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Resilience indicators: Opportunities for including distributive justice concerns in disaster management

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Abstract:
This paper presents a systematic review of the concept of resilience in the field of disaster management, with a focus on the use of indicators and the inclusion of social justice considerations. The literature is reviewed with reference to various definitions of resilience, the relation between concepts of resilience and vulnerability, the conceptualization of resilience and the use of indicators, and the inclusion of social justice issues. The analysis shows that different disciplines employ various definitions of resilience and conceptions of its relation to vulnerability. Although recognized as important, distributive issues are not currently addressed in the literature. As a result, we lack a clear sense of what equality or distributive justice should mean in the context of resilience and disaster management. An approach based on capabilities is proposed as a promising way forward.

Keywords: ethics, justice, resilience, indicators, disaster management

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Resilience indicators: Opportunities for including distributive justice concerns in disaster management

1. Introduction

Over the past two decades, the term "resilience" has entered into common use within the field of disaster management. As such, it has replaced "vulnerability" as the main focus of the disaster management paradigm in the academic and policy literature. In the UK, for example, the Department for Environment, Food & Rural Affairs (Defra) recently commissioned thirteen so-called Pathfinder projects on Flood Risk Community Resilience (Twigger-Ross et al., 2014). In the US, a formal Office of Resilience has been established within the National Security Council at the White House (Cutter, Burton, & Emrich, 2010). Many international organizations, including the Intergovernmental Panel on Climate Change (IPCC, 2014), have put resilience at the heart of their approach to disasters (cf. DFID, 2011; UNU-IAS, 2013). Disaster resilience is also a core focus of the European H2020 funding scheme, and in 2014 and 2015 the EU made over 75 million euros available for disaster resilience research each year.

In general, resilience refers to the ability of a system to respond to a threat or hazard (more precise definitions will follow in Section 3). This immediately prompts the question as to the boundaries of the system. Resilience can be assessed at the country level, but also at the levels of the community, household and individual. This paper will focus on community resilience, but insights will also be included from studies of resilience at other levels. This general definition indicates that resilience is about capacity or ability; something that a system is able to do. This reflects a significant shift away from traditional risk management strategies that focus on levels of risk.

The focus on resilience has also resulted in the development of resilience indicators and indices to assess the resilience of a system. The way in which resilience is framed and operationalized is not trivial, however; if resilience indicators are used to evaluate policy interventions, different definitions and operationalizations of resilience will lead to different actions and emphases (Prior & Hagmann, 2014). Indeed, the term "resilience" originates from the natural sciences, and focuses less on issues of power, inequality and deprivation than the social-scientific literature on vulnerability.

One of the dilemmas that we face when developing resilience indicators is thus how to account for more complex socio-economic variables (Twigger-Ross et al., 2014), a dilemma that seems all the more acute for indicators reflecting social and economic equality and distributive justice. If one wants to achieve distributional justice in flood risk management, for example, one of the most important (and notoriously difficult) questions to answer is, "equality of what?". Does distributional justice refer to equality of risk levels, equality of resources spent, or some other measure (Doorn, 2015)? Philosophers such as Amartya Sen and Martha Nussbaum reject the focus on the equal distribution of resources and propose that we look at capabilities instead (Nussbaum, 2011; Sen, 1992). What matters is what people are actually able to do (their "capabilities"). This latter approach may thus be more in line with the resilience approach to disasters.

This paper presents a systematic review of the concept of resilience and the use of resilience indicators in the academic and policy literature. The aim is to explore the extent to which existing resilience indicators address distributive concerns and to identify opportunities for further inclusion. The review is based on the premise that resilience indicators have the potential to contribute to the evaluation of risk-related policy. I am aware that indicators are sometimes criticized for their narrow focus on quantifiable effects (Barnett, Lambert, & Fry, 2008). In this paper, I consider the use of indicators a given and I hope that this research may contribute to the development of more inclusive

indicators. Yet, I will address some of the common criticisms voiced against the use of indicators in general. Following a section on methodology (Section 2), I will present the general results of the review (Section 3) and then discuss some salient aspects related to the use of resilience indicators and distributive justice in more detail (Section 4). I propose the capability approach as a tentative framework for addressing distributive issues. In the concluding Section 5, I summarize the findings and present some open issues that require further development.

2. Methodology

A systematic review of the English-language academic literature was conducted, covering a broad set of publications on resilience indicators and cognate concepts. As many resilience-related developments are taking place in the policy domain, "grey literature" (policy reports, commissioned research) and research reports were included as well.

The following search strategy was used: resilien* AND (indicator or inde*) AND (hazard OR threat OR flood OR drought OR vulc* OR torn* OR extreme weather OR earthqua*) AND publication date (1990-2014) NOT (plant OR fish OR salmon OR trout OR invertebrate* OR vegetation OR forest). The "NOT" category was added to exclude papers that focus solely on resilience in ecosystems. Although this may have resulted in the exclusion of some papers on socio-ecological systems, the resulting string produced a sufficiently large sample to explore the current use of resilience indicators. The Scopus and Web of Knowledge databases were used (both with all subject areas included; the search was restricted to journal articles and reviews).

