Interdisciplinary Theory, Methods, and Approaches for Hazards and Disaster Research:

An Introduction to the Special Issue

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ABSTRACT

What is interdisciplinary research? Why is it vital to the advancement of the field of hazards and disaster research? What theory, methods, and approaches are fundamental to interdisciplinary research projects and their applications? This article addresses these and other pressing questions by taking stock of recent advancements in interdisciplinary studies of hazards and disasters. It also introduces the special issue of *Risk Analysis,* which includes this introductory article and 25 original Perspectives papers meant to highlight new trends and applications in the field. The papers were written following two National Science Foundation-supported workshops that were organized in response to the growing interest in interdisciplinary hazards and disaster research, the increasing number of interdisciplinary funding opportunities and collaborations in the field, and the need for more rigorous guidance for interdisciplinary researchers and research teams. This introductory article and the special collection are organized around the cross-cutting themes of theory, methods, approaches, interdisciplinary research projects, and applications to advance interdisciplinarity in hazards and disaster research.

KEYWORDS

interdisciplinary research, hazards, disasters, methods, theory

200 CHARACTER SUMMARY

This article introduces a special issue on interdisciplinary theory, methods, and approaches for hazards and disaster research. It defines interdisciplinarity and underscores its importance for the field. Read more here:

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1. INTRODUCTION

Interdisciplinarity in hazards and disaster research is growing. Interdisciplinary research… has made major contributions to the field. Interdisciplinarity figures prominently in the research needs of the field. While unanswered disciplinary questions remain, all of the priority research needs identified by the committee involve multiple disciplines and are in part, if not fundamentally, interdisciplinary

(National Research Council, 2006, p. 212).

What is interdisciplinary research? Why is it so important to the advancement of the field of hazards and disaster research? What theory, methods, and approaches are fundamental to interdisciplinary research and its applications?

This special issue of *Risk Analysis* tackles these and other pressing questions with the publication of this introductory article and 25 original Perspectives papers focused on interdisciplinary theory, methods, approaches, and applications for hazards and disaster research. At least one of the authors of each of the papers participated in two National Science Foundation-supported workshops, which were held in Arlington, Virginia, in March of 2017 and Boulder,

Colorado, in February of 2018. The workshops were organized in response to the growing interest in interdisciplinary hazards and disaster research, the increasing number of interdisciplinary funding opportunities and collaborations in the field, and the need for more rigorous guidance for interdisciplinary researchers and research teams. More than 40 researchers with a wide range of interdisciplinary research experiences and different disciplinary backgrounds took part in the convenings. This collection represents the results of their intellectual contributions.

2. KEY DEFINITIONS

In this special issue, the term *disciplinarity* refers to a specific branch of learning or body of knowledge, such as anthropology, biology, or mathematics (Moran, 2010, p. 2). The defining elements of a discipline—objects and subjects of study, phenomena, assumptions, epistemology, concepts, theories, and methods—distinguish it from other knowledge formations (National Research Council, 2014, p. 45). According to Schulman (2002, p. vi-vii), disciplines have "contrasting substance and syntax" as well as different "ways of organizing themselves" and "talking about… the problems, topics, and issues that constitute their subject matters."

The central goal of this special issue is in understanding how researchers—who are still mostly trained in a single discipline—can move into the increasingly conceptually integrative spaces that are the hallmark of multidisciplinary, interdisciplinary, and transdisciplinary research (see Figure 1).

