Understanding Vulnerability to Understand Disasters

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Abstract:

This chapter outlines aspects of vulnerability leading to disasters, describing how to understand vulnerability better in order to better understand and deal with disasters. Drawing on illustrative examples of key literature and authors, rather than trying to be comprehensive, the chapter starts with background illustrating how vulnerabilities rather than hazards are the root cause of disasters. The implications for vulnerability analysis are then discussed, presenting vulnerability as a process with qualitative, subjective, and contextual aspects along with the need for proportional vulnerability metrics. That leads into some material regarding resilience followed by a section with specific examples of how the theory applies in practice.

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Introduction

Humanity has long sought to explain disasters, often invoking deities, bad luck, or nature's anger as the explanation. When modern Western science started tackling the challenge of disasters, much blame was attributed to environmental hazards causing disasters, often because individuals allegedly had poor perception of disaster risk or lacked the interest to deal with the hazards. Disaster risk was often identified predominantly with hazard, focusing primarily on nature's behavior. This view implied solutions that involved society controlling and dominating nature in order to "protect" people from "nature's wrath". The debate was framed as a battle or war of humanity against the elements.

Through a long history of research, policy, and practice (e.g. Gaillard, 2010), many realized and showed that disasters emerged primarily from human activities. But human activities frequently caused disasters for others, not necessarily oneself. That is, sometimes disasters were imposed on other people. Too frequently, those who suffered most in a disaster often had the least to do with causing the disaster. This potential for harm to occur, or for harm to be caused to others, by human action represents the root cause of disasters: vulnerability. Vulnerability and hazard combine in different ways to yield risk. The presence of risk leads to disasters. Without vulnerability, a disaster cannot happen, especially since vulnerable aspects of society, such as straightening a river to provide land for housing along the banks, often cause a normal environmental event such as water rising to become a hazard such as a dangerous flood.

As with "disaster", "risk", and "hazard", many definitions and interpretations exist for "vulnerability". Vulnerability is sometimes heavily partitioned, such as focusing on physical aspects (e.g. infrastructure damage or ecosystem changes) or discussing only societal aspects (e.g. the most marginalized people or interrupted livelihoods). Models and theories try to develop more encompassing approaches to vulnerability, covering all aspects while incorporating characteristics that are used to tackle and reduce vulnerability—characteristics that are sometimes termed "resilience".

This chapter outlines aspects of vulnerability leading to disasters, describing how to understand vulnerability better in order to better understand and deal with disasters. This chapter is deliberately not comprehensive in ideas or literature. For instance, many fields have their own interpretations and applications of "vulnerability", "resilience", and related terms. Instead of trying to cover everything, this chapter provides illustrative examples based on some of the most important literature and key authors who founded and progressed the area of vulnerability studies in order to improve disaster risk reduction. Further details and other terms can be found especially in Section 7 "Supplementary websites".

Vulnerabilities, not Hazards, Cause Disasters

In tackling disasters, the focus is frequently on an environmental event, such as a tornado or earthquake, which is often termed the "hazard". These environmental events are normal and they serve important ecological and societal functions. Examples are a flood fertilizing land and providing water resources or a windstorm knocking down old trees to provide habitats on the forest floor along with space for new trees to grow. Such events can be termed "hazards" from a human perspective when humans identify the potential for society to be harmed by those events.

Hazards can become disasters when a situation where a community's ability to cope with an event is surpassed, regardless of that event being environmental or non-environmental in origin and regardless of how extreme that event is. Hewitt (1997) refers to "unnatural hazards" suggesting that "natural hazards" are not "natural" because they are generally hazardous to only humans. That is, humanity has the ability to live with nature and to avoid nature's processes causing damage to society. Nature's normal events become hazardous due to societal choices of how to deal with nature. While the event is natural, the hazardous aspects of the event are not natural because the hazardous aspects result from societal choices.

