

# Chapter 1

## Disaster Management: Socio-Legal and Asia-Pacific Perspectives

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### 1.1 Disasters

A disaster can be defined as ‘a serious disruption of the functioning of society, which poses a significant, widespread threat to human life, health, property or the environment, whether arising from accident, nature or human activity, whether developing suddenly or as a result of long-term processes, but excluding armed conflict’.<sup>1</sup> This is the view taken by the United Nations (UN) International Strategy for Disaster Reduction (UNISDR) as well as the Red Cross and Red Crescent societies.<sup>2</sup> Examining ‘emergency risk regulation’, Alemanno suggests that a disaster comprises:

a natural or man-made [or manufactured] hazard resulting in an event of substantial extent causing significant physical damage or destruction, loss of life, or drastic change to the natural environment . . .

Typically, one speaks of crisis or disaster when a threat is perceived against the core values or self-sustaining functions of a social system, which calls for urgent remedial action under conditions of uncertainty. Yet although the category of disaster at first may seem

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For helpful feedback on earlier drafts, we thank especially Lloyd Burton, Jeff Kingston, Andrew Pardieck and Rick Wallace. We particularly thank Diana Hu for superlative research assistance in compiling Appendices A and B.

<sup>1</sup> Verchick (2010), p. 6.

<sup>2</sup> On the UNISDR, see <http://www.unisdr.org/>.

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unproblematic it is an elastic concept centered on the following common-place three-part characterization: sudden, significant and natural.<sup>3</sup>

Aldrich elaborates the latter point further, focusing on the role of ‘social capital’ or networking that fosters community resilience in recovery from large-scale catastrophes. He considers a disaster to be ‘an event that suspends normal activities and threatens or causes severe community-wide damage’.<sup>4</sup>

These international organisations and commentators, along with several others,<sup>5</sup> note that the lines between ‘natural’ and ‘manufactured’ risks are becoming increasingly blurred. Examples include the ‘volcanic ash crisis’ that disrupted travel throughout Europe in 2010, and Japan’s devastating earthquake, tsunami and subsequent nuclear power plant meltdown in 2011 (outlined in Table 1 in this chapter).<sup>6</sup> With Hurricane Katrina in 2005, much destruction in and around New Orleans ‘occurred precisely because of human attempts to subvert or artificially control nature’ (especially by constructing levees and waterways to allow development closer to the shoreline).<sup>7</sup> Other research has suggested that construction of China’s colossal Zipingpu Dam may have helped trigger the 2008 Sichuan Earthquake.<sup>8</sup> Drilling for natural gas was also the likely trigger for ‘Lusi’, the massive mud volcano that has displaced 13,000 families in Indonesia.<sup>9</sup> Arguably, global warming was a contributing factor to the world’s most lethal disaster over the last decade: the 2003 heat wave throughout Europe, which resulted in 30,000–50,000 fatalities.<sup>10</sup> Appendix B briefly outlines the timing and impact of recent catastrophes in Asia-Pacific jurisdictions.<sup>11</sup>

This book mainly considers relatively *sudden* disasters or catastrophes, especially those with a significant *natural* cause. However, Japan’s recent experience with the Fukushima nuclear power plant suggests how a nuclear accident might

<sup>3</sup> Alemanno (2011), p. xxi.

<sup>4</sup> Aldrich (2012b), p. 3. After helpfully reviewing the intellectual history behind notions of ‘social capital’, Aldrich defines it as ‘the resources available through bonding, bridging, and linking social networks along with the norms and information transmitted through those connections’, focusing then on ‘the ways social capital accesses or alters public policies’ (p. 33).

<sup>5</sup> For example Hutter (2010), p. 8. More broadly, the Organisation for Economic Cooperation and Development (OECD) highlights the growing complexity of contemporary ‘systemic’ risks: OECD (2003), pp. 49–52.

<sup>6</sup> Alemanno (2011). On the ‘3/11’ or ‘triple disasters’ in Japan, see also Japan Times (2012), Birmingham and McNeill (2012) and Claremont (2013), in this volume.

