sustainability

MDPI

Article

Leveraging Post-Disaster Windows of Opportunities for Change towards Sustainability: A Framework

Katja Brundiers * and Hallie C. Eakin

School of Sustainability, Arizona State University, P.O. Box 875502, Tempe, AZ 85287-5502, USA; Hallie.Eakin@asu.edu

* Correspondence: katja.brundiers@asu.edu

Received: 31 March 2018; Accepted: 30 April 2018; Published: 1 May 2018

Abstract: Disasters are catalysts for change: they are increasingly recognized as offering opportunities to direct and navigate change towards aspired outcomes, such as sustainable development goals. However, we know little about how to leverage the opportunities created by disasters to achieve sustainability objectives. Learning from existing case studies is challenging, partly because there is no framework that integrates concepts of change from both sustainability science and disaster recovery literatures. This study develops a unified analytical framework to facilitate the documentation and analysis of case studies of sustainability transitions following disasters. Our aim is to enhance the potential for theory-building, and to draw lessons that can be used to help leverage opportunities presented by disasters in the future. We apply the framework to available empirical cases and identify specific conditions, resources, social relations and constraints that affect disaster-to-sustainability transitions. Our expectation is that this framework will serve professionals and researchers in the fields of sustainable development and disaster mitigation to enhance the effectiveness of their research and applied activities.

Keywords: change agents; development; disaster recovery; opportunity; sustainability transitions

1. Introduction

Sustainability action faces inherent tensions: there is an urgency to create and safeguard a safe and just operating space for humanity [1,2], although sustainability action is inhibited by the often slow process of institutional change [3]. While disasters are undesirable in and of themselves, they can be catalysts for change and social transformation [4,5]. Moreover, they are recognized as offering opportunities to direct change towards aspirational outcomes, such as the Sustainable Development Goals (SDG), reduced disaster risk, and enhanced resilience [6]. However, we know little about how to leverage the opportunities presented by disasters for change towards sustainability.

Over the last decade, evidence on change following disasters has been presented from case studies of disaster recovery. Most of these cases have documented how certain constellations of governmental and private sector actors work to accelerate change towards particular interests, which are often not focused on the common good and, thus, lead to unsustainable practices and aggravated inequities (e.g., [7,8]). There is also a growing literature on disaster recovery that highlights the opportunities that arise in later stages of disaster recovery and reconstruction for "building back better" (cf., [9–11]). A third type of cases is emerging, encompassing a small group of in-depth case studies that investigate how communities have leveraged the "positive side of disasters" to advance sustainability [12]. These latter cases are disparate, employing diverse frameworks and drawing on distinct theories, such as those pertaining to innovation, socio-ecological systems, or humanitarian aid (e.g., [13–16]).

Research in sustainability science has contributed to the understanding of long-term transition and transformation processes towards normative sustainability-oriented visions, while focusing on

actors, their agency and participation in this process (e.g., [17–19]). Following Patterson et al. [20], this research includes approaches of resilience thinking and socio-ecological systems transformations (e.g., [21,22]), socio-technical transitions and transition management (e.g., [17,23]), transformative pathways [18], and transformative adaptation [24]. We use the term "sustainability transitions" as an umbrella term to encompass perspectives on transitions and transformations. Work in sustainability transitions has been done on "windows of opportunities," or identified moments in time in which there is a heightened probability that efforts to alter a system state will be more likely to succeed (e.g., [25,26]). Yet, most studies have focused on processes occurring in normal times, or in contexts of crisis, rather than disasters. Crisis is defined as a "symptom of underlying persistent unsustainability" in systems ([20], p. 34) and "collective stress situation" ([27], p. 23) contrasting with the more specific cases of disasters, triggered by a hazard. For this reason the lessons from this body of work in the sustainability literature may be less applicable to the messy political and social realities of disasters, where proposed steps and mechanisms may, or may not, be employed as in normal times, or in the context of prolonged stress, as defined by "crisis".

Nevertheless, there are notable efforts now to bring the fields of disaster risk management and transition research together. Becker and Reusser [28] use the multi-level perspective of socio-technical transitions to analyze whether disaster risk reduction measures implemented during disaster recovery processes lead to systemic vulnerability reductions. Gibson et al. [16] use an actor-based framework to analyze whether disaster risk management policy can become transformative, especially when linked normatively to the SDGs. Their framework evaluates changes in risk management policy following disaster using characteristics of transformative pathways. While these efforts procedurally link the concept of transformation with disaster risk management approaches, neither approach operationalizes sustainability criteria as a normative framework to guide development following disaster. To construct the evidence base on which to build a robust theory of how sustainability transitions can be stimulated following disasters, there is a need for a unifying framework integrating knowledge on sustainability transformation and disaster recovery efforts.

The objectives of this paper are, thus, to contribute to this emerging work by synthesizing existing theoretical and empirical knowledge as the basis for creating a unifying framework. We propose that the framework could be used to document and comparatively analyze case studies, and identify pivotal factors critical for success or posing barriers towards advancing sustainability. We illustrate the application of the framework to existing cases, and through this application identify emerging factors, which can be considered in the analysis of future cases. Despite an increase in literature on individual disaster recovery cases, there are few comparative studies or studies that synthesize findings [9]. We posit that the framework can help identify key features from empirical cases that can be used to help plan for sustainability transitions and leveraging opportunities presented by disasters in the future. Hence, we draw on the above-mentioned third type of disaster studies, investigating cases that embraced (directly or indirectly) sustainable development as a main goal orienting their post-disaster transition.

In the next section, we synthesize the concepts of change in disaster recovery and sustainability transitions literatures into a framework. We apply the framework to a set of cases that purportedly leveraged post-disaster opportunities for transitions towards sustainability. We identify some factors that seem pivotal for leveraging opportunities presented by disasters and discuss how accounting for these factors could support seeds of sustainability transitions while reducing disaster risk. We conclude by arguing that employing a unified framework allows for systematic analysis of cases and identification of intervention points to strengthen emerging sustainability transformations; absent such a framework, drawing conclusions about processes and outcomes of post-disaster sustainability transitions is difficult, as the collected evidence remains partial.

2. Framework to Analyze Sustainability Transitions Originating in Disaster Contexts

This section proposes an analytical framework derived from a review of how change and transitions towards sustainability are theorized in disaster and sustainability transition literatures. Figure 1 illustrates the key elements of the framework, which we explain below. The figure is based on three quadrants, reflecting the overlap of both literatures. Both literatures present change processes as occurring over phases, with each phase entailing a set of contextual factors as well as "Inputs and Resources" that actors draw upon to create conditions for change. Additionally, both literatures acknowledge the importance of multiple scales, drawing attention to the interplay of bottom-up, as well as top-down, processes. The arrows illustrate how actors navigate these phases in the pursuit of advancing change towards sustainability, starting with the catalyzing role of "change agents"; the immediate and longer term products ("outputs") of efforts to foster sustainability transitions; and the need to evaluate the "outcomes" of such efforts in terms of sustainability criteria. What is depicted as linear in Figure 1 are, in reality, patchy, iterative, and emerging pathways. Complementary concepts of change from disaster (in red) and sustainability (in blue) literatures are highlighted. The overlapping and complementary focus of these literatures suggests that an integrative framework could help understand how opportunities presented by disaster can be leveraged for change towards sustainability.

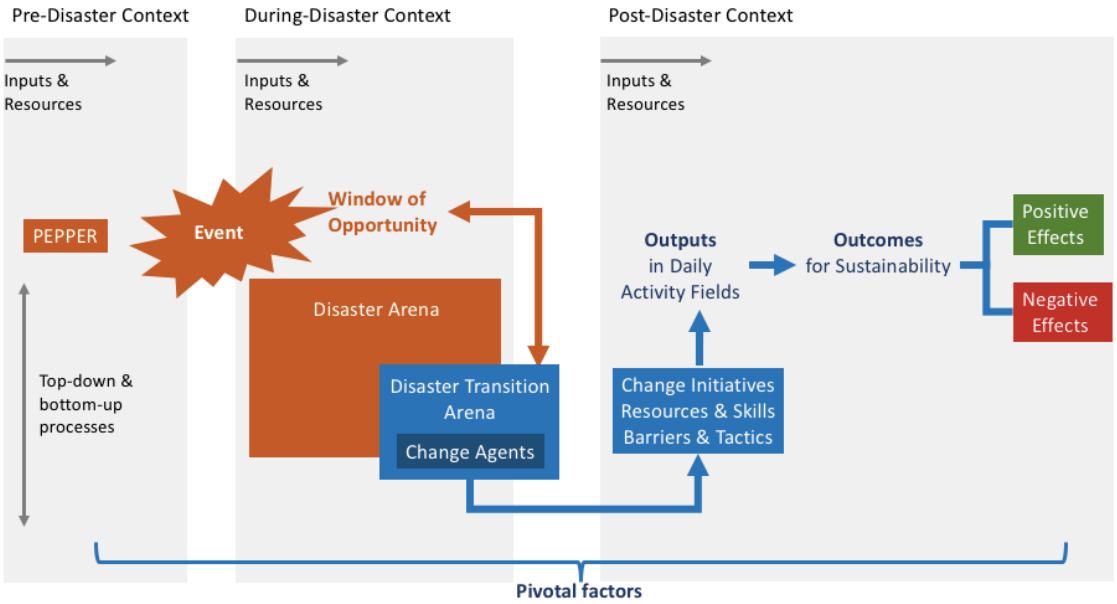

Figure 1. Analytical framework, illustrating actors' pathways of change across phases.