The academic literature was assessed in two steps. The academic search resulted in 326 unique publications. The abstracts were then sifted for relevance, excluding papers that framed resilience in engineering, technical, psychological, or medical terms. This produced a set of 98 papers, which was then scanned on a full-paper basis. The papers were studied with the following questions in mind:

1. How is resilience defined?
2. Does the paper describe the relation between resilience and vulnerability?
3. How is resilience operationalized?
4. Does the paper discuss distributive issues or issues related to social justice? If so, how?

3. Framing resilience

3.1 Defining resilience

The term resilience is derived from the Latin word "resiliere," meaning to jump or bounce back (Klein, Nicholls, & Thomalla, 2003). Many articles in the review emphasize that the term was originally used in the ecological domain (Holling, 1973). In ecological contexts, the term refers to the ability of a system to return quickly to normal functioning following a disturbance (Prior & Hagmann, 2014). From the late 1990s onwards, the term resilience was also applied to social systems (W.N. Adger, 1999, 2000) and socio-ecological systems (W. N. Adger, Hughes, Folke, Carpenter, & Rockstrom, 2005; Carpenter, Walker, Anderies, & Abel, 2001; Folke, 2006; Gunderson, 2010; B. Walker, Holling, Carpenter, & Kinzig, 2004). These different uses of the term share a focus on the ability of a *system* to respond to something (a hazard, threat or risk), and not the functioning of one single component.

In the last decade, several studies have been published that refer to varying meanings and definitions of the term resilience (cf., Cutter et al., 2010; L. A. Johnson, 2010; Menoni, Molinari, Parker, Ballio, &

Tapsell, 2012; Norris, Stevens, Pfefferbauam, Wyche, & Pfefferbaum, 2008; Sudmeier, Jaboyedoff, & Jaquet, 2013; Twigger-Ross et al., 2011; B. Walker et al., 2004; J. Walker & Cooper, 2011; Zhou, Wang, Wan, & Jia, 2010). The variety of definitions can partly be explained by the different uses of the term *across* disciplines, but we can also see a shift of focus *within* disciplines. In the context of natural hazards, the reports of the IPCC shed light on how the meaning of the term has shifted over time. In 2007, the fourth assessment report of the IPCC defined resilience as "the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt naturally to stress and change" (IPCC, 2007: p. 37). In 2014, by contrast, the fifth assessment report of the IPCC defined resilience as "the ability of a social, ecological, or socio-ecological system and its components to anticipate, reduce, accommodate, or recover from the effects of a hazardous event or trend in a timely and efficient manner" (IPCC, 2014: p. 1108). This shows that the shift and extension in focus (from a social or ecological system to a social, ecological, or socio-ecological system) has been accompanied by an extension of the *meaning* of the term (from absorption, self-organization, and adaptation, to anticipation, reduction, accommodation, and recovery).

Conceptualizations

Folke (2006) distinguishes between three concepts of resilience, ranging from a narrow interpretation ("engineering resilience"), via ecological/ecosystem and social resilience, to a broader social-ecological interpretation of resilience (see Table 1). The narrow interpretation refers to the return to a stable equilibrium, and focuses on recovery and constancy. Ecological/ecosystem and social resilience refer to a system's buffer capacity and ability to withstand shocks and maintain its functions. Here the focus is on persistence and robustness. Lastly, the concept of social-ecological resilience incorporates ideas about adaptation, learning, and self-organization, in addition to the general ability to recover from a disturbance. This last interpretation of resilience is based on the work of Carpenter et al. (2001), who characterize social-ecological resilience as:

1. The amount of change the system can undergo and still retain the same controls on function and structure.
2. The degree to which the system is capable of self-(re)organization to accommodate external changes.
3. The ability to build and increase the capacity for learning and adaptation.

In the field of disaster management, social-ecological resilience now seems the most widely supported interpretation of the term, thus moving beyond the idea of equilibrium and allowing for change through adaptation and learning to ensure that a system's functions persist (Prior & Hagmann, 2014; Wardekker, De Jong, Knoop, & Van der Sluijs, 2010). Although academics disagree as to whether resilience should be seen as an outcome or a process (Cutter et al., 2010), most are inclined to conceptualize resilience as an ability or process, rather than as an outcome. Similarly, there is a general consensus that resilience is better conceptualized as adaptability than as stability (Norris et al., 2008).

Table 1: A sequence of resilience concepts, from the more narrow interpretation to the broader social-ecological context (Source: Folke, 2006)

Resilience concepts	Characteristics	Focus on	Context
Engineering resilience	Return time, efficiency	Recovery, constancy	Vicinity of a stable equilibrium
Ecological/ecosystem resilience, social resilience	Buffer capacity, withstand shock, maintain function	Persistence, robustness	Multiple equilibria, stability landscapes
Social–ecological resilience	Interplay disturbance and reorganization, sustaining and developing	Adaptive capacity transformability, learning, innovation	Integrated system feedback, cross-scale dynamic interactions

With a few notable exceptions, most authors who distinguish between "resilience as bounce-back" and "resilience as adaptation or transformation" do not explicitly discuss whether these conceptions should be seen as mutually exclusive or complementary. Twigger-Ross et al. (2014) warn against the interpretation of resilience as bounce-back. Not only can this be unrealistic, but it may also lead to the reproduction of vulnerabilities (for a similar claim, see Jordan & Javernick-Will, 2013). Similarly, Barnett (2001) argues that recovery is insufficient in the longer term; in a context of uncertainty, a resilient system should "bounce back in better shape" (Barnett, 2001: p. 984), because that will enable the system to cope with uncertainty and deal with surprises. This suggests that "resilience as bounce-back to the original" and "resilience as adaptation or transformation" should be seen as mutually exclusive, because bounce-back to the original may in the long run be insufficiently flexible and hamper improvement. Over longer timescales, a resilient system should "encompass the dynamics to accommodate trends and co-evolve" (Wardekker et al., 2010: p. 988).