<sup>7</sup> Aldrich (2012b), p. 3. For an overview of the Hurricane Katrina devastation, see also pp. 130–134.

<sup>8</sup> Verchick (2010), p. 38. Sichuan was also struck by a 7.0 magnitude earthquake on 20 April 2013, killing at least 196 people and injuring more than 11,000: Chan (2013). On disaster management in China generally, see also Bath (2013), in this volume.

<sup>9</sup> See Butt (2013), in this volume.

<sup>10</sup> Farber (2011), p. 2.

<sup>11</sup> That list focuses on ‘environmental disasters’, which destroy ‘important environmental amenities or [those] in which harm to human interests is mediated by an environmental change’: Farber (2011), p. 2.

**Table 1** Disaster law—an overview

Disaster management	Types of law		
	Public law	Private law	International law
Mitigation	<p><b>Constitution</b> (for example local/central government powers,<sup>a</sup> electoral law<sup>b</sup>)</p> <p><b>Urban planning law</b> (for example coastal settlements)</p> <p><b>Environmental law</b> generally<sup>c</sup></p> <p><b>Safety regulation</b><sup>f</sup> (for example seawalls, earthquake-resistance<sup>g</sup>)</p> <p><b>Competition law</b> (for example on bid-rigging for public works)</p> <p><b>Nuclear plant licensing laws</b><sup>k</sup></p>	<p><b>Tort law</b> (indirectly)</p> <p><b>Product liability law</b><sup>h</sup> (including private enforcement mechanisms)<sup>j</sup></p>	<p><b>Customary international law</b> (for example state responsibility), <b>treaties</b><sup>d</sup> and <b>soft law</b><sup>e</sup></p> <p><b>Trade agreements, Memoranda of Understanding</b> (MoUs)<sup>i</sup></p>
Relief	<p><b>Constitution</b> (for example on emergency measures or military deployments,<sup>l</sup> local versus central government powers<sup>m</sup>)</p> <p><b>Tax/NGO laws</b><sup>p</sup></p> <p><b>Quarantine or immigration laws</b></p> <p><b>Health and welfare laws</b></p> <p><b>Nuclear accident response laws</b></p> <p><b>Criminal law</b> (for example against looters)</p>		<p><b>Human rights treaties</b> (for example on children, women)<sup>n</sup>; 1994 Convention on Nuclear Safety<sup>o</sup></p> <p><b>MoUs</b> or possible addenda to trade agreements (allowing temporary ingress of foreign products and personnel)</p> <p><b>WHO Laws</b><sup>q</sup></p> <p>Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency<sup>r</sup></p>

(continued)

**Table 1** (continued)

Types of law			
Disaster management	Public law	Private law	International law
		<b>Contract and consumer law</b> (for example terminating existing contracts), <sup>s</sup> <b>property law</b>	
		<b>Insolvency law</b> <sup>t</sup>	
Recovery	<b>Nuclear accident compensation laws</b> <sup>u</sup>	<b>Insurance law</b> <sup>v</sup>	1960 Paris Convention and 1963 Vienna Convention <sup>w</sup>
	Government 'guidelines', compensation funds <sup>x</sup>	<b>Tort law</b> (against private parties and sometimes the state) <sup>y</sup>	
	Government support for Alternative Dispute Resolution <sup>z</sup>	<b>Dispute resolution systems</b> (for example Court mediation/litigation)	Hague conventions for cross-border litigation <sup>aa</sup>
		<b>Consumer law</b> (for example frauds, supply of credit, mortgages <sup>bb</sup> )	
	Zoning law, community-enhancing laws <sup>cc</sup> and other <b>administrative law</b> (for example <b>privacy law</b> <sup>dd</sup> )		