2.1. Contextual Factors: Phases of Change and Related Inputs and Resources

Disasters are the focal point of the proposed framework, as catalyzing events and inflection points in system interactions. Drawing from the "Pressure and Release model" (PAR) [29], we can analyze the parallels in sustainability and disaster framings in relation to the three phases of disaster: pre-disaster, disaster, and post-disaster. The PAR model helps understand the conditions that give rise to a disaster, how disasters and their impacts unfold, and identifying points of intervention for reducing vulnerability. The PAR conceptualizes change as resulting from two opposing forces: factors that produce social vulnerability, and the probability of hazard events. Vulnerability, in turn, arises from unsafe conditions (e.g., housing, water supply, waste management), dynamic pressures (e.g., political, economic, and environmental trends), and root causes (e.g., dominant ideologies, power relations, and structures to accessing resources).

Just as the PAR model situates disasters in a historical perspective, and relates disasters to conditions operating at diverse organizational levels and spatial scales, theories of transitions to sustainability converge in that they present transitions as occurring in phases over the long-term, across geographical scales and organizational levels (niche, regime, landscape), and encompassing social, economic, and environmental dimensions (cf., [20,30]). One theory of sustainability transitions, for example, conceptualizes change as unfolding when niche-level innovations designed to address complex and persistent sustainability challenges become viable. Niche experiments can mobilize interest in disrupting established systems and can catalyze the substitution of old ways for new ways of doing things. Such experiments can lead to pathways of change that scale up and institute innovations over time and space until they become, if successful, the new normal. In general, sustainability transitions are concerned with developing processes that radically shift established systems towards sustainable modes of production, consumption, governance, and ecosystem dynamics [31]. Similar to the process of disaster recovery, sustainability transitions are political endeavors occurring in complex adaptive systems, with behavior that is uncontrollable and opaque. These dynamics require abilities to test, observe, learn and adapt transition actions in order to achieve intended outcomes, while negotiating contested and uncertain processes of change.

The **pre-disaster context** is the period before disasters, which entails prevention and mitigation activities to reduce disaster risk and the beginnings of response activities [32]. To connect disaster risk reduction with sustainable development, experts have long advocated for Pre-Event Planning for Post-Event Recovery, or PEPPER [33], to introduce planning for sustainability prior to the occurrence of any disaster event [34–36]. Scholars have emphasized the importance of enhancing interactions and building networks among state entities, non-governmental organizations, and local communities; these relations are catalyzed through the disaster impact and have been shown to influence what emerges during disaster recovery [12,34]. Nevertheless, in practice, most emphasis in planning is given to disaster response, rather than to pre-event mitigation and preparing for long-term recovery ([37], p. 348). In the absence of activities that envision alternative sustainable states and disaster recovery paths, the existing discourses, agendas, and development trajectories at the time of impact are likely to become the dominant themes following a disaster [38,39].

The corresponding phase in sustainability transitions is the predevelopment phase. Preparing the transition entails establishing a network of actors ("frontrunners"), who gather around a sustainability challenge, deliberating pathways of change, while trying to integrate diverse interests, to advance sustainability collectively. This process is called building a "transition arena" [17] and actualizes latent system resources that others have identified as a "shadow network" [21]. It is an informal social organization comprising of instrumental actors from diverse domains (government, private-, and third-sectors) sharing values, knowledge, skills and resources. These individuals self-identify as change agents in diverse roles including, e.g., as technical expert, networker or opinion leader, and enjoy respect in their networks [17]. While people meet as individuals, they have "strategic agency." Using their professional expertise about institutional processes and ability to invest time and energy, they devise strategic courses of action through jointly framing sustainability challenges, creating big picture sustainability visions, and engaging in sense-making [40].

The **period of the disaster** itself entails the time of impact and the response period, which often overlaps with recovery activities [32]. While this phase has been the primary focus of disaster research and practice [4], changes triggered by disaster impacts have received less attention. Such changes—for example, in social organization, in policy, or in practices and ecosystems—can affect all dimensions of society (environmental, social, economic) and can amplify or mollify disaster impacts. Changes are carried forward through formal channels (e.g., governmental interventions) and informal mechanisms (e.g., local groups), in some cases spontaneously, in indirect ways, or through deliberate action. Both formal and informal mechanisms shape the disaster's impacts and disaster recovery processes [4]. Understanding how changes emerge in disaster contexts and interact with concurrent socio-ecological

change processes is critical to inform institutional learning and developing policy to reduce disaster risk and advance sustainability outcomes.

In addition to these change processes, disasters are often perceived as creating the opportunity of a "reset button" for building infrastructure and institutions deliberately in better ways [12]. The destructive power of hazards shatters ecosystems, habitats, infrastructures, and institutions, and often erases development gains. Laying bare past political processes, disasters can present opportunities for populations to critically review established ways of thinking, the social contract, and the competencies of elected leaders [41,42]. Disasters can provide leverage and finance for alternative projects and agendas, which may be politically "unpalatable" in normal times [43]. Together, these factors create a window of opportunity: a decision point that generally remains open for a short period of time [44], and closes due to a variety of factors [42,45].

The corresponding phase in theories of sustainability transitions is what is called the "take off-phase", where actors seize a window of opportunity. The window of opportunity in normal times refers to an opportune moment, where the time is right to introduce radical change, because "a problem is recognized, a solution is available, the political climate makes the time right for change, and the constraints do not prohibit actions" ([46] as cited in [21], p. 8). Anticipating such a window, agents, and their shadow networks, foster coalitions with additional groups and create transition-agendas, i.e., action plans to disrupt established systems and catalyze the sustainability vision into niche experiments and pathways, while considering uncertainty and possible consequences of these actions. When the time comes, agents seize windows of opportunity to establish new governance systems by implementing the transition agenda step-by-step [17]. Actors mobilize resources by connecting ideas with each other and to resources and institutions; these actions require tactical skills as innovators, experimenters, and brokers [40].

The **period after disasters** is also the context before the next disaster [32]. It entails a sequence of phases extending over years and decades, summarized under the umbrella term of recovery [47]. The recovery period bleeds into normal times, although this occurs differently for different people depending on their social position [48]. Even when pre-disaster activities and the initial window of opportunity were missed to direct changes towards sustainability, the recovery phase provides opportunities to introduce sustainability objectives [10,11,49,50].

The corresponding phase in sustainability transitions aims to build resilience of the new system by accelerating change and working to overcome barriers to eventually stabilize introduced changes. It combines operational activities, including pilot projects and experiments that represent tangibly what the sustainability vision looks like on a small scale. Simultaneously, strategic activities aim at changing structures and culture. In addition to offering a glimpse of the envisioned sustainability future, these change projects test the new ways of doing things, making visible what works and what problems might emerge. Mobilizing additional actors is crucial to continuously build momentum for the change activities, and to connect the change process to the larger contexts by using small wins to acquire more resources and institutional support [17,40]. These actions require change agents to have political savvy and interactional skills, like incentivizing, bargaining, and continuous mobilizing around the vision [40].

Both literatures point to the importance of specific conditions, inputs, and resources as catalysts of change: existing and newly-emerging social relationships and organization, the presence of plans and visions, and the ability to mobilize resources at key moments to make use of opportunity. These attributes of change processes are shaped in the disaster context by the historic, structural, and institutional processes that have given rise to vulnerability, and the specific resources and assets that are either destroyed or created as a result of the disaster itself and the recovery process. These resources, social networks, visions and agendas come to the fore and are made most visible within the "disaster arena": the space in which existing actors and new actors (such as aid agencies) negotiate their agendas and the allocation of resources in disaster response and recovery.

