Dimensions. Asian

982 Perspective: April-June 2014, Vol. 38, No. 2, pp. 263-284.

983 Hochrainer, S., & Mechler, R. (2011). Natural disaster risk in Asian megacities: A case for risk

984 pooling?. Cities, 28(1), 53-61.

985

986 Hulme, M. (2009). Why we disagree about climate change: Understanding controversy inaction and

987 opportunity Cambridge Cambridge University Press

988

989 Hulme, M. and Mahony, M. (2010). Climate change: What do we know about the IPCC? Progress in

990 Physical Geography 34:705-718

991

992   Jasanoff, S. (1990). The Fifth Branch: Scientific Advisors as Policymakers. Cambridge: Harvard

993   University Press.

994

995   Jasanoff, S. (ed) (2004). States of Knowledge The co-production of science and social order

996   (Abingdon Routledge)

997

998   Jasanoff, S. (2005). Designs on Nature Science and democracy in Europe and the United States

999   Princeton Princeton University Press

1000

1001   Joseph, J. (2013). Resilience as embedded neoliberalism: a governmentality approach. Resilience,

1002   1(1), 38-52.

1003

1004   Kelman, I. (2006). Acting on disaster diplomacy. Journal of International Affairs, 59(2), 215.

1005

1006   Kelman, I., Davies, M., Mitchell, T., Orr, I., & Conrich, B. (2006). Island disaster para-diplomacy in the

1007   Commonwealth. The Round Table, 95(386), 561-574.

1008

1009   Kelman, I. (2007). Hurricane Katrina disaster diplomacy. Disasters, 31(3), 288-309.

1010

1011   Kelman, I., & Gaillard, J. C. (2007). Disaster diplomacy in Aceh. Humanitarian Exchange, 37, 37-39.

1012

1013   Kelman, I., & Mather, T. A. (2008). Living with volcanoes: the sustainable livelihoods approach for

1014   volcano-related opportunities. Journal of Volcanology and Geothermal Research, 172(3), 189-198.

1015

1016   Kreutz, J. (2012). From tremors to talks: Do natural disasters produce ripe moments for resolving

1017   separatist conflicts? International Interactions, 38(4), 482-502.

1018

1019   Krüger, F., Bankoff, G., Cannon, T., Orlowski, B., & Schipper, E. L. F. (Eds.). (2015). Cultures and

1020   disasters: understanding cultural framings in disaster risk reduction. Routledge.

1021

1022   Kuus, M. (2013). Geopolitics and expertise: Knowledge and authority in European diplomacy. John

1023   Wiley & Sons.

1024

1025   Lane, S.N., Odoni, N., Landström, C., Whatmore, S.J., Ward, N. and Bradley, S. (2011). Doing flood

1026   risk science differently an experiment in radical scientific method. Transactions of the Institute of

1027   British Geographers 36(1)15-36.

1028

1029   Larsen, S. E. (2006). The Lisbon earthquake and the scientific turn in Kant's philosophy. European

1030   Review, 14(03), 359-367.

1031

1032   Lewis, J. and Kelman, I. (2010). Places, people and perpetuity: community capacities in ecologies of

1033   catastrophe. ACME: an international e-journal for critical geographies 9(2):191-220.

1034

1035   Livingstone, D. N. (2003). Putting Science in Its Place: Geographies of Scientific Knowledge. Chicago:

1036   University of Chicago Press.

1037

1038   Livingstone, D. N. (2005). Science, text and space: thoughts on the geography of reading.

1039   Transactions of the Institute of British Geographers, 30(4), 391-401.

1040

1041   Lövbrand, E., Stripple, J., & Wiman, B. (2009). Earth System governmentality: Reflections on science

1042   in the Anthropocene. Global Environmental Change, 19(1), 7-13.

1043

1044   Luke, T. W. (1999). Environmentality as green governmentality. Discourses of the Environment, 121-

1045   151.

1046

1047   Mahony, M. (2014). Climate change and the geographies of objectivity: the case of the IPCC's

1048   burning embers diagram. Transactions of the Institute of British Geographers 40(2):153-167.

1049

1050   Manyena, S.B. (2006), The concept of resilience revisited. Disasters 30(4):434-450

1051

1052   Marston, S. A. (2000). The social construction of scale. Progress in Human Geography, 24(2), 219-

1053   242.