Levels of analysis

In addition to different conceptualizations, resilience can also be analyzed at different levels. In the typical systems approach, the boundary of the system and the accompanying level of analysis are of crucial importance. Many of the papers in the review cite Norris et al., who distinguish between the following levels of analysis: physical, ecological, social, city, community, and individual (Norris et al., 2008). In the context of disaster management, resilience is most often studied at the community level (Ainuddin & Routray, 2012; Chen, Ferng, Wang, Wu, & Wang, 2008; Cutter, Ash, & Emrich, 2014; Felsenstein & Lichter, 2014; Frazier, Thompson, Dezzani, & Butsick, 2013; Kafle, 2012). In the context of disasters, individual resilience is the second most prevalent level of analysis and the one most often studied in the medical and psychological literature (cf., Chang & Taormina 2011; Eisenman et al., 2014; Livanou et al., 2005; Rodriguez-Llanes, Vos, & Guha-Sapir, 2013; Van der Velden, Wong, Boshuizen, & Grievink, 2013).

3.2 Relation between resilience and vulnerability

As stated in the introduction, the concept of resilience is increasingly replacing vulnerability as the focus of the literature on disaster risk reduction. Although some authors see vulnerability and resilience as flipsides or opposites – which would render the shift from vulnerability to resilience a

matter of mere rhetoric – most authors recognize that the relationship between vulnerability and resilience is more complicated than this.

Some authors define resilience in terms of vulnerability, and consider resilience to be an element of the latter (Balica, Wright, & van der Meulen, 2012; Costa & Kropp, 2013; Glatron & Beck, 2008; Lee, 2014; Manyena, 2006; McLaughlin & Cooper, 2010; Thomalla, Downing, Spanger-Siegfried, Han, & Rockstrom, 2006). Less often, they take the opposite approach (Arlikatti, Peacock, Prater, Grover, & Sekar, 2010; Kafle, 2012; Kusumastuti, Viverita, Husodo, Suardi, & Danarsari, 2014). Thomalla et al. (2006), for example, define vulnerability in terms of three components: exposure, sensitivity, and resilience. Taking the opposite approach, some authors conceive of resilience as the broader concept, including vulnerability as one of the elements. Kusumastuti et al. (2014), for example, define resilience as the ratio between preparedness and vulnerability.

Defining vulnerability in terms of resilience or defining resilience in terms of vulnerability renders resilience and vulnerability mutually inclusive. Recognizing that there is more to the shift from vulnerability to resilience than simply moving the term to the other side of the equation, some authors propose a third approach: they view resilience and vulnerability as neither mutually inclusive nor exclusive, but as partially overlapping concepts. This is because many actions affect only vulnerability or resilience, whereas some affect both vulnerability and resilience. Following the definition of Cutter et al. (2008) of vulnerability as "the pre-event, characteristics or qualities of social systems that create potential for harm" and resilience as "the ability of a social system to respond and recover from a disaster" (p. 599), spatial planning measures that prevent residential buildings in risk-prone areas primarily affect the vulnerability of a system, whereas adaptive capacity building (such as learning, post-event monitoring, etc.) typically affects resilience. Hazard-preparedness measures typically affect both vulnerability and resilience. Although the linkages between vulnerability and resilience are far from established, they are used in different, sometimes incompatible, ways across disciplines (Cutter et al., 2008; Gallopín, 2006). Since research on disaster management is often interdisciplinary in nature, there is a need to work towards "a general, self-consistent set of […] basic concepts that could be applied across disciplines" (Gallopín, 2006: p. 302).

3.3 Operationalizing resilience

There is thus a general consensus in the literature that resilience is a multifaceted concept. Although there is disagreement as to its precise formulation and classification, most attempts to operationalize the concept start by distinguishing between several dimensions of disaster resilience. As suggested above, many of the papers in this review cite the work of Norris and colleagues, who operationalize resilience as "a process linking a set of adaptive capacities to a positive trajectory of functioning and adaptation after a disturbance" (Norris et al., 2008: p. 130). These capacities are economic development, social capital, information and communication, and community competence. Norris et al. explicitly state that these capacities are neither orthogonal nor synonymous, but should rather focus our attention on community resilience theory, research, and application (p. 136).

Given the popularity of the concept among policymakers, a need has arisen for metrics to assess resilience. In the last decade, several attempts have been made to develop such indicators. Based on the literature, we can make a rough distinction between bottom-up and top-down approaches for developing indicators.