2.2. Change Agents, Their Processes, and Opportunities

Change during and following disaster occurs among individuals and social relations, leading to an altered sense of agency, social responsibility, and capacity. There is emerging evidence how the disastrous experience can trigger a "positive transformation" within individuals, i.e., the ability to transform experienced trauma into agency [51]. Research shows, for example, that people affected by disaster often demonstrate greater psychological resilience than assumed [52]. Other work has illustrated how the shared experience of disaster survival can bring the best out of people; it can enhance solidarity, helpfulness, and amiability; facilitating bonding among people, who would otherwise not have met due to their social situations [53]. Such bonding offers opportunities to leverage cultural change, because people see new roles for themselves to realize wishes that remained latent and unfulfilled under the old system ([54], p. 57). This internal shift is thought to unleash these actors' potential to commit and care to effect change for a better life [55]. Some of the actors are catalyzed by disaster into change agents; others may have already been motivated as change agents prior to the disaster impact and accelerate their efforts following the event [56]. Recognizing agency in disaster survivors is critical: it helps overcome the view of them as powerless victims and facilitates replacing the deficit model with asset- and capacity-based approaches to disaster recovery [57].

Human agency is increasingly addressed in sustainability transitions as a driver of deliberate actions that aim to create systemic shifts [58], acknowledging that people initiate sustainability transitions and advance change by defining and legitimizing new practices [59]. This emphasis reflects critiques that approaches failed to account for underlying politics, power structures, and inequality, differently affecting people's abilities to develop agency and participate in transitions [60,61]. As self-identified sustainability change agents, actors initiate sustainability projects with the intention to enact "substantial change" in their communities and society [62]. To be effective, collective action with supporters and opponents is essential. The constellation of actors, their networks, and participating actors' skills vary for each phase, as different capacities and relationships are necessary to prepare for change, seize opportunities, and translate change into a new normal [40].

In sum, the change agents can be described by (i) their sustainability change initiatives (formal and informal actions, projects, and programs); (ii) related purposes, resources, skills and tactics to overcome barriers towards sustainability goals; and (iii) the relations among change agents and other actors. Accounting for these factors helps identifying the "disaster transition arena" as a network that is part of, and extending beyond, the disaster arena. The disaster transition arena coordinates sustainability change initiatives across daily activity fields, scales, and sustainable development goals and, combining different groups of actors across the three phases, it responds to contextual constraints and offerings. Change agents' ability to recognize the emergence of windows of opportunity and envision sustainability change in diverse areas of daily activity is a key leverage.

2.3. Outputs: Sustainability Change Initiatives

The outputs of actors' sustainability change initiatives can be identified as changes in specific daily activity fields. Daily Activity Fields (DAF) include housing, eating, educating, working, being mobile, recreating, worshipping, communicating, shopping, caring, and engaging [63]. The DAF have been employed in sustainability research as a means of holistically describing a way of life and as a way of reconstructing local sustainability transitions after the fact (cf., [64]). By employing the heuristic of the DAF in disaster transitions, it is possible to explore how rebuilding sustainable communities affects all aspects of life activities, just as disasters also affect all such activities [65]. The outputs of sustainability change initiatives are also reflected in changes of infrastructure, institutions, and people's practices. Moreover, while infrastructure and institutions influence people's practices, people's practices simultaneously shape infrastructures and institutions—confirming or altering them [66]. Outputs of sustainability change initiatives can appear in different stages of realization ranging from being fully manifest, in process, in a nascent stage of envisioning, or as discontinued sustainability

change processes [67]. Achieving these outputs, however, presents challenges described by both disaster and sustainability transitions literatures.

Disaster literature points to the challenge of time compression, where normal processes proceed compressed in time and space, changing dynamics in planning, distribution of funding, governance, participation, and in power relations, often exacerbating inequities [68]. Expediency in the recovery phase often overrules deliberation about the trade-offs between "restoring what was lost" and "building back better, stronger, greener, and more equitable" ([9], p. 289). Pressure to address short-term needs while accounting for long-term development goals can result in policies that undermine sustainable development [69]. Compounding the challenge of time compression is the fraught nature of disaster governance. Coordination among actors and organizations improved for disaster response, but remains insufficient for disaster recovery [70]. As formal local planning and decision-making capacities are decreased by the disaster impact, external organizations step in to implement recovery efforts, often without being asked, filling perceived governance gaps and insufficiencies of host agencies. Such efforts often lack accountability and fail to connect with local and national development programs [34]. Meanwhile, while there is enhanced interest in local populations to participate in decision-making to accelerate and direct development, bureaucratic planning processes are often unable to embrace this increased desire for participation [71]. Governance, including accountability, coordination, and legitimacy, is key to achieving sustainable recovery [72].

Similar challenges are also raised in the literature on sustainability transitions. While agency is fundamental for sustainability transitions, outcomes of intended actions can be unexpected due to system complexity. Therefore, mobilizing for change across all phases requires spaces and processes that enable social learning, reflection, as well as monitoring and evaluation; hence, actors need to be apt at adjusting their intentional change processes in response to changing contexts and uncertainties and acknowledging their bounded rationalities [59,73]. Mechanisms for reflection and learning include real-world experiments to test and learn about proposed shifts on small scales [25,74], as well as spaces, where groups—proposing alternative visions and working through informal processes—can be in dialogue with policy-makers operating within formal processes [75].

2.4. Outcomes: Appraising Change towards Envisioned Sustainability Outcomes

Any framework used to analyze transitions to sustainability requires a focus on the outcomes and the extent to which these are, in effect, materializing sustainability visions. Established sustainability criteria can, thus, be employed to evaluate the direction of change initiatives vis-à-vis the envisioned sustainability future. This approach is in line with the definition of post-disaster resilience as the ability to "bounce forward" as opposed to "bounce back" [76], the latter implying measuring progress using a pre-disaster baseline instead of a future sustainability vision.

Gibson and colleagues [77] conducted a seminal review across sustainability assessment approaches worldwide synthesizing eight generic sustainability principles from which evaluation criteria can be derived. The principles are: (1) socio-ecological systems integrity; (2) resource maintenance and efficiency; (3) meaningful livelihood sufficiency and opportunity; (4) socio-ecological civility and democratic governance; (5) intergenerational justice; (6) intragenerational justice; (7) precautionary practices and adaptability; as well as an (8) integrated approach, simultaneously applying all principles at once, aiming at mutual benefits and multiple gains [78]. We integrated the principles proposed by Gibson [78] into a matrix and simplified them into a set of five principles (see Table 1). We specified the principles into appraisal criteria for the disaster context drawing on literature on sustainable disaster recovery (for details see [56]). Three principles represent the environmental, social and economic dimensions of sustainable systems. We consider justice and adaptability principles as cross-cutting principles given that such requirements are integral to development efforts across all dimensions. Applying these criteria to the changes that emerge following disasters allows an appraisal of whether or not sustainability change initiatives, in different daily activity fields, have advanced sustainability. Changes that contribute positively to sustainability

principles and provide services and products to broad populations (not only disaster-affected populations) and over the longer term (not only during the recovery periods) could be interpreted as changes that represent progress towards sustainability [56]. Obviously, it is challenging to ensure that any appraisal is comprehensive and address the diversity of sectors and activities that are entailed in systemic transitions.

Table 1. Integration of generic sustainability principles after Gibson [78].

Natural Environment • Socio-ecological system integrity • Resource maintenance and efficiency	**Justice** • Intra-and inter-generational justice	**Adaptability** • Precaution and adaptability
Economic • Livelihood sufficiency and opportunity		
Social Wellbeing • Socio-ecological civility and democratic governance		

2.5. Pivotal Factors

Beyond its potential use for academic and conceptual goals, the ultimate purpose of the proposed integrative framework is to enable stakeholders embedded within a disaster context to explore whether their desired transition is enfolding to the desired potential, and to be able to support the "sustainability transition in the making" [59]—especially in the early years of the post-disaster recovery. Pivotal factors can be identified for an individual case when reflecting on the interplay among the above categories. Applying the framework to a set of cases helps reveal initial factors for success (drivers, enhancing the transition) or failure (obstacles, curbing the transition).