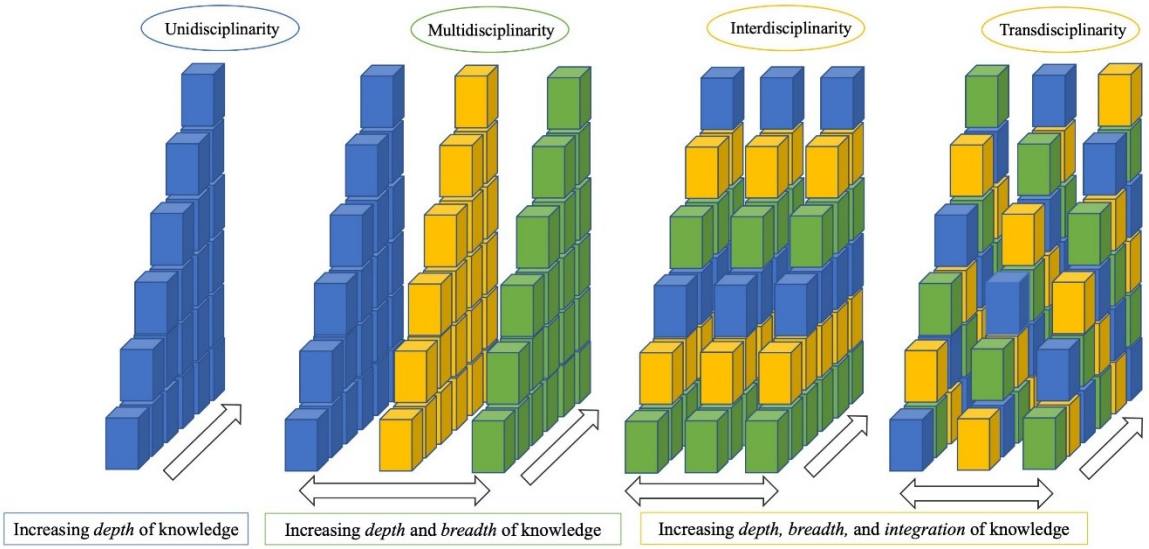

Fig. 1. Unidisciplinarity to Transdisciplinarity—A Representation of Increasing Depth, Breadth, and Integration of Knowledge (adapted from Peek et al., 2020b, p. 7)

While the primary focus of this special issue is on interdisciplinarity, we draw on the National Research Council's (2014, p. 45-46) definitions and synthetic typology to distinguish the following modes of research activity and degrees of interaction within or across disciplines:

- *Unidisciplinarity:* Researchers from a single discipline, field, or area of established research and education work alone or collaboratively to study an object or to address a common question, problem, topic, or theme. *Example:* A group of hydraulic engineers studying the physics of flooding in a community at risk of hurricane surge.

- *Multidisciplinarity:* Juxtaposes two or more disciplines focused on a question, problem, topic, or theme. The juxtaposition fosters an array of information, knowledge, and methods,

but disciplines remain separate. The existing structure of knowledge is not questioned. *Example:* A group of hydraulic engineers working together with a group of economists to study the costs and benefits of different approaches for flood risk management in a community at risk of hurricane surge. The engineers and economists would keep their work solidly within their traditional disciplinary approaches, but leverage data and information from the other group.

- *Interdisciplinarity:* Integrates information, data, methods, tools, concepts, and/or theories from two or more disciplines focused on a complex question, problem, topic, or theme. The key defining concept of interdisciplinarity is integration, a blending of diverse inputs that differs from and is more than the sum of the parts. *Example:* A group of hydraulic engineers, economists, urban planners, and sociologists working together to test codeveloped research hypotheses about hurricane surge and flood mitigation approaches. The team would draw on multiple, integrated data sources generated through the lens of interdisciplinary theory and use of interdisciplinary methods.
- *Transdisciplinarity:* Transcends disciplinary approaches using more comprehensive frameworks, including synthetic paradigms. The construct goes beyond interdisciplinary combinations of existing approaches and fosters new worldviews or domains. Transdisciplinarity often involves stakeholders from academia, public and private sectors, and/or nonprofit organizations. *Example:* A stakeholder-driven research team that spans many disciplines working together to define a new paradigm for assessing and managing coastal flood risk in hurricane-prone areas.

The above definitions are helpful when considering disciplinarity in the context of both the *composition of the research team* and the *mode of investigation.* A unidisciplinary team might include only sociologists, and therefore would draw on traditional sociological theories and methods to test a hypothesis or answer a research question. A multidisciplinary team involves researchers from two or more disciplinary backgrounds, but their modes of investigation remain separate and additive rather than integrative. An interdisciplinary team also involves researchers from two or more disciplines or from explicitly interdisciplinary fields, but true interdisciplinarity goes beyond bringing together different disciplines "to create one product… characterized by the synthesis of research ideas and methods" (National Research Council, 2006, p. 182). Such interdisciplinary work ties principles from multiple disciplines together cohesively, creating a whole that is more than the sum of the parts (Davidson, 2015; National Research Council, 2014). A transdisciplinary team is even more comprehensive in scope and vision and may have evolved into an entirely new realm of investigation that transcends all prior disciplinary confines (Klein, 1990; National Research Council, 2006).