Top-down approaches start with a theoretical framework as the basis for variable selection (Freudenberg, 2003). Cutter et al. develop a framework specifically for the construction of indicators

in which they distinguish between social resilience, economic resilience, institutional resilience, infrastructure resilience, and community capital (Cutter et al., 2014; Cutter et al., 2008; Cutter et al., 2010). A set of indicators is constructed to assess each of these components, covering the following general aspects (Cutter et al., 2010: pp. 8-9):

- Social resilience: the differential social capacity within and between communities, including demographic attributes (e.g., age, level of educational, health and special needs), transportation and communication access (telephone coverage, vehicle access), and health insurance coverage.
- Economic resilience: the economic vitality of communities, including housing capital, equitable incomes, employment, business size, and physician access. The assumption is that a more diversified local economic base is more resilient and better able to enhance economic stability at the community level.
- Institutional resilience: characteristics related to mitigation, planning, and prior disaster experience, affecting communities' capacity to reduce risk, to engage local residents in mitigation, to create organization linkages, and to enhance and protect the social systems within a community.
- Infrastructural resilience: primarily an appraisal of community response and recovery capacity (e.g., sheltering, vacant rental housing units, healthcare facilities, and any actions people might have taken to increase their household's resilience to disasters), also providing an overall assessment of the amount of private property that may be particularly vulnerable to sustaining damage and likely economic loss.
- Community resilience: this component captures the relationships that exist between individual people and their larger neighborhoods and communities. This is measured through proxies such as political engagement, social capital (membership of religious communities, civic organizations, advocacy organizations), and people employed in creative-class occupations.

Several other authors also use this classification by Cutter and colleagues (e.g., Ainuddin & Routray, 2012; Glatron & Beck, 2008; Hiete, Merz, Comes, & Schultmann, 2012; Joerin, Shaw, Takeuchi, & Krishnamurthy, 2014; Safi, Smith, & Liu, 2012; Zou & Wei, 2009).

Bottom-up approaches[1] often start from dissatisfaction with the neglect of local-scale factors (Fekete, Damm, & Birkmann, 2010; Frazier, Thompson, & Dezzani, 2014). Over-reliance on general vulnerability and resilience measures, whilst paying too little attention to the spatial and temporal context, may produce results that are too general to be effective for sub-county hazard mitigation (Frazier et al., 2013; Wood & Soulard, 2009). Bottom-up approaches typically use qualitative data to explore individual resilience. Boon (2014), for example, held post-disaster interviews with residents to identify factors that residents believed increased their disaster resilience. Similarly, Frazier et al. (2013) organized focus groups with local professionals involved in disaster management to identify and prioritize factors contributing to a specific region's resilience.

With numerous frameworks and conceptual models currently being developed, the main challenge seems to be to develop a common set of indicators for cross-cultural comparison, whilst recognizing that these indicators should be sensitive to local contextual conditions and the temporal dimension of social vulnerability and resilience (Harrald, 2012; Kuhlicke, Scolobig, Tapsell, Steinfuhrer, & De

[1] Although I use the term "bottom-up", bottom-up approaches are in fact most often mixed approaches, combining more general (top-down) indicators of resilience and vulnerability with place-specific resilience factors (bottom-up).

Marchi, 2011). Be it not for reasons of democracy and participation (Twigg, 2009), it may also be more efficacious to involve local stakeholders, in order to give them a sense of ownership of resilience and their role in disaster management (DFID, 2011; Doorn, 2016).

3.4 Inclusion of distributive concerns

Inequality has always been a focal point of the vulnerability paradigm. Vulnerability has emerged as "a concept for understanding what it is about the condition of people that enables a hazard to become a disaster" (Tapsell, Tunstall, Green, & Fernandez, 2005: p. 3). Central to this paradigm is the observation that people are not equally affected by hazards. Though partially unavoidable, it is increasingly being recognized that this is partly caused by the fact that some people's needs are not sufficiently considered in organizations' planning (Flanagan, Gregory, Hallisey, Heitgerd, & Lewis, 2011) or by a lack of access to resources that might reduce levels of vulnerability (Bosher, Penning-Rowsell, & Tapsell, 2007; Gaillard et al., 2013). As such, this unequal distribution of vulnerability levels could in principle be remedied by taking measures specifically targeted at vulnerable people (Prashar, Shaw, & Takeuchi, 2012).

The question, then, is how distributive issues are being addressed within the resilience paradigm. With the observation that "genuine" resilience should be considered as "bouncing forward" rather than simply "bouncing back" (as discussed in Section 3.1), one also would expect to find a discussion about ways to reduce inequality in the resilience literature (Sudmeier et al., 2013). Yet, this is not the case; the literature focuses on the identification of factors that contribute to resilience and the conditions under which resilience can be improved. If discussed at all, social justice and inequality are therefore primarily discussed as factors *contributing to* resilience. Cutter et al. (2008), for example, mention income and equality as elements of economic resilience. Similarly, Bahadur et al. (2010) present ten key characteristics of resilient systems, one of them being "a high degree of social and economic equity". In the review, we did not identify any article that explicitly discussed what distributive justice or social equality would mean in the context of resilience.