1054

1055   Marston, S. A., Jones, J. P., & Woodward, K. (2005). Human geography without scale. Transactions of

1056   the Institute of British Geographers, 30(4), 416-432.

1057

1058   Massey, D. (1999) Space-Time 'Science' and the Relationship between Physical Geography and

1059   Human Geography Transactions of the Institute of British Geographers 24(3):261

1060

1061   McFarlane, C. (2009). Translocal assemblages: space, power and social movements. Geoforum,

1062   40(4), 561-567.

1063

1064   McFarlane, C. (2011). The city as assemblage: dwelling and urban space. Environment and Planning-

1065   Part D, 29(4), 649.

1066

1067   Mercer, J. (2010). Disaster risk reduction or climate change adaptation: are we reinventing the

1068   wheel?. Journal of International Development, 22(2), 247-264.

1069

1070   Mercer, J., Kelman, I., Suchet-Pearson, S., & Lloyd, K. (2009). Integrating indigenous and scientific

1071   knowledge bases for disaster risk reduction in Papua New Guinea. Geografiska Annaler: Series B,

1072   Human Geography, 91(2), 157-183.

1073

1074   Mercer, J., Kelman, I., Taranis, L., & Suchet-Pearson, S. (2010). Framework for integrating indigenous

1075   and scientific knowledge for disaster risk reduction. Disasters, 34(1), 214-239.

1076

1077   Mercer, J., Dominey-Howes, D., Kelman, I., & Lloyd, K. (2007). The potential for combining

1078   indigenous and western knowledge in reducing vulnerability to environmental hazards in small

1079   island developing states. Environmental Hazards, 7(4), 245-256.

1080

1081   Middleton, N., & O'Keefe, P. (1997). Disaster and development: the politics of humanitarian aid.

1082   Pluto Press.

1083

1084

1085   Morss R E Wilhelmi O V Downton M W and Gruntfest E (2005) Flood risk uncertainty and scientific

1086   information for decision making lessons from an interdisciplinary project Bulletin of the American

1087   Meteorological Society 86(11):1593-1601

1088

1089   Nelson, T. (2010). When disaster strikes: on the relationship between natural disaster and interstate

1090   conflict. Global Change, Peace & Security, 22(2), 155-174.

1091

1092   Nelson, T. (2012). Determinants of disaster aid: donor interest or recipient need?. Global Change,

1093   Peace & Security, 24(1), 109-126.

1094

1095   Neumann, R. P. (2009). Political ecology: theorizing scale. Progress in Human Geography, 33(3), 398-

1096   406.

1097

1098   Neumayer, E., Plümper, T., & Barthel, F. (2014). The political economy of natural disaster damage.

1099   Global Environmental Change, 24, 8-19.

1100

1101   Nigg, J. M., Barnshaw, J., & Torres, M. R. (2006). Hurricane Katrina and the flooding of New Orleans:

1102   Emergent issues in sheltering and temporary housing. The Annals of the American Academy of

1103   Political and Social Science, 604(1), 113-128.

1104

1105   O'Brien K 2010 Responding to environmental change: A new age for human geography? Progress in

1106   Human Geography 35(4):542-549

1107

1108   O'Brien, K., Sygna, L., & Haugen, J. E. (2004). Vulnerable or resilient? A multi-scale assessment of

1109   climate impacts and vulnerability in Norway. Climatic change, 64(1-2), 193-225.

1110

1111

1112   O'Connor, D., Brisson-Boivin, K., & Ilcan, S. (2014). Governing failure: development, aid and audit in

1113   Haiti. Conflict, Security & Development, 14(3), 309-330.

1114

1115   O'Keefe, P., Westgate, K. and Wisner, B. (1976). Taking the naturalness out of natural disasters.

1116   Nature 260, pp. 566–567.

1117

1118   O'Keefe, P., & Wisner, B. (1977). Landuse and development. International African Institute.

1119

1120   O'Malley, P. (2011). Security after risk: security strategies for governing extreme uncertainty.

1121   Current Issues Crim. Just., 23, 5.

1122

1123   Oels, A. (2013). Rendering climate change governable by risk: From probability to contingency.

1124   Geoforum, 45, 17-29.

1125

1126   Oliver-Smith A 1999 'What is a disaster?' Anthropological perspectives on a persistent question in

1127   Oliver-SmithA and HoffmanS eds The angry earth: disaster in anthropological perspective Routledge,

1128   New York 18–34

1129

1130   Oliver-Smith, A. 2015. Conversations in catastrophe. In Krüger, F., Bankoff, G., Cannon, T., Orlowski,

1131   B., & Schipper, E. L. F. (Eds.). (2015). Cultures and disasters: understanding cultural framings in

1132   disaster risk reduction. Routledge.