<sup>a</sup>Rheuben (2011). <sup>b</sup>Ramseyer (2012). <sup>c</sup>Takahashi et al. (2013) and Kabashima (2013). <sup>d</sup>Birnie et al. (2009). On climate change measures, see also Saul et al. (2012). <sup>e</sup>For example, the 'First Responder' guidelines regarding disposal of dead bodies: Johns (2012). <sup>f</sup>Generally Nottage (2010). <sup>g</sup>Nottage (2006). <sup>h</sup>Osaka (2012). <sup>i</sup>For example, regarding accident information, as with consumer product safety hazards recently: see Nottage (2009b); Nottage (2011). <sup>j</sup>Kozuka (2013). <sup>k</sup>Pardieck (2013). <sup>l</sup>Ames and Koguchi-Ames (2012) and Yates and Bergin (2011). <sup>m</sup>See generally Samuels (2013), pp. 151–179. <sup>n</sup>Office of the UN High Commissioner for Human Rights and UN Development Programme (2007); compare with White and Grieve (2013), in this volume and de Guttry et al. (2012). <sup>o</sup>See also Cook (2013), in this volume. <sup>p</sup>See for example Avenell (2012); Kawato et al. (2012); Burch (2013), in this volume. <sup>q</sup>Constitution of the World Health Organisation and International Health Regulations 2005. <sup>r</sup>Cook (2013), in this volume. <sup>s</sup>Morita (2013). <sup>t</sup>Steele and Chun (2013). <sup>u</sup>Weitzdörfer (2013), in this volume. <sup>v</sup>Kozuka (2012, 2013). <sup>w</sup>Cook (2013), in this volume. <sup>x</sup>Morita (2013). <sup>y</sup>Weitzdörfer (2013), in this volume. Tort and/or criminal sanctions may even sometimes be attached to individuals helping governments in disaster management, as with six scientists recently convicted of manslaughter for failing to predict an earthquake that struck L'Aquila (Italy) in 2009: cf. McGowan (2012). <sup>z</sup>Rheuben (2013), in this volume; see also Foote (2013). <sup>aa</sup>See [http://www.hcch.net/index\\_en.php](http://www.hcch.net/index_en.php). <sup>bb</sup>See for example Kabashima (2013). <sup>cc</sup>Aldrich (2012a, b). <sup>dd</sup>Impacting, for example, on the retention and sharing of health records, see in Japan for example Tohoku Medical Megabank Organization (undated) and Thia (2011). On privacy law in Japan, see generally Lawson (2006). In New Zealand recently, see White and Grieve (2013), in this volume.

escalate even without any natural event such as an earthquake or resultant tsunami. Human errors caused earlier nuclear plant accidents in Chernobyl in the Ukraine in 1986, and at Pennsylvania's Three Mile Island in the US in 1979.<sup>12</sup> Rheuben (2013), in this volume also compares these sudden disasters with slower-onset disasters—namely diseases and environmental pollution—caused by asbestos products particularly in Australia,<sup>13</sup> to explore the different degrees to which governments become actively involved in responding to widespread harm.

One key research question addressed by several contributors to this volume is whether attitudes, preparedness and responses to disasters differ significantly depending on whether the disaster is more or less 'natural'. Japan certainly did extremely well in preparing and responding to the magnitude 9.0 earthquake that struck on 11 March 2011, and quite well regarding the consequent tsunami, but performed poorly in anticipating and dealing with the related accidents at the Fukushima nuclear power plant.<sup>14</sup> Duus notes that during the Tokugawa shogunate era (1603–1868), measures to cope with fires paved the way for similar effective techniques to cope with other natural disasters such as earthquakes. The Meiji government subsequently extended these techniques nationwide as aspects of a modern centralised state—and a new 'imagined community' on a national scale.<sup>15</sup>

There is now evidence of the growing frequency and impact of natural disasters world-wide, particularly in the Asia-Pacific region, as well as heightened perceptions or fears of some types of disaster risks. One major cause of disasters is environmental degradation.<sup>16</sup> For example, dam construction limits silting downstream, leaving fewer protective islands ('natural levees') to protect against storm surges and causing delta lands to subside.<sup>17</sup> Buffers against tsunami are weakened by deforestation in coastal areas, and possibly also by dying reefs. Inland deforestation results in more landslides and wildfires. Adverse impact on the environment is exacerbated by climate change, which causes the sea level to rise as well as more

<sup>12</sup> See, respectively, Gerstein (2008), pp. 92–125; Chiles (2002), pp. 39–57. See also Rees (1994) and Perrow (1999).