3. Approach to Case Study Selection

We identified 10 cases purportedly describing sustainability transitions following disaster events (four in the USA, two in Italy, three in Honduras, one in China, and an international study on mental health; see Table 2). The cases result from a literature review in 2014/2016 using Web of Science and combinations of the following search words included in either the title, abstract, or keywords: sustainability/sustainable development; opportunity/window of opportunity; disaster; recovery/reconstruction. The case studies of Soldiers Grove, WI; Kinston, NC; and Valmeyer, Il, did not emerge through the Web of Science search; however, they were added as they were referenced in articles on the Greensburg case (cf., [10,13,79,80]). Clearly, the set of cases is small. Identifying case studies proved challenging as disaster and development studies employ distinct foci on the analysis of change in disasters (recovery vs. development) and inconsistent terminology. Nevertheless, the collection of cases provides an initial sample with which we can explore the facets of disaster-to-sustainability transitions, as made visible through the application of the framework. In the next section, we summarize the insights revealed in using the framework to analyze the 10 cases. As a framework for analysis, it does not, in itself, offer a theory of disaster and transitions to sustainability, but helps disaggregate complexity into manageable units for analysis. Its application to specific cases might also help identify initial pivotal factors that can strengthen sustainability transitions in disaster contexts.

Table 2. Overview of select cases that seized opportunities for change to sustainability.

Greensburg, KS. Greensburg is a small rural town in the USA (~1200 people), which was almost completely destroyed by an EF 5-strong tornado in 2007. It leveraged the disaster to rebuild itself as "Greensburg-Greentown, the greenest town in rural America." Greensburg indicates that creating a safe and participatory space for creativity, exploration, experimentation and innovation is possible in a disaster context and can be leveraged to shape a town's sustainable development especially related to green building and renewable energy developments [13,79,80].
Soldiers Grove, WI (1978), **Kinston**, **NC** (1996, 1999), **Valmeyer**, **Il** (1993): These are small rural towns in the USA (600–900 people), with histories of recurring floods and hurricanes ravaging their regions. The approaches taken by these towns have been influential in informing the idea of rebuilding sustainably [10]. After surviving extreme weather events, the towns decided to relocate and do so in a sustainable way to survive in the long-term. Their strategy involved renewable energy production, disaster risk mitigation, and sustainable relocation. They framed their efforts to seize the window of opportunity as *VISIONS: Valmeyer Integrating Sustainably Into Our New Setting* [81,82] or *Soldiers Grove: The Little Town That Could* [83].
Abruzzi, Italy. The Abruzzi earthquake (MG 6.3) struck the town of L'Aquila and surrounding municipalities on 6 April 2009. While the state-led disaster recovery process was critiqued for many reasons (cf., [84]), some communities seized the window of opportunity to pursue their aspirations. For instance, the residents and newcomers to the village of Pescomaggiore seized the opportunity to become a resilient eco-village [85]. Also, the town of L'Aquila seized opportunities to substitute fossil fuel energy systems for renewable energy systems—temporarily installing renewable pilot projects in camps during the relief phase and permanently incorporating sustainable construction, energy efficiency, bio-architecture and use of renewable sources as part of the new building regulations for reconstruction efforts [86].
Wenchuan province, China. The Wenchuan earthquake (MG 7.9) devastated the province of Wenchuan, China, on 12 May 2008 and killed 69,197 people. The Chinese Government proclaimed to seize the window of opportunity for sustainable development [87]; in particular to support a more equitable peri-urban development, accounting for the needs of rural areas [88]. Yet, the government abandoned its efforts quickly, responding to pressures from the tourism industry and trying to finish reconstruction before the impending global financial crisis rippled through. Nevertheless, rural villages continued to pursue opportunities for change towards sustainability. They tried to reassert their rural identity despite insatiable peri-urban growth and to establish enterprises in agroecology and ecotourism despite the standardizing efforts of the national tourism industry [88].
Honduras. Hurricane Mitch (1998) devastated the impoverished indigenous Tawahaka community in Krausirpi. Women and youth mobilized post-disaster and facilitated processes that resulted in changed land-tenure systems, granting previously marginalized community members better access to land, and in improved forest management that reactivated the traditional ecological knowledge, informing disaster mitigation and diversified livelihoods [12,14]. Another study compared the relocation processes of three communities in Honduras, including Divina, Providencia, and Ciudad España, which relocated to a new area with the help of strong NGOs. Of the three, the community of Divina successfully relocated, in particular, as it developed shared norms that resulted in healthier community structures and reduced social inequities [15]. The Stockholm Declaration, a mutual agreement between international donors and the disaster-affected governments, failed on a large scale, but led locally to some positive developments in Honduras and Nicaragua [89].
International examples of mental health care. Armed conflicts and natural disasters ravaged communities in low- and middle-income countries creating windows of opportunities to address major gaps in community-based mental health care during disaster times and as part of development. Epping-Jordan et al. [90] reviewed 10 cases including Afghanistan, Burundi, Indonesia (Aceh Province), Iraq, Jordan, Kosovo, the occupied Palestinian territory, Somalia, Sri Lanka, and Timor-Leste. This seminal article identified lessons emerging across the 10 cases how to seize opportunities created by both natural hazards and armed conflict to establish a mental health care system during the post-disaster recovery. They include, in particular, adopting a long-term perspective from the outset and focusing on system-wide reform that addresses pre-existing and new-onset mental disorders.

4. Findings from Applying Sustainability Cases to the Framework

4.1. Change Agents, Their Processes, and Opportunities

In all cases, there is a prominent role of sustainability-oriented social networks advancing the transition. The American case studies highlight the role of an entity comprising of residents

(some representing village boards or citizen committees), government leaders (e.g., mayor, city staff from disaster management and regular departments, and staff from state and national agencies) and representatives of civil-society organizations and business owner associations. For the Honduras cases, the ability of state government and international donor organizations to understand when to engage with the local communities and when to step back was key to support the community's change process. Similarly, in the mental health cases, central government and external actors engaged with local and national health professionals in the recovery process in ways that asserted and employed the expertise of the latter two. These examples illustrate the existence of a disaster transition arena comprised of local and external sustainability change agents from different sectors and administrative scales working together. In these cases, the participants in these arenas appeared to have contributed to sustainability transitions through activities that strengthened local capacity and ownership while being connected to national and international networks.

Two other aspects emerged within these examples of disaster transition arenas. One is the role of the liaison, specifically, what might be termed a sustainability liaison. In Greensburg, a sustainability liaison was appointed as the go-to entity for everyone—residents, contractors, or officials—to address anything related to sustainability-oriented recovery efforts and development plans. In Krausirpi, Honduras, the young community members, who attended pre-disaster capacity building workshops on natural resource management, informally took on the liaison role, engaging a diffuse decision-making process around reforming land tenure rules. The second aspect is the collaboration between actors in the disaster transition arena and research/educational entities to support sustainability pursuits. In Wenchuan Province, China, rural villages turned to the university's social work department seeking guidance in developing their sustainability initiatives around local ecotourism and agroecology. In L'Aquila, Italy, and the USA case studies, some of the disaster-affected municipalities self-identified as learning laboratories for sustainability technologies. They agreed to partner with federal departments, as well as university professors and students, to test green building features and renewable energy systems as part of the disaster recovery process. Some of these pilots contributed to now well-established innovations, such as the US Green Building Council's green building certification program. Universities were also asked to assess if proposals prepared by donors, federal, or consulting groups support the groups' sustainability pursuits or not.

In the different cases, the window of opportunity for change played different roles in the process of sustainability transitions. For example, for change agents in the USA cases, rural areas experiencing pre-disaster economic decline, the idea of sustainability represented the central way forward in light of a lack of other viable options for the future. Similarly, the town of Valmeyer, Il, initially seized the opportunity not because it was pulled by a compelling sustainability vision, but rather because residents saw no alternatives. Taking advantage of the new US hazard mitigation program was the only viable option; engaging with mitigation questions triggered residents to envision alternative development pathways. In contrast, in Pescomaggiore, Italy, people had envisioned building an eco-village prior to the disaster. The disaster allowed them to accelerate this process; some change agents were strategic about obtaining temporary exemptions for their plans during the relief phase and turned them into permanent permits for development. In Wenchuan, China, rural villages seized opportunities to define their identity on their own terms: e.g., by establishing local ecotourism and agroecology programs, they attempted to defy the standardizing processes of the national tourism industry. Additionally, external actors started to see windows of opportunities to forward a broader agenda that coincided with the local sustainability transition goals. For instance, in Greensburg, national organizations, corporations, the University of Kansas, community groups, and individuals were attracted to the town because they saw Greensburg as a place that allowed them to pilot their own sustainability innovations. While these external actors contributed to the sustainability processes in Greensburg, that engagement helped them to increase their own capacities and networks allowing for scaling their sustainability products beyond the disaster-affected place. Similarly, benefitting from the media attention given to Greensburg, these external actors used their own media relations to spread

the word in new circles, which, in turn, generated media coverage about Greensburg. The barriers to seizing such opportunities that were evident across the cases incorporated many of those known to affect disaster recovery in general (e.g., perceived slow/no progress) and those relevant for leveraging sustainability post-disaster (e.g., a lack of sustainability alternatives, a lack of funding slated for sustainability, or trade-offs among competing sustainability goals). As a consequence of these barriers, people started to drop out of post-disaster sustainability initiatives.