1133

1134   Oppenheimer, C. (2010). We told you so! Reflections on the 'ashpocalypse" Elements 2010

1135

1136   Pelling, M. (2003). Natural disaster and development in a globalizing world. Routledge.

1137

1138   Pelling, M. (2007). Learning from others: the scope and challenges for participatory disaster risk

1139   assessment. Disasters, 31(4), 373-385.

1140

1141   Pelling, M. (2010). Adaptation to climate change: from resilience to transformation. London:

1142   Routledge.

1143

1144   Pelling, M. and Dill, K., (2010). Disaster politics: tipping points for change in the adaptation of

1145   sociopolitical regimes Progress in Human Geography 3421

1146

1147 Pelling, M., & Wisner, B. (2012). Disaster risk reduction: Cases from urban Africa. London: Routledge.

1148

1149 Platt, R. H. (1999). Disasters and democracy. Washington DC: Island Press.

1150

1151 Porter L, Davoudi S (2012) The politics of resilience: A cautionary note. Planning Theory and Practice

1152 13(2): 329–333.

1153

1154 Powell, R. C. (2007). Geographies of science: histories, localities, practices, futures. Progress in

1155 Human Geography, 31(3), 309-329.

1156

1157 Power, M. (2004). The risk management of everything: Rethinking the politics of uncertainty. Demos.

1158

1159 Pugh, J. (2014). Resilience, complexity and post-liberalism. Area.

1160

1161 Reid, J. (2012). The disastrous and politically debased subject of resilience. Development Dialogue

1162 58, pp. 67–79.

1163

1164 Reinhardt, O., & Oldroyd, D. R. (1983). Kant's theory of earthquakes and volcanic action. Annals of

1165 Science, 40(3), 247-272.

1166

1167 Robbins P and Marks B (2009) Assemblage geographies. In: Smith SJ, Pain R, JP III Jones and Marston

1168 SA (eds) The SAGE Handbook of Social Geographies. Thousand Oaks, CA: SAGE, 176–194.

1169

1170 Romieu, E., Welle, T., Schneiderbauer, S., Pelling, M., & Vinchon, C. (2010). Vulnerability assessment

1171 within climate change and natural hazard contexts: revealing gaps and synergies through coastal

1172   applications. Sustainability Science, 5(2), 159-170.

1173

1174   Rothstein, H., Huber, M., & Gaskell, G. (2006). A theory of risk colonization: The spiralling regulatory

1175   logics of societal and institutional risk. Economy and society, 35(1), 91-112.

1176

1177   Salloukh, B. F. (2013). The Arab Uprisings and the Geopolitics of the Middle East. The International

1178   Spectator, 48(2), 32-46.

1179

1180   Sassen, S. (2006). Territory, authority, rights: from medieval to global assemblages. Princeton, NJ:

1181   Princeton University Press.

1182

1183   Schipper, E. L. and Pelling, M. (2006). Disaster risk, climate change and international development:

1184   scope for, and challenges to, integration. Disasters 30 (1), pp. 19–38.

1185

1186   Shackley, S., Wynne, B., (1995). Global climate change: The mutual construction of an emergent

1187   science-policy domain Science and Public Policy 22 (4)218-230

1188

1189   Shackley, S., Wynne, B. (1996). Representing Uncertainty in Global Climate Change Science and

1190   Policy Boundary-Ordering Devices and Authority Science Technology & Human Values 21 (3)275-302

1191

1192   Shaw, I. G. (2012). Towards an evental geography. Progress in Human Geography, 36(5), 613-627.

1193

1194   Shaw, I. G. R., Robbins, P. F., & Jones III, J. P. (2010). A bug's life and the spatial ontologies of

1195   mosquito management. Annals of the Association of American Geographers, 100(2), 373-392.

1196

1197   Smit, B., & Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. Global environmental

1198   change, 16(3), 282-292.