3. THE IMPORTANCE OF INTERDISCIPLINARY HAZARDS AND DISASTER RESEARCH

Disasters unfold on different geographic and temporal scales and occur at the intersection of natural and built environments and social and technical systems. Hazards and disaster research, accordingly, has long engaged researchers in traditional disciplines within the natural sciences, engineering, and social sciences, among others. In addition, various explicitly interdisciplinary fields, such as risk analysis, public administration, public health, and urban planning, have made substantial contributions by further bridging academic, policy, and practice divides (see Figure 2).

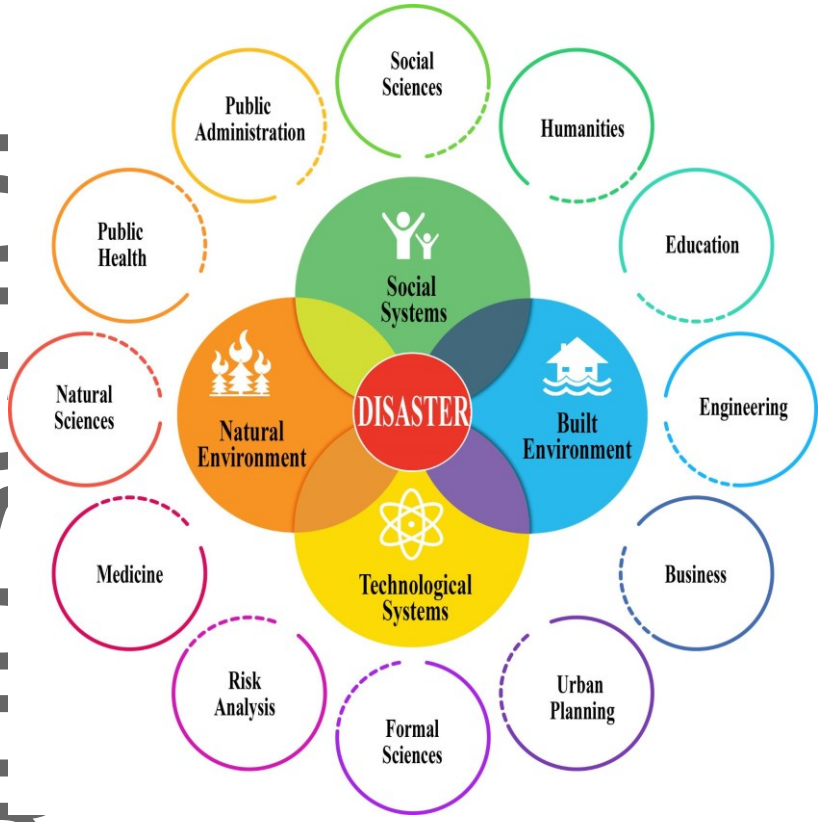

Fig. 2. Disciplines and Disciplinary Domains Involved in Hazards and Disaster Research

Hazards and disaster researchers have made important contributions both *within* and *across* disciplines. While numerous highly influential studies have been carried out by sole investigators or small teams that represent a single discipline, the hazards and disaster field is especially noteworthy for its long history of multidisciplinary and increasingly interdisciplinary research. Consider, for example, that many of the foundational social science disaster studies in the late 1940s and 1950s were conducted by teams of sociologists, psychologists, political scientists, and anthropologists (Quarantelli, 1987). Similarly, some of the first systematic post-earthquake reconnaissance missions in the 1960s involved civil and structural engineers studying alongside geologists and seismologists

(Spence, 2014). Beginning in the 1970s, scholars started working across even more expansive disciplinary divides in engineering and the social sciences to understand disasters holistically (Kendra & Nigg, 2014). In the United States, the first national assessment of research on natural hazards was co-led by a geographer and a sociologist and supplemented by "insights and methods of climatologists, economists, engineers, lawyers, meteorologists, and social psychologists" (White & Haas, 1975, p. xviii). The second national assessment involved even more researchers and disciplines, drawing together more than 130 of the nation's leading hazards and disaster experts (Mileti, 1999).