<sup>13</sup> In Japan, see Nottage (2006); and more generally Miyamoto et al. (2011).

<sup>14</sup> See generally Anderson (2011) and Yasumura et al. (2012). This is not to say that preparedness and short-term responses regarding the 2011 tsunami, which reached heights of between 3.5 to 9.3 m when it hit Japan's coastline, have not been questioned. One concern is that some 500 schoolchildren were among over 18,000 killed or still missing. More generally, several victims' groups have pursued civil claims against officials for negligently failing to initiate safe evacuations, and the police were also prompted to investigate Jin Sato, mayor of Minamisanriku (a heavily-hit town), for the potential offence of criminal negligence causing death. See Samuels (2013), pp. 3 and 44. However, the Japanese government also highlights examples of very successful preparedness and evacuations from schools: see Government of Japan Public Relations Office (2013).

<sup>15</sup> Duus (2012), pp. 180–181.

<sup>16</sup> Verchick (2010), pp. 29–40.

<sup>17</sup> In the Bengal Delta, a storm surge killed 138,000 in 1991. Cyclones killed around 1,000 in the Godavari delta in 1996, and 10,000 in 1999 in a neighbouring delta in India. See further Appendix B.

volatile temperature fluctuations. These are increasingly regarded as global ‘threat multipliers’ that worsen existing vulnerabilities and instability.<sup>18</sup> Another cause, however, is partly ‘man-made’ in a different sense: population pressures.<sup>19</sup> More people are living closer to rivers and shorelines, with growing urbanisation and industrialisation, and this leads to more severe impact from natural disasters even in developed countries like the US.<sup>20</sup>

The literature on *risk assessment*, underpinned especially by disciplines such as engineering and the natural sciences, emphasises that ‘hazards’ combine with ‘inventories’ (of people, infrastructure and the physical environment) to generate ‘vulnerability’ and consequent losses. The latter can be direct (such as deaths, injuries and damage to facilities) as well as indirect (including foregone income or growth).<sup>21</sup>

Recent data shows that more people were affected by natural disasters world-wide between 1990 and 2010, compared to the two prior decades pre-1990, although the number of deaths (primarily from earthquakes) continues to fluctuate without showing such a clear upward trend. The World Bank suggests that one explanation is greater exposure to hazards, as half the world’s population now lives in cities (compared to 30 % in 1950). In addition, there has been better reporting of disasters. Both factors also probably underpin growing damages estimated from disasters since the 1990s, which have risen in spurts. The most devastating events are storms, earthquakes, and then floods. Damage costs tend to be higher in wealthier countries, reflecting higher-value physical infrastructure and indirect losses.<sup>22</sup>

However, fatalities from disasters are particularly acute in developing countries, due to less effective infrastructure, emergency response and health care. The total impact also falls disproportionately on the poor *within* states, as well as on women, children and discriminated groups. This has been evident in the developing countries devastated by the Indian Ocean (or Asian ‘Boxing Day’) tsunami in 2004, Cyclone Nargis in Burma (Myanmar) in 2008, and the higher impact on certain schools and rural villages compared to metropolitan Chengdu following the

<sup>18</sup> Farber (2011), pp. 15–19. See also Saul et al. (2012).

<sup>19</sup> See also generally OECD (2003), pp. 38–42.

<sup>20</sup> A major problem following Hurricane Katrina, for example, was contamination resulting from fuels, chemicals and other products stockpiled in the severely flooded urban areas: Verchick (2010), pp. 132–135.

<sup>21</sup> Kunreuther and Useem (2009), pp. 3–4. Recent preliminary research, however, indicates considerable resilience across disparate countries within Asia—namely China, Burma (Myanmar) and Iran—in rebuilding families after recent natural disasters: James (2013). On earthquake risks concerning Iran’s sole nuclear reactor, see also <http://www.smh.com.au/world/quake-too-close-to-irans-reactor-for-comfort-20130412-2hqoq.html>.

<sup>22</sup> World Bank (2010), pp. 26–30. Earthquakes are the deadliest events globally—except in Africa, where droughts kill the most people. See also the growing impact of ‘natural’ and ‘technological’ disasters outlined in OECD (2003), pp. 33–37.