4.2. Outputs

The case studies manifest a variety of outputs in diverse activity fields, and in some cases actor groups created outputs in more than one daily activity field. Many of these outputs were first-of-its-kind innovations. For instance, some of the USA cases established sustainability inventories and submitted regulatory changes, including novel federal and state laws on renewable energy and natural resource conservation (Soldiers Grove, Kinston). Greensburg received international awards for its sustainability master plan that was derived from a publicly-endorsed sustainability vision. New institutions, such as the community-based mental health care system (health care studies), redefined land tenure-system (Krausirpi), and household registry for peasants (Wenchuan), were implemented, increasing access to quality care or land-ownership of previously disadvantaged land-poor households. New networks were established, including a novel inter-agency sustainability-working group, city-to-city partnerships (Greensburg, Wenchuan), community-university relationships (various cases), and healthier intra-community relationships (Divina, Honduras). These networks facilitated an increase in people's capacities and the development of new products and services, such as municipal educational services, commercial consulting, and technical support (USA case studies), and niche-markets for agroecology and ecotourism (Krausirpi, Wenchuan). The latter helped slow down deforestation of primary forest in Krausirpi by fostering the forests' ecosystem services for hazard mitigation.

4.3. Outcomes

Employing the sustainability appraisal rubric across the cases illustrates that various sustainability principles were pursued, although, as one might expect, not every principle was equally addressed in every case study. Overall, the local sustainability initiatives that emerged in each case of disaster represented seeds of change: nascent processes that in most cases were not fully developed or comprehensive in scope. For example, in many cases, in the domain of the Natural Environment, natural capital, like soil, air, and water quality, was enhanced when it was clear that such capital would benefit livelihoods and hazard mitigation measures (e.g., agroecology efforts in Krausirpi and Wenchuan; the first US conservation zone in Kingston). Nevertheless other aspects of the natural environment—e.g., remediation actions of non-disaster-related contaminated natural resources—were not reported in the cases. Efficient use of material was a primary objective in the eco-village and towns participating in the renewable energy pilots in L'Aquila and the USA case studies; yet, the remoteness of these areas made implementation of this objective challenging.

In the domain of Social Wellbeing, the case studies illustrated how a strong association with place and place-making served as a driver of sustainability transitions across all cases. This place attachment was expressed through the slogans defining the small US towns (e.g., VISIONS—Valmeyer Integrating Sustainably into Our New Setting), or by reactivating cultural heritage and indigenous ecological knowledge in Wenchuan and Krausirpi. Similarly, the sustainability change efforts enhanced social cohesion and civic engagement capacities. In fact, the restructuring of social relations following the disaster was seen as one of the reasons why the relocation of the community of Divina, Honduras, succeeded. In terms of whether public facilities and services were created or maintained, the mental health care case studies documented progress in establishing an entire public mental health *system* and the Krausirpi case describes how state entities and international NGOs gained a better understanding of local needs related to public services. The USA cases reported new investments in creating good

public spaces. In contrast to these areas of progress, high quality, affordable, and sustainable housing was reported as a challenge for service provision across most cases.

In the Economic domain improving livelihoods and public finances by creating meaningful, sufficient employment and strengthening a local economy was reported only in few cases and with limited success. For instance, people in Krausirpi were able to diversify their sources of income, but youth are still leaving the area. In other remote places, like Greensburg and Wenchuan, attracting sustainable businesses was challenging. The studies indicate that post-disaster funding was made available for the relief phase, and to some extent, for long-term recovery. Nevertheless, securing funding for ongoing recovery remained a continuous and tiring effort. We were unable to appraise the extent to which public finances where reorganized to serve the public good.

The cross-cutting dimensions of sustainability, including Justice and Adaptability, were difficult to appraise. One challenge in evaluating the cases was to differentiate between the intent to equitably distribute costs and benefits of recovery efforts and sustainability initiatives among social groups (including current and future generations as well as neighboring or otherwise functionally connected communities), and the data available on the actual outcomes of such intentions.

4.4. Contextual Factors: Phases, Inputs, and Resources

In most of the cases surveyed, it was indicated that pre-disaster activities that spread ideas about sustainability and built latent capacities became accelerators for seizing the window of opportunity. For example, the town of Greensburg had engaged in (unsuccessful) efforts to revitalize their declining rural town; this experience and the relationship-building that it had involved was successfully reactivated post-disaster. In Krausirpi, Honduras, residents who participated in natural resource management workshops employed that learning successfully post-disaster. Other disaster inputs highlighted included the availability of large sums of funding that would otherwise not be attainable, national and international professional expertise supporting local efforts and, in some cases, a supportive and sustained role of the media.

5. Discussion

The application of the framework to a disparate set of case studies allows for a more systematic picture of sustainability transitions originating from the disaster context. The framework provides a structure for analysis, facilitating cross-case comparisons, and reveals where evidence is weak or missing. Weak evidence related to measuring sustainability outcomes, for instance, was indicated by the sustainability appraisal; hence, conclusions about sustainability transitions remain based on partial evidence. Employing the framework to ongoing efforts allows for more exploratory purposes such as identifying evidence gaps to be addressed and points of intervention to strengthen sustainability transitions across daily activity fields. Since the framework integrates concepts of change towards sustainability from disaster and sustainability research, these reflexive attempts could support coherence between sustainable development efforts and disaster risk reduction efforts as called for by the Sendai Framework for Disaster Risk Reduction [91].

The exercise also points to mechanisms that appear to be significant in sustainability transitions originating in disaster contexts. For example, the case study analyses suggest a central mechanism is building actor networks that integrate actors across scales and timeframes. For instance, the analyzed cases support the idea of a disaster transition arena emerging as a distinct sustainability-oriented network that spans disaster governance [37] and sustainability governance in the disaster context [92]. Additionally, they reveal the potential utility of sustainability liaisons and community-university research collaborations as tools used by members of the disaster transition arena. Sustainability liaisons and research collaborations are recognized as drivers of community-based sustainable development in normal times [18]. As both tools are also reflected in the disaster literature, (cf., [49,93]), these cases suggest that these entities play equally important, yet to date under-appreciated, roles in disaster governance for sustainability.

Our framework provides a basis from which scholars and practitioners working on either disaster or sustainability transitions can learn from each other and, as such, builds on Becker and Reusser's [28] conclusion that the disaster and transition literatures are complementary. The analyzed cases suggest that the elements that support formation and existence of disaster transition arenas, including the creation of sustainability liaisons and research collaborations, generate innovations that advance sustainable development and disaster risk reduction. Further, it appears that disaster transition arenas are spaces in which actors can link disaster recovery needs (and interest groups) with the initiatives supporting sustainable development needs (and interest groups) that are most active in normal times. In this way, theses arenas align "multiple local and external actors ... in critique of established systems," which makes "transformation ... most likely" ([16], p. 16).

Applying the framework to the case studies also allowed us to explore the temporal dimensions of transitions. The evidence from the cases suggests that transitions originating in a disaster context are more likely to succeed when they can access longer-term support structures. For example, in the disaster scholarship, the concept of a "window of opportunity" is often presented as a single opportunity, opening after impact, and for a limited period of time. Some scholars caution that this short-term framing fails to account for changes manifesting over the longer term and it might not apply to all actor groups in the same way. For instance, Christoplos [94] stipulated that NGOs may be more effective in leveraging opportunities in later stages of the recovery. Frühling [89] concluded that the international effort to seize the window of opportunity for social transformation after Hurricane Mitch in 1998 (the Stockholm Declaration) failed. However, local groups implemented specific sustainability interventions in reference of the Stockholm Declaration, giving rise to measures that, years later, contributed to reducing social and ecological vulnerabilities at least locally in Honduras and Nicaragua. Similarly, McSweeney and Coomes ([14], p. 5206) argue that the "hopeful process" of the land-poor effectively escaping the poverty trap, a systemic shift, became apparent only years later. A key for success was that the indigenously-led network and process emerged slowly and with external support as needed, as it was not tied to specific disaster reconstruction initiatives. Additionally, Epping-Jordan et al. [90] found that systemic improvements manifested in the mental health care sectors in those places where local disaster recovery activities were used to reform the national mental health care system. They conclude that a key to achieving systemic shifts included the collaboration among local and external actors, working toward local improvements, while adopting a long-term perspective from the outset and accounting for system-wide measures that addressed pre-existing and new onset issues. Thus, seizing the initial window of opportunity is a necessary, but insufficient step (cf., [16]). Arrangements like the disaster transition arena can help access funding and institutional support on higher administrative scales, related and unrelated to disaster recovery initiatives, and necessary to sustain local transitions over the longer-term.