However, a number of articles do describe inequity or inequality as undesirable; an evaluation of post-disaster humanitarian aid, for example, mentions that media and political pressure led to "the very uneven and inequitable financing system for humanitarian emergencies" (Telford & Cosgrave, 2007: p. 9) and that "such aid has led to inequities, gender- and conflict-insensitive programmes, indignities, cultural offence and waste—rarely tracked accurately" (p. 21). Similarly, Arlikatti et al. state that there is a need to assess equity in recovery trajectories (Arlikatti et al., 2010). Lee states that "climate change mitigation policies are socially differentiated, and therefore are matters of local and international distributional equity and justice" (Lee, 2014: p. 33). Some authors draw a link with sustainability and intergenerational justice. Kusumastuti et al. mentions that "disaster resilience along with economic vitality, environmental quality, social and inter-generational equity, quality of life, and participatory process are the six principles of sustainability" (Kusumastuti et al., 2014: p. 327). Norman et al. (2012) touch upon intergenerational justice when they state that resilience is necessary for sustainable development. Referring to the Brundtland definition of sustainable development ("development that meets the needs of the present without compromising the ability of future generations to meet their own needs" Brundtland, 1987), they state that equity and social justice are major social goals of sustainable development. Jordan and Javernick-Will (2013) suggest that despite recognizing the importance of social and economic indicators of recovery, scholars assessing recovery still focus on the more easily measurable indicators associated with infrastructural and physical loss. Consequently, recovery often means rebuilding the existing physical system.

These examples suggest that equality and distributive concerns are considered important, but that there is a need to look more closely at what equality or distributive justice mean in relation to resilience.[2] In the next section, I will present some tentative ideas for filling this gap.

4. Discussion

The literature review presented in Section 3 reveals an increasing tendency to view hazards through a "resilience" lens. Current approaches in the literature are diverse, and sometimes even incompatible and contradictory. The review suggests that measures for addressing distributive concerns are thought to be important, but that they are not explicitly included. In this section, I discuss the relation between resilience indicators and distributive issues in more detail. I do so by first elaborating on the use of composite indicators (Section 4.1) and then on the different aspects of justice that are relevant to resilience (Section 4.2).

4.1 Indicators

Structural, process, and outcome indicators

As described above, there is a vast and growing body of literature on the use and development of resilience indicators and indices. Before discussing these indicators in more detail, it is helpful to take a step back and consider the use of indicators in general. Although they are widely used, there is still no universally accepted definition of what an indicator actually is (Mayunga, 2009). For example, some authors consider an indicator to be a proxy measure of some abstract, multidimensional concept (cf., Ainuddin & Routray, 2012; Schneiderbauer & Ehrlich, 2006), whereas others consider them to be variables that are hypothetically linked to the phenomenon under study, which in itself cannot be measured directly (Chevalier, Choiniere, & Bernier, 1992).

The general literature on indicators often makes a distinction between process, outcome, and structural indicators, with process indicators being a measure of how well the activities or interventions are being run, outcome indicators showing how well certain activities or interventions are accomplishing their intended results, and structural indicators referring to the characteristics of a system that affect its ability to function (Mainz, 2003). If we look at the literature on resilience indicators, we see that the aims of the different indicators or composite indictors do not always match the way they are constructed. This is partly related to the fact that resilience cannot be measured directly, meaning that the variables used to construct an indicator are proxies for resilience or, more indirectly, for a phenomenon linked to resilience; and also to the fact that it is not always clear whether the indicators are outcome, process, or structure-based. Cutter et al. (2010), for example, aim to develop "a methodology and a set of indicators to measure the present *conditions influencing disaster resilience within communities*. […] The resilience indicators proposed in this paper serve as the baseline set of conditions, from which *to measure the effectiveness of programs, policies, and interventions specifically designed to improve disaster resilience*" (p. 1; emphasis added). If we take a closer look, we see that age and special needs, together with educational equity and health coverage, are chosen as variables to operationalize the indicator "social resilience" (Table 1). Both the percentage of non-elderly people and the percentage of the population without a sensory, physical, or mental disability will indeed have a positive effect on the resilience of a community and as such provide a good indication of "conditions influencing disaster resilience." However, these percentages make little sense when used to "measure effectiveness of programs, policies, and interventions specifically designed to improve disaster resilience."

[2] This may also be related to the fact that distributive issues in disaster management do not seem to be high on philosophers' agendas (Doorn, 2013). Their primary focus seems to be on climate change and its causes.

Table 2: Variables used to construct component social resilience in disaster resilience index (after Cutter et al., 2010)

Category	Variable	Effect on resilience
Social resilience		
Educational equity	Ratio of the pct. population with college education to the pct. population with no high school diploma	Negative
Age	Percentage of non-elderly population	Positive
Transportation access	Percentage of population with a vehicle	Positive
Communication capacity	Percentage of population with a telephone	Positive
Language competency	Percentage of population not speaking English as a second language	Positive
Special needs	Percentage of population without a sensory, physical, or mental disability	Positive
Health coverage	Percentage of population with health insurance coverage	Positive

Many authors follow Cutter et al.'s model, or a version of it, without further specifying whether these indicators should be seen as baseline conditions, predictors of resilience, metrics for evaluating the effectiveness of policies, or a variation on the above (Ainuddin & Routray, 2012; Hiete et al., 2012; Joerin et al., 2014).