Consequently, disasters are not confined to situations involving rapid-onset, relatively clearly-defined events, such as earthquakes and cyclones. Disasters resulting from events which are more diffuse in space and time are also incorporated, such as droughts and epidemics. Conditions which become disastrous, but with less clear starting and ending points are disasters too; for example, glaciation, desertification, sea-level rise, and changes to the climate. Glantz (1994) uses the terms "creeping environmental changes", "creeping environmental problems", and "creeping environmental phenomena" to describe ongoing changes which overwhelm a community's ability to cope, such as desertification, salinization of water supplies, and sea-level rise.

Sometimes, population numbers, population densities (including urbanization), and population inequalities (determined through discrimination, livelihoods, poverty, or entitlements) are highlighted as being the chronic disasters faced (see also McEntire, 2001). The longer-term processes could also be termed "disaster conditions", or "disastrous conditions", in contrast to "disaster events".

Expanding the definition of "disaster", especially beyond the view of disasters as one-off events (see also Hewitt 1983, 1997; Lewis, 1999; Wisner et al., 2004), leads to more political interpretations. Disaster conditions could be interpreted as including a lack of resources available for tackling outside interests which are exploiting local human and material resources or discrimination based on gender, ethnicity, caste, or abilities. Lack of choice, entitlement, or empowerment can be debated as the fundamental disaster conditions, leading to, for example, the population growth and population density growth that exacerbate disasters. Incompetence, ignorance, or corruption in failing to implement disaster risk reduction could be considered to be the disaster, rather than the tornado or flood event which kills.

These key ideas are prominent in the "Pressure and Release" model which has a long history but which is most known through Wisner et al. (2004). The Pressure and Release model describes how disasters result from the interaction between hazard and vulnerability, with the latter emerging from conditions, constraints, and pressures which are imposed and created by some parts of society on other parts society, often those who are least able to help themselves (see also Boyce, 2000; Enarson and Morrow, 1998). When vulnerability interacts with a hazard, a disaster results. The root cause of the disaster, though, is the pressures that create unsafe conditions leading to a disaster waiting to happen—a disaster often triggered by a specific, identifiable hazard such as a volcanic eruption or an avalanche.

How does that inability or disinterest in dealing with normal environmental events arise? Policies and decisions over the long-term have created conditions which:

- Often neglect communities' perceptions and understandings of their own context.

- Fail to account for building and maintaining local abilities to deal with normal environmental events, even if those events display extreme characteristics.
- In some cases exacerbate an environmental event, such as structural flood defenses increasing the depth and velocity of river flows during floods.

These long-term conditions include poverty, lack of choice, lack of entitlement, poor governance, selfishness, and apathy, amongst many other factors (Hewitt 1983, 1997; Lewis, 1999; Oliver-Smith, 1986; Wisner et al., 2004).

This key vulnerability literature (Hewitt 1983, 1997; Lewis, 1999; Oliver-Smith, 1986; Wisner et al., 2004) agrees that the processes by which these conditions are created and maintained involves "vulnerability" and that vulnerability leads to disasters much more than normal environmental events. This "vulnerability process", rather than being a quantitative snapshot in space and time, is not only about the present state, but is also related to what we have done to ourselves and to others over the long-term; why and how we have done that in order to reach the present state; and how we might change the present state to improve in the future.

Vulnerability Analysis

In understanding and analyzing vulnerability, much research and practice neglects the more comprehensive view, instead developing methods which assume that vulnerability is:

- Quantitative: Vulnerabilities can be calculated and summed.
- Objective: Vulnerability analysis is factual and indisputable.
- Absolute: Only the exact numbers, such as the size and density of the population affected, are used to understand vulnerability.
- Non-contextual: Calculation methods are transferable to other locations.
- Useful for understanding the current state only because this snapshot provides the entire story.