In addition to building "linking capital" [95] and awareness about opportunities emerging through the recovery process over time, promoting future thinking capacities appears to be important in encouraging desirable systemic shifts in a disaster context. Sustainability scholars have argued that encouraging the creation of diverse "emancipatory visions of development" may be "one of the most important adaptation capacities;" provided people have the ability to "fundamentally influence governance structures and development paths" ([39], p. 9). Adopting methods such as visioning, scenario planning, and asset-based community development in planning and disaster recovery is long due [9,49,96]. Another approach encouraging visioning is learning lessons about attempted or successful shifts from other places. Mianzhu City (Wenchuan) invited Greensburg to enter a learning partnership to guide its disaster recovery towards sustainability. This suggests that learning about ideas and ways to enact them is possible even in disparate places and if disaster-affected places will not have the "perfect storm" in terms of resources and attention, such as Greensburg [79].

The framework also facilitates the analysis of cross-scalar interactions by strategically situating the local sustainability transition in relation to its interactions with developments happening at higher scales or in related locations concurrently. While many transitions are local and with local

effects [16], macro-trends influence local efforts to leverage post-disaster opportunities positively or negatively. Moreover, sustainability research cautions that local goals and broader aims of system sustainability may not work naturally in synergistic ways [97]. Further research is needed to examine how a disaster-specific sustainability transition is influenced by interactions with other locations and concurrent processes and to devise approaches, which mobilize these interactions strategically to support the transition.

6. Conclusions

We provide a framework that builds on and synthesizes the insights on disaster and change towards sustainability put forth by two highly productive and insightful research communities. The application of the framework to available empirical cases brings to focus specific conditions, resources, social relations and constraints that affect disaster-to-sustainability transitions. Beyond the use of the framework as a tool for case analysis, we expect that the framework can support learning among disaster practitioners, planners, and citizens. The framework permits an exploration of past experiences in diverse disaster contexts and insights into leveraging opportunities for sustainability in the development-disaster spectrum. The framework also allows various contributors—scholars and practitioners—alike, to add their empirical and theoretical data about their case, to complement information about an existing case, and to compare across cases. While the collection of data and building of theory would necessarily be incomplete, a catalogue of such cases would represent an ongoing effort to share experience and help develop theory. It would contribute insights for individuals and organizations in how to prepare pre-events for leveraging opportunities created by disasters to advance sustainability.

Author Contributions: K.B. and H.C.E. jointly designed the research and reviewed the research findings; K.B. carried out the research, analyzed the data, and wrote the major parts of the manuscript; and H.C.E. reviewed and revised iterations of the manuscript prior to the submission.

Funding: This research received no external funding.

Acknowledgments: We would like to thank two anonymous reviewers for their careful review of this article and thoughtful requests for revisions. Katja Brundiers, would also like to thank her dissertation committee, with Hallie Eakin, Daniel Sarewitz, and Adenrele Awotona for their guidance.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Rockström, J.; Steffen, W.; Noone, K. A Safe Operating Space for Humanity. *Nature* **2009**, *461*, 472–475. [CrossRef] [PubMed]
2. Raworth, K. *A Safe and Just Space for Humanity: Can We Live within the Doughnut?* Oxfam Discussion Papers; Oxfam: Oxford, UK, 2012.
3. Van der Leeuw, S.; Wiek, A.; Harlow, J.; Buizer, J. How Much Time Do We Have? Urgency and Rhetoric in Sustainability Science. *Sustain. Sci.* **2012**, *7* (Suppl. 1), 115–120. [CrossRef]
4. Birkmann, J.; Buckle, P.; Jaeger, J.; Pelling, M.; Setiadi, N.; Garschagen, M.; Fernando, N.; Kropp, J. Extreme Events and Disasters: A Window of Opportunity for Change? Analysis of Organizational, Institutional and Political Changes, Formal and Informal Responses after Mega-Disasters. *Nat. Hazards* **2009**, *55*, 637–655. [CrossRef]
5. Pelling, M.; Dill, K. Disaster Politics: Tipping Points for Change in the Adaptation of Sociopolitical Regimes. *Prog. Hum. Geogr.* **2010**, *34*, 21–37. [CrossRef]
6. Solecki, W. Hurricane Sandy in New York, Extreme Climate Events and the Urbanization of Climate Change: Perspectives in the Context of subSaharan African Cities. *Curr. Opin. Environ. Sustain.* **2015**, *13*, 88–94. [CrossRef]
7. Klein, N. Disaster Capitalism: The New Economy of Catastrophe. *Harper's Magazine*, October 2007; 47–58.
8. Gotham, K.; Greenberg, M. From 9/11 to 8/29: Post-Disaster Recovery and Rebuilding in New York and New Orleans. *Soc. Forces* **2008**, *87*, 1039–1062. [CrossRef]

9. Kim, K.; Olshansky, R.B. The Theory and Practice of Building Back Better. *J. Am. Plan. Assoc.* **2015**, *80*, 289–292. [CrossRef]
10. Schwab, J.C. *Post-Disaster Recovery: Next Generation*; American Planning Association: Chicago, IL, USA, 2014.
11. Institute of Medicine. *Healthy, Resilient, and Sustainable Communities after Disasters: Strategies, Opportunities, and Planning for Recovery*; The National Academies Press: Washington, DC, USA, 2015.
12. Agrawal, A. A Positive Side of Disaster. *Nature* **2011**, *473*, 291–292. [CrossRef] [PubMed]
13. Swearingen-White, S. Out of the Rubble and Towards a Sustainable Future: The "Greening" of Greensburg, Kansas. *Sustainability* **2010**, *2*, 2302–2319. [CrossRef]
14. McSweeney, K.; Coomes, O.T. Climate-Related Disaster Opens a Window of Opportunity for Rural Poor in Northeastern Honduras. *Proc. Natl. Acad. Sci. USA* **2011**, *108*, 5203–5208. [CrossRef] [PubMed]
15. Alaniz, R.C. From Tragedy to Opportunity: Long-Term Development in Post-Disaster Intentional Communities in Honduras. Ph.D. Dissertation, University of Minnesota, Minneapolis, MN, USA, 2012.
16. Gibson, T.D.; Pelling, M.; Ghosh, A.; Matyas, D.; Siddiqi, A.; Solecki, W.; Johnson, L.; Kenney, C.; Johnston, D.; Du Plessis, R. Pathways for Transformation: Disaster Risk Management to Enhance Resilience to Extreme Events. *J. Extrem. Events* **2016**, *3*, 1671002. [CrossRef]
17. Loorbach, D. Transition Management for Sustainable Development: A Prescriptive, Complexity-Based Governance Framework. *Governance* **2010**, *23*, 161–183. [CrossRef]
18. Leach, M.; Rockström, J.; Raskin, P.; Scoones, I. Transforming Innovation for Sustainability. *Ecol. Soc.* **2012**, *17*, 11. [CrossRef]
19. Chaffin, B.C.; Gunderson, L.H. Emergence, Institutionalization and Renewal: Rhythms of Adaptive Governance in Complex Social-Ecological Systems. *J. Environ. Manag.* **2016**, *165*, 81–87. [CrossRef] [PubMed]
20. Patterson, J.; Schulz, K.; Vervoort, J.; van der Hel, S.; Widerberg, O.; Adler, C.; Hurlbert, M.; Anderton, K.; Sethi, M.; Barau, A. Exploring the Governance and Politics of Transformations towards Sustainability. *Environ. Innov. Soc. Transit.* **2017**, *24*, 1–16. [CrossRef]
21. Olsson, P.; Gunderson, L.H.; Carpenter, S.R.; Ryan, P.; Lebel, L.; Folke, C.; Holling, C.S. Shooting the Rapids: Navigating Transitions to Adaptive Governance of Social-Ecological Systems. *Ecol. Soc.* **2006**, *11*, 18. [CrossRef]
22. Westley, F.; Olsson, P.; Folke, C.; Homer-Dixon, T.; Vredenburg, H.; Loorbach, D.; Thompson, J.; Nilsson, M.; Lambin, E.; Sendzimir, J.; et al. Tipping Toward Sustainability: Emerging Pathways of Transformation. *Ambio* **2011**, *40*, 762–780. [CrossRef] [PubMed]
23. Geels, F.W.; Schot, J. Typology of Sociotechnical Transition Pathways. *Res. Policy* **2007**, *36*, 399–417. [CrossRef]
24. Pelling, M. *Adaptation to Climate Change. From Resilience to Transformation*, 1st ed.; Routledge: New York, NY, USA, 2011.
25. Gelcich, S.; Hughes, T.P.; Olsson, P.; Folke, C.; Defeo, O.; Fernández, M.; Foale, S.; Gunderson, L.H.; Rodríguez-Sickert, C.; Scheffer, M.; et al. Navigating Transformations in Governance of Chilean Marine Coastal Resources. *Proc. Natl. Acad. Sci. USA* **2010**, *107*, 16794–16799. [CrossRef] [PubMed]
26. Loorbach, D.; Huffenreuter, R.L. Exploring the Economic Crisis from a Transition Management Perspective. *Environ. Innov. Soc. Transit.* **2013**, *6*, 35–46. [CrossRef]
27. Quarantelli, E.L.; Russell, R.D. Response to Social Crisis and Disaster. *Annu. Rev.* **1977**, *3*, 23–49. [CrossRef]
28. Becker, S.L.; Reusser, D.E. Disasters as Opportunities for Social Change: Using the Multi-Level Perspective to Consider the Barriers to Disaster-Related Transitions. *Int. J. Disaster Risk Reduct.* **2016**, *18*, 75–88. [CrossRef]
29. Wisner, B.; Blaikie, P.; Cannon, T.; Davis, I. *At Risk: Natural Hazards, People's Vulnerabilities, and Disasters*, 2nd ed.; Routledge: London, UK, 2004.
30. Charles, L.R. Should Sustainability and Resilience Be Combined or Remain Distinct Pursuits? *Ecol. Soc.* **2013**, *6390*, 1–19.
31. Markard, J.; Raven, R.; Truffer, B. Sustainability Transitions: An Emerging Field of Research and Its Prospects. *Res. Policy* **2012**, *41*, 955–967. [CrossRef]
32. Halldin, S.; Larzon, L.-Å.; Nohrstedt, D.; Nyberg, L.; Ullberg, S. *Science Plan for the Centre for Natural Disaster Science (CNDS)*; CNDS: Uppsala, Sweden, 2011.
33. Spangle, W.E. Pre-Earthquake Planning for Post-Earthquake Rebuilding (PEPPER). *J. Environ. Sci.* **1986**, *29*, 49–54.
34. Philip, R.B.; Kartez, J.; Wenger, D. Recovery after Disaster: Achieving Sustainable Development, Mitigation and Equity. *Disaster* **1993**, *17*, 93–109.