The only paper in the review to distinguish explicitly between outcome and process indicators is the paper by Kafle (2012). In the aftermath of the tsunami that hit Southeast Asia in 2004, the Canadian Red Cross (CRC), together with the Indonesian Red Cross Society (PMI), created an Integrated Community-Based Risk Reduction (ICBRR) tool. Based on the assumption that processes and outcomes are equally important in building disaster-resilient communities, this tool comprised typical process indicators (e.g., indicators related to the formation and strengthening of grassroots-level organizations, risk assessment, community participation, risk-mitigation activities and monitoring and evaluation capabilities) and outcome indicators (e.g., ownership of risk community reduction plans by local government, awareness-raising materials and activities, trained volunteers and community members). Kafle argues that "process indicators are important for community understanding, ownership and the sustainability of the programme; whereas outcome indicators are important for the real achievements in terms of community empowerment and capacity building" (Kafle, 2012: p. 324). Since the indicators often serve as direct input for policymakers, it would be helpful if the policymakers and academics developing indicators were to be more explicit about the intended use of the indicators and about the entity (process, outcome, structure) for which they are supposed to be a proxy measure.

Aggregation or not

In the context of disaster management, use is often made of composite indicators, in which individual indicators are compiled into a single index on the basis of an underlying model (Nardo, Saisana, Saltelli, & Tarantola, 2008). If constructed carefully, composite indicators can be helpful in setting policy priorities and benchmarking or monitoring performance (Saltelli, 2007), as well as predicting performance (Paton & Fohnston, 2001; Saltelli, 2007). With regard to the use of composite indicators or indices, there is much controversy as to whether data on different indicators should be aggregated or not. Proponents of the use of composite indicators argue that they may be useful in garnering interest from the media and policymakers (Sharpe, 2004). Opponents tend to stress the methodological problems associated with weighing and combining seemingly incommensurable data

into “a single number of dubious significance,” thereby hiding and wasting the relevant data that go into the aggregate measure (Saisana, Saltelli, & Tarantola, 2005: p. 308). Not only may these composite indicators send misleading information, but opponents of aggregation also suggest that policymakers may in fact be better off basing their decisions on individual variables (Saltelli, 2007).

The controversy regarding aggregation will probably never be resolved. Without taking a firm position, Nardo et al. propose that we look at the purpose for which composite indicators are developed. They compare composite models with mathematical or computational models and suggest that “their construction owes more to the craftsmanship of the modeler than to universally accepted scientific rules for encoding. With regard to models, the justification for a composite indicator lies in its fitness for the intended purpose and in peer acceptance” (Nardo et al., 2008: p. 14). There may be some truth in this comparison. One could imagine that a composite indicator could in principle prove useful for benchmarking a country’s performance, since benchmarking does not require absolute values (Mori & Christodoulou, 2012). As long as the indicators are calculated consistently, a relative measure allows for comparison of sufficiently similar entities, such as neighboring communities or one community over time (Prior & Hagmann, 2014).

For measuring the effectiveness of specific interventions, individual variables are probably more informative than composite indicators. Since indicators are usually developed such that they are mutually independent and non-interchangeable, the value of a composite indicator cannot tell us how a specific intervention improved performance for one of its sub-components. Taking Cutter’s taxonomy as an example, the effectiveness of a policy that includes both an intervention aimed at improving education and one aimed at improving infrastructure cannot be evaluated on the basis of a composite indicator that aggregates the scores on all dimensions (social resilience, economic resilience, institutional resilience, infrastructural resilience, and community resilience).

Bearing in mind Nardo et al.’s comparison of composite indicators and models, composite indicators are, like models, selective representations with all kinds of epistemological constraints. If the justification for a composite indicator does indeed lie in its fitness for the intended purpose and its acceptance by peers, as Nardo et al. suggest, the use of composite indicators to garner media and policy interest prompts associations with the notion of framing (Kahneman & Tversky, 2000). It is beyond the scope of this paper to discuss the framing issues involved in the construction of resilience indices, the communicative aspects of these indicators deserve more attention in resilience research.

4.2 Social justice in disaster management: Procedural and distributive aspects

As suggested in the introduction, the issue of social justice in the context of resilience is by no means trivial. In this section I will link current insights in political philosophy with the above discussion on resilience and on indicators in particular.

There seems to be an analogy, be it imperfect, between the process-outcome distinction in relation to indicators and the two aspects of justice that are central to contemporary debates on social justice; that is, distributive justice (referring to the justness of a distribution) and procedural justice (referring to the justness of the decision-making process) (Miller, 1999). Dependent on which view one endorses, procedural justice can be seen as a *supplement to* or as an *alternative to* distributive justice (Rawls, 1999[1971]). In case of the latter (pure procedural justice), there is no criterion for what constitutes a just outcome other than the procedure itself. In the remainder of this paper, I shall assume that both distributive justice and procedural justice are important in disaster management, which seems to be in line with the general tendency in the literature reviewed.