2008 earthquake in Sichuan.<sup>23</sup> Yet similar effects on vulnerable groups are evident in developed countries too, as highlighted in the aftermath of Hurricane Katrina and a week-long heat wave in Chicago that killed over 700 residents.<sup>24</sup> In Japan, the 2011 tsunami hit the elderly and infirm particularly heavily, given that the mostly rural Tohoku area tends to have a greater aged population than the rest of the country.<sup>25</sup>

Some argue that contemporary elites sometimes take advantage of high-profile shocks, such as natural disasters but also terrorist attacks and economic crises, to impose drastic free-market ‘solutions’. This general theory of ‘disaster capitalism’<sup>26</sup> appears to be overstated, but some developers and (especially local) governments do seem to have profited from the 2004 Indian Ocean tsunami by clearing out coastal villages, for example, in some parts of Sri Lanka.<sup>27</sup>

More generally, over 20 years ago Beck argued presciently that we increasingly live in a ‘risk society’ characterised by a peculiarly modern belief in rationality, calculability and science.<sup>28</sup> This creates new risks—viewed as the anticipation of catastrophe—and greater awareness of other risks, while heightening feelings of uncertainty as well as highlighting persistent limits in the human capacity to control risks. Such tensions have been exacerbated as risks become increasingly global—involving new technologies with regional or world-wide reach, as well as increasing interdependence between the local and the global—and as more opportunities emerge to ‘produce’ risks for political gains.<sup>29</sup> It does appear that contemporary societies encounter novel and greater risks, but also a new way of ‘understanding’ the world.<sup>30</sup>

Typically adopting a more micro-level perspective, other theories of risk (and associated disasters) increasingly emphasise *risk perception*: the psychological and emotional factors associated with risk, which render more complex what was originally considered the more ‘objective’ field of *risk assessment*. From the

<sup>23</sup> Verchick (2010), pp. 111–116. On the tsunami, see also Aldrich (2012a, b), pp. 91–95; Jayasuriya and McCawley (2011). Focusing on Indonesia, see Samadhi (2013), in this volume and Butt (2013), in this volume. On disasters in China, see Bath (2013), in this volume.

<sup>24</sup> Farber (2011), pp. 21–23.

<sup>25</sup> Anderson (2011). On the impact on women, see also Ito (2012). In New Zealand, see White and Grieve (2013), in this volume.

<sup>26</sup> Klein (2007).

<sup>27</sup> Verchick (2010), pp. 152–154. The aftermath of Japan’s triple disasters in 2011 may also suggest examples of ‘disaster developmentalism’. That is, there are concerns that the government is excessively prioritising larger established Japanese firms for remedial work projects, compared to smaller and more innovative firms (including foreign firms), especially regarding decontamination from the nuclear accident. See Tabuchi (2013).

<sup>28</sup> Beck (1992). The increasing awareness of the vulnerability of certain groups in disaster situations, and the human rights implications, can also be associated with a modernist worldview: see generally Tanase (2010), especially pp. 95–105.

<sup>29</sup> Beck (2009). But compare O’Malley (2008).

<sup>30</sup> Hutter (2010), pp. 4–11. See also for example Boin (2010), pp. 233–234. Bostrom and Cirkovic (2008).

1970s, decision scientists and psychologists began to demonstrate that individuals tended to be much more concerned about certain types of risks, especially those they were personally unfamiliar with or those involving new technologies. Such research has also increasingly shown that people perceive low-probability and high-consequence events very differently from experts, deploying various biases and heuristics (or rules of thumb) instead of the probabilistic assessments expected and advocated by disciplines such as economics.<sup>31</sup> Five now widely-recognised phenomena are ‘availability’, ‘representativeness’, ‘confirmation bias’, ‘anchoring’ and ‘overconfidence’.<sup>32</sup> Others include ‘hindsight bias’, the ‘conjunction fallacy’, the ‘affect heuristic’ and ‘scope neglect’.<sup>33</sup> Several of these, as well as other departures from economically rational behaviour, are related to people’s general intuitive tendency to react more strongly to losses than gains.<sup>34</sup>