35. Natural Hazards Center. *Holistic Disaster Recovery. Ideas for Building Local Sustainability after a Natural Disaster*, 2nd ed.; Natural Hazards Center: Boulder, CO, USA, 2005.
36. Smith, G.P.; Wenger, D. Sustainable Disaster Recovery: Operationalizing an Existing Agenda. In *Handbook of Disaster Research*; Springer: New York, NY, USA, 2007; pp. 234–257.
37. Tierney, K. Disaster Governance: Social, Political, and Economic Dimensions. *Annu. Rev. Environ. Resour.* **2012**, *37*, 341–363. [CrossRef]
38. Penning-Rowsell, E.; Johnson, C.; Tunstall, S. "Signals" from Pre-Crisis Discourse: Lessons from UK Flooding for Global Environmental Policy Change? *Glob. Environ. Chang.* **2006**, *16*, 323–339. [CrossRef]
39. Manuel-Navarrete, D.; Pelling, M.; Redclift, M. Critical Adaptation to Hurricanes in the Mexican Caribbean: Development Visions, Governance Structures, and Coping Strategies. *Glob. Environ. Chang.* **2011**, *21*, 249–258. [CrossRef]
40. Westley, F.; Tjornbo, O.; Schultz, L. A Theory of Transformative Agency in Linked Social-Ecological Systems. *Ecol. Soc.* **2013**, *18*. [CrossRef]
41. Oliver-Smith, A. Anthropological Research on Hazards and Disasters. *Annu. Rev. Anthropol.* **1996**, *25*, 303–328. [CrossRef]
42. Olson, R.S.; Gawronski, V.T. From Disaster Event to Political Crisis: A "5C+A" Framework for Analysis. *Int. Stud. Perspect.* **2010**, *11*, 205–221. [CrossRef]
43. Lakoff, A. Disaster and the Politics of Intervention. In *Disaster and the Politics of Intervention*; Lakoff, A., Ed.; Columbia University Press: New York, NY, USA, 2010; pp. 3–13.
44. Paul, B.; Che, D. Opportunities and Challenges in Rebuilding Tornado-Impacted Greensburg, Kansas as "stronger, Better, and Greener". *GeoJournal* **2011**, *76*, 93–108. [CrossRef]
45. Solecki, W.D.; Michaels, S. Looking through the Postdisaster Policy Window. *Environ. Manag.* **1994**, *18*, 587–595. [CrossRef]
46. Kingdon, J. *Agendas, Alternatives, and Pulblic Policies*, updated 2nd ed.; HarperCollins College Publishers: New York City, NY, USA, 1995.
47. Kates, R.W.; Colten, C.E.; Laska, S.; Leatherman, S.P. Reconstruction of New Orleans after Hurricane Katrina. *Proc. Natl. Acad. Sci. USA* **2006**, *103*, 14653–14660. [CrossRef] [PubMed]
48. Passerini, E. Disasters as Agents of Social Change in Recovery and Reconstruction. *Nat. Hazards Rev.* **2000**, 67–72. [CrossRef]
49. Berke, P.R.; Campanella, T.J. Planning for Postdisaster Resiliency. *Ann. Am. Acad. Pol. Soc. Sci.* **2006**, *604*, 192–207. [CrossRef]
50. UNDP. *National Post-Disaster Recovery Planning and Coordination Empowered Lives. Resilient Nations. A Guidance Note*; UNDP: New York City, NY, USA, 2016.
51. Masten, A.S.; Obradovic, J. Disaster Preparation and Recovery: Lessons from Research on Resilience in Human Development. *Ecol. Soc.* **2008**, *13*, 9. [CrossRef]
52. Bonanno, G.A. Loss, Trauma, and Human Resilience. Have We Underestimated the Human Capacity to Thrive After Extremey Aversive Events? *Am. Psychol.* **2004**, *59*, 20–28. [CrossRef] [PubMed]
53. Solnit, R. Prelude: Falling Together. In *A Paradise Built in Hell: The Extraordinary Communities that Arise in Disaster*; Penguin Books: London, UK, 2009; pp. 1–10.
54. Fritz, C. *Disaster and Mental Health: Therapeutic Principles Drawn From Disaster Studies*; Historical and Comparative Disaster Series; University of Delaware Disaster Research Center: Newark, DE, USA, 1996.
55. O'Brien, K.; Sygna, L. Responding to Climate Change: The Three Spheres of Transformation. In Proceedings of the Transformation in a Changing Climate, Oslo, Norway, 19–21 June 2013; pp. 16–23.
56. Brundiers, K. Disasters as Opportunities for Change towards Sustainability. Ph.D. Dissertation, Arizona State University, Tempe, AZ, USA, 2016.
57. Brown, K.; Westaway, E. Agency, Capacity, and Resilience to Environmental Change: Lessons from Human Development, Well-Being, and Disasters. *Annu. Rev. Environ. Resour.* **2011**, *36*, 321–342. [CrossRef]
58. Fischer, L.B.; Newig, J. Importance of Actors and Agency in Sustainability Transitions: A Systematic Exploration of the Literature. *Sustainability* **2016**, *8*, 476. [CrossRef]
59. Turnheim, B.; Berkhout, F.; Geels, F.; Hof, A.; McMeekin, A.; Nykvist, B.; van Vuuren, D. Evaluating Sustainability Transitions Pathways: Bridging Analytical Approaches to Address Governance Challenges. *Glob. Environ. Chang.* **2015**, *35*, 239–253. [CrossRef]