The issue of procedural justice is closely associated with issues of participation and stakeholder engagement (C. Johnson, Penning-Rowsell, & Parker, 2007) and it comes up in much of the literature in this review (cf., Gaillard et al., 2013; Kusumastuti et al., 2014; Morello-Frosch, Brown, Lyson, Cohen, & Krupa, 2011; Zou & Wei, 2009). Compared to procedural justice, conceptualizing distributive justice is more difficult. Viewed rather abstractly, we can say that every normative theory of social justice that has been advocated in recent times seems to demand equality of something (Sen, 1992). One of the central questions in contemporary debates in political theory and philosophy is that of the metric of distributive justice; that is, the "equality of what?" question. Playing prominent roles in answers to this question are the primary goods approach, which largely builds on the work of John Rawls, and the capability approach, initially developed by Amartya Sen (1993, 2009b) and further developed in partial collaboration with Martha Nussbaum (2006, 2011). The former approach promotes an equal distribution of those goods in which every person is assumed to have an interest, viz. (1) basic rights and liberties; (2) freedom of movement and free choice among a wide range of occupations; (3) the powers of offices and positions of responsibility; (4) income and wealth; and (5) the social bases of self-respect (the recognition by social institutions that gives citizens a sense of self-worth and the confidence to carry out their plans (Rawls, 2001: pp. 58-59). In terms of distributive justice, there is a particular focus on the equal distribution of income and wealth. Proponents of the capability approach argue that this is the wrong focus; in short, the primary goods approach is criticized for being inattentive to the diversity of human beings (Sen, 1980). Even if they are provided with the same amount of primary goods, people can accomplish quite different things (Sen, 2009b). The capability approach therefore focuses on the opportunities that people have to achieve the things they deem valuable, and it makes these opportunities the focal point of the distribution.

Whereas the primary goods approach has been widely accepted by philosophers, the capability approach seems to have been more prominent among policymakers and economists (Brighouse & Robeyns, 2010). It has been operationalized by the United Nations and by a number of local and national governments, with the UN Human Development Index (HDI) being the best-known example (UNDP, 2014). The HDI is a composite indicator comprising three key dimensions of human development: longevity and health, education, and standard of living. It is intended to emphasize that people and their capabilities should be the ultimate criteria for assessing a country's development, not economic growth alone. Although it goes beyond the scope of this paper to develop a full account of how the capability approach could be implemented in resilience management, it is useful to discuss some elements of the capability approach that make it especially suitable for enriching current resilience approaches with distributive aspects.

Central to the capability approach are so-called "functionings" and "capabilities". A person's being is made up of many valuable acts or states of being, and in the capability approach, these are known as functionings. Examples of functionings include being healthy, being nourished, being educated, and participating in the political life of a community. Capabilities refer to the opportunity to achieve a specific functioning: which functionings might an individual feasibly achieve? Against the primary goods approach, an individual's capability is not only a function of or reducible to the amount of resources an agent has at his or her disposal, but it also depends on what he or she is able to do effectively with these resources, which will in turn be influenced by his or her personal resources (e.g., talents and skills), as well as by his or her social and material environment (e.g., legal rules, social norms and customs, and the physical infrastructure and environment). How individuals differ in their ability to use various resources to achieve functionings is referred to as the "individual conversion rate" (Sen, 2009a). For capability theorists, the difference between capabilities and functionings is essential, because it reflects an individual's ability to choose the functionings that he

or she values. For Sen, this freedom is so important that he refuses to define a list of essential capabilities; his approach is thus deliberately under-specified. The relevant capabilities in a specific situation should be the result of democratic deliberation. Unlike Sen, Nussbaum has defined a list of core capabilities that should be supported by all democracies (Nussbaum, 2000).

In practice, different capabilities are interdependent, in the sense that some cannot be achieved simultaneously. Sen cites the example of the opportunity to have a rewarding career and a rich family life. Yet, this example also suggests that a minimal conception of social justice would require having at least minimum fulfillment in both, if one so wished. Where Sen seems to put more emphasis on the freedom that individual people should have in choosing how to shape their lives, Nussbaum puts more emphasis on the demands of justice and the fulfillment of a certain threshold level of capability that all individuals should enjoy (Nussbaum, 2000). Given the "irreducible heterogeneity of the Central Capabilities," she derives a threshold-approach of justice: "respect for human dignity requires that citizens be placed above an ample (specified) threshold level of capability, in all ten [by Nussbaum defined, ND] areas" (Nussbaum, 2011: pp. 35-36). This threshold-approach is grounded in needs. People are able to live meaningful lives only insofar as they have the opportunities associated with the Central Capabilities up to some threshold level.

The philosopher Colleen Murphy and the civil engineer Paolo Gardoni have tried to implement the capability approach in general risk theory (Gardoni & Murphy, 2009; Murphy & Gardoni, 2008, 2012). They apply the capability approach both in the (descriptive) phase of risk analysis and in the (normative) phase of risk evaluation and risk management. Starting from the definition of risk used in engineering (probability times consequences), Murphy and Gardoni see a role for the capability approach in the conceptualization and assessment of consequences of hazardous scenarios (Murphy & Gardoni, 2012: p. 984). In terms of risk evaluation, Murphy and Gardoni (2008) distinguish between tolerable and acceptable threshold levels. The acceptable threshold level is the higher of the two and specifies the minimum level of capabilities that people should be able to enjoy over time. A risk is acceptable if there is a sufficiently small probability that the attained capabilities will not come up to an acceptable level. In practice, it can be tolerable for some individuals, in the immediate aftermath of a disaster, to fall below the acceptable threshold, provided this situation is temporary and reversible, and that there is a sufficiently small probability that capabilities will fall below the tolerability threshold. As such, the tolerability threshold delimits "an absolute minimum level of capabilities attainment below which no individual in a society should ever fall, regardless of whether that level of capabilities attainment is temporary or reversible" (Murphy & Gardoni, 2008: p. 78). It reflects the moral necessity of avoiding permanent damage to the well-being of individuals (Murphy & Gardoni, 2012: p. 990). The need to avoid permanent damage also follows from the demands of intergenerational justice, which states that we should not compromise the needs of future generations. Recovery should therefore not undermine the ability of future generations to achieve or enhance their well-being (Gardoni & Murphy, 2008). It may sometimes be necessary to accept a lower threshold level for temporary damage to avoid permanent loss of capabilities of future generations. In line with the democratic aims of Sen and Nussbaum, Murphy and Gardoni state that the exact threshold levels should be the result of public deliberation.