1199

1200   Sparke, M. (2007). Geopolitical fears, geoeconomic hopes, and the responsibilities of geography.

1201   Annals of the Association of American Geographers, 97(2), 338-349.

1202

1203   Spillius, J. (2013). Natural disaster and political crisis in a Polynesian society. The

1204   Anthropology of Climate Change: An Historical Reader, 157.

1205

1206   Sudmeier-Rieux, K. I. (2014). Resilience–an emerging paradigm of danger or of hope? Disaster

1207   Prevention and Management, 23(1), 67-80.

1208

1209   Surono, Jousset,P., Pallister,J, Boichu, M., Buongiorno, F., Budisantoso, A., Costa,F., Andreastuti, S.,

1210   Prata, F., Schneider, D., Clarisse, L., Humaida, H., Sumarti,Sri, Bignami, C., Griswold,J., Carn,S.,

1211   Oppenheimer, C., Lavigne,F. (2012). The 2010 explosive eruption of Java's Merapi volcano—A '100-

1212   year' event, Journal of Volcanology and Geothermal Research, 241–242: 121-135

1213

1214   Taber, S. (1922). The great fault troughs of the Antilles. The Journal of Geology, 89-114.

1215

1216   Turner, B. L., Kasperson, R. E., Matson, P. A., McCarthy, J. J., Corell, R. W., Christensen, L., et al,.

1217   (2003). A framework for vulnerability analysis in sustainability science. Proceedings of the national

1218   academy of sciences, 100(14), 8074-8079.

1219

1220   Walker, J., & Cooper, M. (2011). Genealogies of resilience: From systems ecology to the political

1221   economy of crisis adaptation. Security dialogue, 42(2), 143-160.

1222

1223   Watts, M. J., & Bohle, H. G. (1993). The space of vulnerability: the causal structure of hunger and

1224   famine. Progress in human geography, 17(1), 43-67.

1225

1226   Weichselgartner, J., & Kelman, I. (2014). Geographies of resilience Challenges and opportunities of a

1227   descriptive concept. Progress in Human Geography, 0309132513518834.

1228

1229   Whatmore, S. (2006). Materialist returns: practising cultural geography in and for a more-than-

1230   human world. Cultural geographies, 13(4), 600-609.

1231

1232   White, G.F. (1945). Human Adjustment to Floods: A Geographical Approach to the Flood Problem in

1233   the United States. University of Chicago.

1234

1235   Wisner, B., & Luce, H. R. (1993). Disaster vulnerability: scale, power and daily life. GeoJournal, 30(2),

1236   127-140.

1237

1238   Wisner, B. (1995). Bridging "expert" and "local" knowledge for counter-disaster planning in urban

1239   South Africa. GeoJournal, 37(3), 335-348.

1240

1241   Wisner, B. (2003). Disaster risk reduction in megacities: making the most of human and social

1242   capital. Building safer cities: The future of disaster risk, 181-196.

1243

1244   Wisner, B., O'Keefe, P. Westgate, K., (1976). Global systems and local sisasters: the untapped

1245   potential of people's science. Disasters 1 (1) 47-57.

1246

1247   Wisner, B., Gaillard, J.C., Kelman, I. (2012). Handbook of hazards and disaster risk reduction London

1248   Routledge

1249

1250 Wisner, B., Blaikie, P., Cannon, T., Davis, I. (2004). At risk Natural hazards people's vulnerability and

1251 disasters London Routledge

1252

1253 Wittneben, B. B. (2012). The impact of the Fukushima nuclear accident on European energy policy.

1254 Environmental Science & Policy, 15(1), 1-3.

1255

1256 Wynne, B. (1989). Sheepfarming after Chernobyl: A case study in communicating scientific

1257 information Environment 31(2):33-39

1258

1259 Wynne, B. (1992). Uncertainty and environmental learning: Reconceiving science and policy in the

1260 preventive paradigm Global Environmental Change 2(2):111-127

1261

1262 Yates, J. S. (2012). Uneven interventions and the scalar politics of governing livelihood adaptation in

1263 rural Nepal. Global Environmental Change, 22(2), 537-546.

1264

1265 Yusoff, K. (2010). Biopolitical economies and the political aesthetics of climate change. Theory,

1266 Culture & Society, 27(2-3), 73-99.

1267

1268 Yusoff, K., Grosz, E., Clark, N., Saldanha, A., & Nash, C. (2012). Geopower: a panel on Elizabeth

1269 Grosz's" Chaos, Territory, Art: Deleuze and the Framing of the Earth". Environment and Planning D:

1270 Society and Space, 30(6), 971-988.