60. Cote, M.; Nightingale, A.J. Resilience Thinking Meets Social Theory: Situating Social Change in Socio-Ecological Systems (SES) Research. *Prog. Hum. Geogr.* **2011**, *36*, 475–489. [CrossRef]
61. Shove, E.; Walker, G. Governing Transitions in the Sustainability of Everyday Life. *Res. Policy* **2010**, *39*, 471–476. [CrossRef]
62. Hesselbarth, C.; Schaltegger, S. Educating Change Agents for Sustainability—Learnings from the First Sustainability Management Master of Business Administration. *J. Clean. Prod.* **2014**, *62*, 24–36. [CrossRef]
63. Kahneman, D.; Krueger, A.B.; Schkade, D.A.; Schwarz, N.; Stone, A.A. A Survey Method for Characterizing Daily Life Experience: The Day Reconstruction Method. *Science* **2004**, *306*, 1776–1780. [CrossRef] [PubMed]
64. Forrest, N.; Wiek, A. Learning from success—Toward Evidence-Informed Sustainability Transitions in Communities. *Environ. Innov. Soc. Transit.* **2014**, *12*, 66–88. [CrossRef]
65. Awotona, A.; Donlan, M. Introduction. In *Rebuilding Sustainable Communities in Iraq: Policies, Programs and International Perspectives*; Awotona, A., Ed.; Cambridge Scholars Publishing: Newcastle upon Tyne, UK, 2008; pp. 3–38.
66. Giddens, A. *The Constitution of Society: Outline of the Theory of Structuration*; University of California Press: Berkley, UK; Los Angeles, CA, USA, 1984.
67. Brundiers, K. Disasters as Opportunities for Sustainability: The Case of Christchurch, Aotearoa New Zealand. *Sustain. Sci.* **2017**. [CrossRef]
68. Olshansky, R.B.; Johnson, L.A. Disaster and Recovery: Processes Compressed in Time. *Nat. Hazards Rev.* **2012**, *13*, 173–178. [CrossRef]
69. Ingram, J.C.; Franco, G.; Rio, C.R.; Khazai, B. Post-Disaster Recovery Dilemmas: Challenges in Balancing Short-Term and Long-Term Needs for Vulnerability Reduction. *Environ. Sci. Policy* **2006**, *9*, 607–613. [CrossRef]
70. Raju, E.; Niekerk, D. Van. Intra-Governmental Coordination for Sustainable Disaster Recovery: A Case-Study of the Eden District Municipality, South Africa. *Int. J. Disaster Risk Reduct.* **2013**, *4*, 92–99. [CrossRef]
71. Chandrasekhar, D.; Zhang, Y.; Xiao, Y. Non-Traditional Participation in Disaster Recovery Planning: Cases from China, India, and the U.S. *J. Am. Plan. Assoc.* **2014**, *80*, 373–384. [CrossRef]
72. Guarnacci, U. Governance for Sustainable Reconstruction after Disasters: Lessons from Nias, Indonesia. *Environ. Dev.* **2012**, *2*, 73–85. [CrossRef]
73. Simon, H. Alternative Visions of Rationality; Rational Processes in Social Affairs. In *Reason in Human Affairs*; Stanford University Press: Standford, CA, USA, 1983; pp. 3–35, 75–107.
74. Tschakert, P.; Dietrich, K.A. Anticipatory Learning for Climate Change Adaptation and Resilience. *Ecol. Soc.* **2010**, *15*, 11. [CrossRef]
75. Pahl-Wostl, C.; Becker, G.; Sendzimir, J.; Knieper, C. How Multi-Level Societal Learning Processes Facilitate Transformative Change: A Comparative Case Study Analysis on Flood Management. *Ecol. Soc.* **2013**, *18*, 58. [CrossRef]
76. Manyena, S.B.; O'Brien, G.; O'Keefe, P.; Rose, J. Disaster Resilience: A Bounce Back or Bounce Forward Ability? *Local Environ.* **2011**, *16*, 417–424.
77. Robert, B.G.; Hassan, S.; Holtz, S.; Tansey, J.; Whitelaw, G. *Sustainability Assessment: Criteria and Process*, 1st ed.; Earthscan: New York City, NY, USA, 2005.
78. Gibson, R.B. Sustainability Assessment: Basic Components of a Practical Approach. *Impact Assess. Proj. Apprais.* **2006**, *24*, 170–182. [CrossRef]
79. Rozdilsky, J. City as Sandbox for Green Building: The Greensburg Tornado Recovery. An Invited Comment. In *Natural Hazards Observer*; Natural Hazards Center: Boulder, CO, USA, 2012; pp. 7–10.
80. Bromberg, A. *Greensburg, Kansas: Rebuilding a Green Town*; Massachusetts Institute of Technology: Cambridge, MA, USA, 2009.
81. Watson, B. A Town Makes History by Rising to New Heights. *Smithsonian* **1996**, *Jun96*, 110–111.
82. Knobloch, D. *Valmeyer, Illinois—Operation Fresh Start: Using Sustainable Technologies To Recover From Disaster*; National Center for Appropriate Technolog: Butte, MT, USA, 2006.
83. Becker, W.S. *Rebuilding for the Future... A Guide to Sustainable Redevelopment for Disaster-Affected Communities*; United States Department of Energy (DOE): Washington, DC, USA, 1994.
84. Özerdem, A.; Rufini, G. L'Aquila's Reconstruction Challenges: Has Italy Learned from Its Previous Earthquake Disasters? *Disasters* **2013**, *37*, 119–143. [CrossRef] [PubMed]

85. Fois, F.; Forino, G. The Self-Built Ecovillage in L'Aquila, Italy: Community Resilience as a Grassroots Response to Environmental Shock. *Disasters* **2014**, *38*, 719–739. [CrossRef] [PubMed]
86. Micangeli, A.; Michelangeli, E.; Naso, V. Sustainability after the Thermal Energy Supply in Emergency Situations: The Case Study of Abruzzi Earthquake (Italy). *Sustainability* **2013**, *5*, 3513–3525. [CrossRef]
87. Dong, X. *Post-Disaster Recovery Planning and Sustainable Development—A Lesson from the Wenchuan Earthquake, China, 2008*; University of Illinois at Urbana-Champaign: Champaign, IL, USA, 2012.
88. Abramson, D.; Qi, Y. "Urban-Rural Integration" in the Earthquake Zone: Sichuan's Post-Disaster Reconstruction and the Expansion of the Chengdu Metropole. *Pac. Aff.* **2011**, *84*, 495–523. [CrossRef]
89. Frühling, P. *Turning Disasters into Opportunities. Swedish Contributions to Reconstruction & Transformation in Central America after Disaster Mitch*; SIDA: Stockholm, Sweden, 2002.
90. Epping-Jordan, J.E.; van Ommeren, M.; Ashour, H.N.; Maramis, A.; Marini, A.; Mohanraj, A.; Noori, A.; Rizwan, H.; Saeed, K.; Silove, D.; et al. Beyond the Crisis: Building Back Better Mental Health Care in 10 Emergency-Affected Areas Using a Longer-Term Perspective. *Int. J. Ment. Health Syst.* **2015**, *9*, 15. [CrossRef] [PubMed]
91. UNISDR. *Sendai Framework for Disaster Risk Reduction 2015–2030*; UNISDR: Sendai, Japan, 2015.
92. Lassa, J. Strategic Group Formation for Carbon Governance in Indonesia after the Indian Ocean Tsunami. *Int. J. Disaster Risk Sci.* **2010**, *1*, 28–39.
93. Love, R.; Vallance, S. The Role of Communities in Post-Disaster Recovery Planning: A Diamond Harbour Case Study. *Lincoln Plan. Rev.* **2013**, *5*, 3–9.
94. Christoplos, I. The Elusive "Window of Opportunity" for Risk Reduction in Post-Disaster Recovery. In Proceedings of the ProVention Consortium Forum, Bangkok, Thailand, 2–3 February 2006; pp. 2–5.
95. Vallance, S. Community, Resilience and Recovery: Building or Burning Bridges? *Lincoln Plan. Rev.* **2011**, *3*, 4–8.
96. Song, Y.; Li, C.; Olshansky, R.; Zhang, Y.; Xiao, Y. Are We Planning for Sustainable Disaster Recovery? Evaluating Recovery Plans after the Wenchuan Earthquake. *J. Environ. Plan. Manag.* **2017**, *60*, 2192–2216. [CrossRef]
97. Eakin, H.C.; Wehbe, M.B. Linking Local Vulnerability to System Sustainability in a Resilience Framework: Two Cases from Latin America. *Clim. Chang.* **2008**, *93*, 355–377. [CrossRef]