To fully tackle the vulnerability challenges faced over the long-term, analysis methods should include that vulnerability is also:

- Qualitative: Emotions and intangibles (e.g. photographs and archeological sites) are important.
- Subjective: Characteristics termed "vulnerable" depend on the point of view adopted. For instance, Russia has been saved at least three times

from invading armies by the winter being a significant factor in their enemy's defeat. Storms were a key factor in at least two English naval victories. In these cases, one side saw weather damage as vulnerability while the other side saw the weather damage as being helpful. The label depends on to whom the damage was being done and the point of view adopted.

- Proportional: Percentages of people or infrastructure affected matter in addition to absolute numbers. For example, islands often have small populations relative to megacities, so even if 100% of an island's population is affected by an event, it is unlikely to match the numbers which could be affected during a similar event in a megacity. Yet 100% of a small population affected can be much worse than 1% of a large population affected. Absolute and proportional metrics provide different characteristics of vulnerability. As well, here they are presented as being quantitative, but it might be useful to consider the qualitative implications of considering relative (proportional) rather than specific (absolute) values when analyzing vulnerability.
- Contextual: Vulnerability depends on each specific situation. Some languages do not have a word for "vulnerability" and the concept is difficult to explain within that cultural context. Two examples are Nepali and Inuktitut, based on personal communication from colleagues who speak those languages and who have conducted disaster research in locations where these languages are spoken. "Vulnerability" and related terms could be predominantly modern Western constructs, in comparison to other cultures where "vulnerability" has less meaning. One field of study exploring such aspects is termed the "social construction of risk" (or "social construction of disaster" or "social construction of vulnerability"; e.g. Cannon, 2008).
- A process with a past and future, which is not dictated by, or interpretable through, a single event or a specific disaster type.

Incorporating these theoretical ideas into practice is an ongoing challenge, but a solid basis exists from which to start. GIS can represent proportions as easily as absolutes. PGIS (Participatory GIS), while far from a panacea, can incorporate elements of qualitativeness and contextuality (Kemp, 2008). Maps can be drawn to represent people's perceptions or to emphasize relative results, rather than always being accurate with regards to distances (e.g. http://www.worldmapper.org). These ideas can be further incorporated into participatory mapping processes (e.g. Maceda et al., 2009). Textbooks exist on qualitative data collection and analysis to support this work (e.g. Dey, 1993). Skills in history, geography and anthropology can link the past, present, and future along with results from different scales of analysis (e.g. Wisner, 1993). Participatory methods can ensure that subjectivity, qualitativeness, and contextuality are properly considered (e.g. Chambers, 2002; Hemmati, 2002). Different styles and sizes for interviews and surveys can provide data for cross-checking to see how contextual any quantitative results might be, rather than relying on a single interview approach or a single survey method. The main lessons are:

- Do not permit the rules of a technique (e.g. participatory mapping) or the constraints of a technology (e.g. GIS) to dictate fully the analysis method or the complete understanding of the situation.
- Do not rely on numbers to provide the complete story, especially since all vulnerability-related numbers have some level of subjectivity to them.
- Involve the people who are affected in any analysis that is being completed. The population being analyzed must be fully involved to ensure that their views, understandings, and perspectives are factored into the work.

Overall, no group has perfect knowledge, no single technique can provide all that is needed, and all knowledge forms have strengths and limitations. The keys are to be honest about what can and cannot be achieved and to combine different techniques and knowledge forms (Dekens, 2007; Mercer et al., 2007; Sudmeier-Rieux et al., 2009).

Vulnerability and Resilience

As part of understanding, analyzing, and reducing vulnerability, related concepts are emerging. One prominent notion is “resilience” with diverse meanings, multiple interpretations, and a decades-long history of uses and debates across different fields (Buckle et al., 2000; Gaillard, 2010; Lewis and Kelman, 2010; Manyena, 2006). Three examples of connecting vulnerability and resilience are:

- Klein and Nicholls (1999) suggesting that vulnerability is a function of:
    - Resistance, the ability to withstand change due to a hazard.
    - Resilience, the ability to return to the original state following a hazard event.
    - Susceptibility, the current physical state, without taking into account temporal changes.