Such ‘subjective’ factors in decision-making by individuals complicate strategies for *risk management*, developed by economists and other policy analysts to reduce future losses from disasters and to facilitate recovery. Kunreuther and Useem therefore suggest various hybrid improvements for risk-management strategies, encompassing: risk forecasting, communication of risk information, the design of economic incentives, private–public partnerships, reinsurance and other financial instruments, resilience and sustainability (especially in developing

<sup>31</sup> Kunreuther and Useem (2009), pp. 6–8.

<sup>32</sup> Cleary (2009), p.70 (original emphasis):

- **Availability:** We tend to interpret any story through the lens of a superficially similar account. We recall unusual, emotionally charged events more easily and unconsciously adjust the specifics of the new case, and of our recollections, to make the two fit. This distortion often leads to our misjudging the probability of an event, as things that we can recall easily seem more likely.
- **Representativeness:** We judge the substantial similarity of events based on superficial, perhaps insignificant, resemblances. We also tend to see *patterns* in circumstances where none exist.
- **Confirmation bias:** We underpin an assumption by focusing on instances that confirm it, while ignoring those that don’t.
- **Anchoring:** We cling mentally to a number or “fact” that we have absorbed in a particular context, and employ it more generally across a presumed field, even when it is irrelevant or misleading in another context.
- **Overconfidence:** We tend to overestimate the probability of our success in actions that we plan.

<sup>33</sup> Yudkowsky (2008). He also outlines another bias, relevant to management of global catastrophic risks, which derives instead from the wider field of social psychology: ‘bystander apathy’, whereby larger numbers of people are *less* likely to act in emergencies.

<sup>34</sup> Kahneman (2011), especially pp. 282–286. This summarises ‘prospect theory’, premised not only on loss aversion, but also decision-making made relative to a reference point—such as one’s level of wealth, which may be subject to the ‘anchoring’ heuristic—and a principle of diminishing sensitivity to sensory dimensions as well as the evaluation of changes in wealth. According to this theory, in mixed gambles (where losses and gains are possible), loss aversion results in very conservative choices; but when faced with bad choices, comparing a sure loss to a larger but merely probable loss, diminishing sensitivity leads to risk-seeking behaviour.



countries), and building leadership for averting and responding to disasters before it is needed.<sup>35</sup> In a similar vein, noting the political tension implicit in a democratic system if economists and other public policy experts view risks differently to the general public, Kahneman also favours a compromise solution: 'Psychology should inform the design of risk policies that combine the experts' knowledge with the public's emotions and intuitions'.<sup>36</sup>

## 1.2 Disaster Management

This volume takes a broad approach to 'disaster management', which we divide generally into:

1. Disaster mitigation (including prevention);
2. Relief (emergency and subsequent short-term responses); and
3. Recovery (longer-term post-disaster assistance, including compensation and reconstruction).<sup>37</sup>

While useful for conceptual and practical purposes, these three aspects or phases are not completely independent. For example, a generous government-supported compensation scheme for a nuclear accident or liberal zoning rules in coastal areas can create incentives for nuclear plant operators not to take sufficient precautions to minimise risks of accidents, or citizens building too close to tsunami-prone coastlines. A more holistic view of disaster mitigation, relief and recovery may also help identify new possibilities for effective disaster management. For example, Leonard and Howitt urge more attention to certain recovery activities *before* a major event arises, just as policy-makers increasingly prepare in advance for relief efforts that can be implemented soon after a disaster strikes.<sup>38</sup> These *ex ante* measures could include identifying or revisiting regulations that might need to be suspended to allow rapid rebuilding, developing financial arrangements to allow better access to resources for recovery efforts, and measures to bolster neighbourhood-based leadership. Unlike disaster mitigation measures, such 'advance recovery' actions are not necessarily aimed at reducing the consequential harm from the hazard (or indeed its likelihood); instead, they aim 'to make whatever recovery *does* need to take place more efficient, rapid and effective'.<sup>39</sup>

<sup>35</sup> Kunreuther and Useem (2009), pp. 13–17. On hazard information-sharing in the context of the Fukushima nuclear power plant disaster, see Aronson (2013).