What lessons can we draw from the capability approach when it comes to the inclusion of distributive concerns in resilience management? A first lesson would be to apply what Sen calls an accomplishment-based understanding of justice. In the medical world, it is widely accepted that indicators only signify quality to the extent that they demonstrate a relationship to desirable outcomes (Mainz, 2003). Similarly, from a justice perspective, resilience indicators should take into account the conversion rate and the extent to which people are actually able to realize certain

functionings. For instance, general indicators referring to the availability of flood warning technologies are less useful if they are not linked to the social performance of these technologies. An illustrative example in which the conversion rate is taken into account is the UK Environmental Agency's Flood Warnings Direct project. This flood warning system provides a choice of visual and audible flood warnings media, warnings in different languages, and various channels for accessing warnings (Tapsell, Burton, Parker, & Oakes, 2004).

The second lesson concerns the recognition of pluralism and the use of threshold levels. The former requires that people be able to pursue their own conception of the good life. Taking pluralism seriously would imply that people should decide for themselves what they consider to be the constituent elements of resilience (referred to in the literature as a subjective account of well-being). Developing a completely subjective account of resilience might be going too far; resilience should always cover certain elements (for example, a capacity for shelter or medical capacity). A more nuanced position would be to give people a say, at least, in the assessment of resilience. Given that people may highlight different aspects of resilience – some people may be more concerned about the situation in the intermediate aftermath of a disaster, whereas others may focus on the long-term recovery of the ecosystem – and given the irreducible heterogeneity of these different capacities, a threshold approach would seem an appropriate way to approach distributive questions. Notwithstanding Sen's remark that all normative theories of social justice appeal to some sort of equality, nature itself is inherently unfair. The probability that a hazard will materialize varies widely over time and space (C. Johnson et al., 2007). Since policy measures to improve resilience are costly and different elements of resilience often cannot be improved simultaneously, a threshold approach would seem the most realistic and just way to approach distributive questions.

This brings me to the third point, which is related to aggregation. Given the abovementioned irreducibility, merging incommensurable data into one index number may not only raise methodological concerns, it also leaves little room for subjective accounts of resilience and the threshold approach advocated above. As such, aggregation seems undesirable, by which I not only refer to the aggregation of several subcomponents of resilience, but also aggregation over geographical units (King, 2001). Data aggregated over whole countries or cities do not tell us enough about the resilience of specific communities, let alone households. Even a micro-level approach such as that developed by (Prashar et al., 2012), which aims to assess the resilience of nine districts in the city of Delhi, lacks sufficient detail to assess the resilience of communities or households. The aggregated data say little about how resilience scores are distributed among the different people in one unit of analysis. Gardoni and Murphy (2009) therefore argue for computing the societal impact of a hazard at the level of relevant sub-groups, which might be geographical groups, but could also be ethnic, gender, and age groups. Whereas more descriptive approaches to resilience take the presence of certain sub-group members to be an indicator of resilience (such as the percentage of non-elderly people in a population in Cutter's index), distributive justice seems to require that these vulnerable groups be taken as the starting point for assessing resilience.

5. Conclusions

In this paper I have presented a critical review of the literature on resilience and resilience indicators, with a particular emphasis on distributive issues. The review shows that research on distributive issues in the context of disaster management is still in its infancy. Although there seems to be wide recognition of the importance of social justice and economic equality in this context, none of the papers in the review discussed what is meant by these terms in the context of disaster management.

With regard to the use of resilience indicators, the following conclusions can be drawn. First, when developing indicators, we should be clear about the purpose for which indicators are being developed, in order to make the indicators consistent with this purpose. For most purposes, the use of non-aggregated indicators seems preferable to aggregated measures and indices. The latter are more useful for evaluating the effectiveness of interventions. Aggregated measures are mainly useful for drawing attention to an issue, but less useful for contributing to the analysis of disaster risks per se.

With regard to distributive justice, the capability approach seems a promising lens through which to view issues of distribution. On a conceptual level, there seems to be a relation between resilience as a capacity to do something and the capability approach, which focuses on what people are actually able to do or to achieve. Recognizing pluralism requires that people be able to pursue their own conception of the good life. Given that people may favor different capacities within the more general concept of resilience, and given the irreducible heterogeneity of these different capacities, a threshold approach to distributive questions would seem the most appropriate way forward.

More work is needed to find out how the "system lens" of resilience relates to justice at the individual level. If resilience is to replace vulnerability as the dominant paradigm in disaster management, it is important that we not only see vulnerable sub-groups as factors affecting the resilience of the group as a whole, but that the resilience of these sub-groups should also be strengthened up to some threshold level.

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