- SOPAC (c. 2002) defining "vulnerability" to be "The tendency for an entity to be damaged" and "resilience" to be "The opposite of vulnerability and refers to the ability of an entity to resist or recover from damage". Additionally, "Vulnerability and resilience are two sides of the same coin. Something is vulnerable to the extent that it is not resilient."

- UNISDR (2004), whose definitions are:
    - **Resilience/Resilient –** The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures.
    - **Vulnerability –** The conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards.

In 2009, UNISDR updated their 2004 definitions, but those updates have been discussed as weakening the meaning and applicability of the terms (Lewis and Kelman, 2010). Other authors (e.g. W.N. Adger, C. Folke) have attempted to put their own spin on vulnerability and resilience, mainly from a climate change perspective and thereby ignoring wider disaster and development contexts, but their work has come under severe criticism (Kelman, 2008). Instead, Kelman and Gaillard (2008) propose climate change as one form of disaster amongst many, indicating that wider disaster and development literature should be applied to climate change rather than re-inventing the same concepts in order to apply to climate change only. Meanwhile, Twigg (2007) provides an excellent synthesis of the practicalities of understanding a disaster-resilient community.

Irrespective of the choice of definition or background to interpret "resilience", connections must be made with vulnerability. The same cautions and lessons articulated for vulnerability in the previous section apply to "resilience". Care is particularly needed to avoid too much discussion over definitions and excessive theoretical debate without trying to connect vulnerability and resilience to the reality of dealing with disasters in practical settings in order to help the people affected on their own terms.

Putting Theory into Practice

These theoretical ideas and principles have been implemented in practice. Oliver-Smith (1979) referred to a 400-year earthquake in examining the 31 May 1970 earthquake and rock avalanche in Yungay, Peru which killed most of the city's inhabitants. That 400 years is not the geological return period of the seismic or avalanche event, but instead refers to the fact that the root causes of the vulnerability, which were exposed during the event, took 400 years to build up. That was because the vulnerability that caused the disaster can be traced back to the Spanish conquest of the region, in terms of demographics, settlement locations, and ways of living (see also Figure 1).

Figure 1: Vulnerability build-up for the 2004 Tsunamis

On 26 December 2004, a massive, shallow earthquake off the coast of Indonesia generated tsunamis that devastated nearby coastlines and then crossed the Indian Ocean, eventually killing over 250,000 people across more than a dozen countries. Both the earthquake and the tsunamis had century-scale return periods. Over what time period did such a high level of vulnerability build up? Did it take centuries for people to settle in coastal locations without integrating tsunami awareness into their culture? That seems to be the case for many affected places in Indonesia. There, perhaps 26 December 2004 was a 100-year or 400-year event. But many of the vulnerabilities witnessed in Thailand were related to the tourism industry, as seen by the high number of fatalities amongst local workers in the tourism industry and amongst international tourists. There, 26 December 2004 might be a 10-year or 30-year event, with the vulnerability being relatively recent and as a result of improper coastal development focused on short-term profit from external sources rather than local sustainable livelihoods.

As another example, Etkin (1999) describes how relying on structural flood defenses increases vulnerability over the long-term in a process termed "risk transference". Structural defenses stop smaller floods, permitting people to live in floodplains while remaining relatively dry. As a result of this false sense of security, flood risk reduction measures are neglected and flood risks are underplayed. Consequently, flood vulnerability increases. Most structural defenses must fail at some point, especially if proper maintenance and monitoring are not carried out. Often, that failure occurs due to an event which exceeds or has different characteristics from the design flood (Figure 2). Then, the damage incurred by the flood is much greater than it would have been without the false sense of security imposed by the structural defenses. Short-term flood risk has decreased, but long-term flood risk has increased. Risk is transferred into the future and augmented, hence the term “risk transference”.