<sup>36</sup> Kahneman (2011), p. 145.

<sup>37</sup> Compare also Alemanno (2011), p. xxii; Leonard and Howitt (2009), pp. 24–25; OECD (2003) and McCawley (2011).

<sup>38</sup> Leonard and Howitt (2009).

<sup>39</sup> Leonard and Howitt (2009), p. 26 (original emphasis). Another example may be a 'template' or general principles for establishing compensation funds or other relief and recovery measures: see Verchick (2010), pp. 178–182. A similar approach is urged, in decision-making more generally, by

In Chap. 2 of this volume, focusing primarily on relief and recovery in Japan, Reich examines patterns of ‘care, compensation and clean-up’ as well as how disasters can progress from ‘private’ to ‘public’, and ‘political’ issues.<sup>40</sup> Another key research question explored by several contributors is whether such patterns or stages vary significantly across countries. Rheuben in Chap. 5, for example, suggests that a more ‘hands-off’ approach to compensation issues may be taken by Australia and other jurisdictions that expose their government to less potential liability for allegedly not adequately preparing for or responding to disasters. Other chapters focus more on disaster mitigation and preparedness, such as Nasu on emerging risks from nanotechnology.

Generally, researchers and policy-makers are increasingly placing emphasis on such *ex ante* questions. In the US, for example, both Hurricane Katrina in 2005 and the 11 September 2001 terrorist attacks revealed that the government was alarmingly under-prepared for large-scale disasters, and that its structures remained heavily focused on *ex post* issues such as disaster relief.<sup>41</sup>

Disaster management in a broader sense has consequently become a burgeoning field in many developed countries, and more recently in parts of the developing world. Important research centres, often established after major natural disasters and increasingly interested in disaster mitigation or planning problems, are now found in the US (such as the Natural Hazards Centre at the University of Colorado, since 1976<sup>42</sup>; and the Pacific Disasters Centre, affiliated with the University of Hawai’i, since 2006),<sup>43</sup> Australia (the Centre for Disaster Studies at James Cook University, 1979),<sup>44</sup> Zambia (the African Centre for Disaster Studies, 2002),<sup>45</sup> and

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Taleb (2012): given the possibility of ‘black swans’ (highly uncertain but dramatic occurrences) and other difficulties in predicting major adverse events, far more attention should be paid to mechanisms that facilitate dealing with their consequences. See also, on fostering resilience generally, Zolli and Healy (2012).

<sup>40</sup> Reich (1991). See also Reich (2013), in this volume.

<sup>41</sup> Nolon and Rodriguez (2007), p. 1, adding that:

If there is an overarching philosophy of disaster mitigation and relief, it is essentially this: government ought to respond rapidly, compassionately and efficiently to minimize, and ultimately help compensate for, the injuries and other losses incurred by well-meaning citizens resulting from acts of God.

<sup>42</sup> <http://www.colorado.edu/hazards/>. Collaborating with a Centre established in 2008 at the North Dakota State University: <http://www.ndsu.edu/cdsem/>.

<sup>43</sup> <http://www.pdc.org/iweb/history.jsp?subg=1> (first established in the early 1990s, after Hurricane Iriki devastated Kauai). The University has increasingly focused on tsunami research: <http://www.soc.hawaii.edu/uhtoday/research/tsunami/index.html>. See also the University of Southern California, at <http://www.tsunamiresearchcenter.com/>.

<sup>44</sup> <http://www.jcu.edu.au/cds/about/index.htm> (established after cyclones devastated Townsville in 1971 and Darwin in 1974.) On the latter, see Writer (2011), pp. 104–116.

<sup>45</sup> <http://acds.co.za/>.

Asia-Pacific Disaster Management  
Comparative and Socio-legal Perspectives  
Butt, S.; Nasu, H.; Nottage, L. (Eds.)  
2014, XII, 303 p. 4 illus., 2 illus. in color.,  
ISBN: 978-3-642-39768-4