Figure 2: Structural Flood Defense Failures

Many structural flood defenses are constructed according to design specifications that use the return period of the flood depth. The defenses aim to separate the land behind them from water up to a certain depth. Examples of ways in which water has gone past such defenses are:

- The flood depth is higher than the design flood depth.
- Waves overtop the defenses, sometimes throwing debris over the defenses that causes significant damage.
- Water percolates underneath or, for permeable defenses, through the defenses.
- Water goes around the defenses and ends up behind the defenses.
- Water from another source ends up trapped behind the defenses; for example, from accumulation due to rain, from snow melt, or from overflow from another river.
- The defenses break, for example from flood velocity, flood momentum (e.g. high density flows), debris impact, or explosions such as from bombs or petrol.
- The water pushes the defenses off their foundations, permitting infiltration.

This discussion leads to the tenet that no disasters are natural; the term “natural disaster” is a misnomer (Hewitt 1983, 1997; Lewis, 1999; Mileti et al., 1999; O’Keefe et al., 1976; Oliver-Smith, 1986; Wisner et al., 2004). The event from nature, whether it is a thunderstorm, wildfire or landslide, is perfectly normal—and in many cases has significant advantages. Human decisions over the long-term build up vulnerability and that vulnerability is exposed by the event to yield the disaster. This notion can be extended further, as per the earlier discussion about “unnatural hazards”, to explain that no hazards are natural; the term “natural hazard” is a misnomer too. “Hazard” is a judgment foisted onto a normal—and often ecologically essential—environmental process because humans have made long-term choices which make the event hazardous to themselves and to others. Extracting such principles from absolute and quantitative metrics is difficult, suggesting the need to think beyond numbers—and beyond analyzing only what is observed quantitatively in the present.

The discussion regarding the “naturalness” of hazards and disasters acknowledges that viewpoints tend to depend on the definition adopted. Definitional arguments are not just academic exercises. They are needed for insurance, liability, and constitutional processes amongst others. For insurance and liability, Brun and Etkin (1997) and Martin et al. (2000) describe the legalistic machinations that companies can undertake regarding disaster and event definitions to determine the form or appropriateness of a payout for a loss. Additionally, it can be challenging to reduce vulnerability to some events such as basaltic flood volcanic eruptions, large meteorite strikes, and gamma ray bursts from nearby stars. These events cause planet-wide effects and involve forces and energies so large that humans might not be able to avoid or reduce the destruction. Yet the counterargument is that society has not tried to reduce vulnerability to such events, even though many suggestions exist for doing so (see Figure 3).

Figure 3: Reducing Vulnerability to Meteorite Strikes

The technology and technical capability exist to monitor for potential threats to Earth from astronomical objects such as asteroids and comets. That monitoring can provide enough warning to act to avoid a major strike, with the main proposed solutions being deflecting or breaking up the object. Cellino et al. (2006) and Stokes et al. (2000) provide examples of actual and possible monitoring efforts. Carusi et al. (2005) and Peter et al. (2004) detail action options once a threat manifests.

For understanding vulnerability, the important ethos is to accept human responsibility for the observed disaster ills and to accept human abilities and responsibility to heal these ills. For research, policy, and practice, this ethos should be the starting point for understanding—and then reducing the risks and impacts of—disasters. That ethos must then be placed within wider development, environmental management, and sustainability processes to ensure that any action addresses root causes of societal difficulties while contributing to communities and society over the long-term. The discussion and references here provide the starting point.

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Supplementary Websites

1. Defining Risk at http://www.ilankelman.org/abstracts/kelman2003frn.pdf
2. Disaster Lexicon at http://www.ilankelman.org/miscellany/DisasterLexicon.rtf
3. Gender and Disaster Network at http://www.gdnonline.org
4. Natural Disasters Do Not Exist (Natural Hazards Do Not Exist Either) at http://www.ilankelman.org/miscellany/NaturalDisasters.rtf
5. Overcoming Disaster Through P^3: Principles, Policies, Practices at http://www.ilankelman.org/fpp.pdf
6. Radix – Radical Interpretations of Disasters and Radical Solutions at http://www.radixonline.org
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