Most scholars in the hazards and disaster field do not obey rigid disciplinary boundaries. There are several explanations for why this is the case, including the fact that disasters serve as a forcing function—dramatically revealing the deep interconnections between a myriad of systems and environments and thus drawing in researchers with widely varied types of expertise. The time dimension associated with post-disaster research has also led researchers from different institutions and disciplines to rapidly form teams to collect perishable or ephemeral data (Wartman et al., 2020). This process has been encouraged and sometimes required by funding agencies as well as organizations that support such research, including, for example, the Earthquake Engineering Research Institute's Learning from Earthquakes program and the Natural Hazards Center's Quick Response Research program (Oulahen et al., 2020).

Even in the case of less time-sensitive research, the nature of the questions that hazards and disaster researchers ask and the complicated real-world problems they address has led to "a good deal of borrowing and synthesis across disciplines" (Tierney, 2019, p. 39). Indeed, most of the grand challenges of our time have cross-cutting moral, ethical, political, economic, social, environmental,

and technical dimensions that require researchers searching for solutions to traverse disciplinary boundaries (Peek et al., 2020b).

Interdisciplinary research holds much promise, but its full potential often goes unrealized. Barriers to interdisciplinarity, which have been well-described (National Academy of Sciences et al., 2005; National Research Council, 2006), occur at the micro-, meso-, and macro-levels. *Micro-level barriers* involve the researchers themselves and might include issues related to indifference, negative attitudes, or even overt hostilities toward interdisciplinarity; harmful power differentials associated with the race, class, gender, age, and educational backgrounds of investigators; communication breakdowns emerging from disciplinary-specific terminologies, frameworks, and approaches; a lack of cultural competence; or the devaluing of individual contributions within the context of a team (National Research Council, 2006; Reich & Reich, 2006). *Meso-level barriers* encompass the organizational or institutional level and are associated with the lack of structures, systems, and incentives to train, mentor, support, and retain researchers with interdisciplinary aspirations. Organizations that do not offer holistic educational programs for students and lack flexible structures for faculty development and promotion are particularly problematic places for seeding and growing interdisciplinary efforts (Davidson, 2015; National Academy of Sciences et al., 2005). *Macro-level barriers* tend to emerge from the lack of funding for interdisciplinary research from the public and private sectors, as well as deeply ingrained cultural and historical differences among disciplines. These differences translate into challenges with the peer-review process and amplify dissimilarities in publishing norms that affect the entire production of scientific knowledge and the role of interdisciplinarity in it (Holbrook, 2010; National Research Council, 2014).

Interdisciplinarity is intellectually challenging as well, as it requires researchers to synthesize epistemological stances (*ways of knowing*), theoretical perspectives (*ways of seeing*), and methodological contributions (*ways of doing*). As White and Haas (1975, p. xviii) observed decades ago in reflecting on the compilation of the first assessment of natural hazards, "It was far easier to bring together the methods of a variety of disciplines than to integrate them." This helps explain why, despite advances in interdisciplinary research, so much work remains insufficiently integrated and is therefore dominated by one discipline within a larger interdisciplinary team (Miller et al., 2008). Kendra and Nigg (2014, p. 2) argue that such efforts "cannot truly be considered interdisciplinary unless they are initially conceptualized as such because the research process must be phased (using the outcomes of one part of the process to feed into other parts), and time must be allowed for the conclusions of such an effort to truly reflect the integration of various factors—technical, social, and economic—that will affect any preparedness or mitigation efforts that are recommended."

There has perhaps been more focus in the hazards and disaster field on encouraging the formation of *multidisciplinary research teams* than on understanding the processes and enabling conditions that would allow those teams to move into more deeply integrative *interdisciplinary research spaces*. This special issue is dedicated to filling this gap by systematically documenting the purposes, pitfalls, and possibilities associated with interdisciplinary hazards and disaster research.

4. THE SPECIAL ISSUE: THEMES AND CONTRIBUTIONS

This special issue speaks to multiple topics of enduring and emerging interest in the science and practice of interdisciplinary research. Accordingly, we grouped the articles into five thematic areas: (1) Theory; (2) Methods; (3) Approaches; (4) Interdisciplinary Research Projects; and (5)

Applications. While these themes provide an organizational framework for the collection, they are certainly not mutually exclusive. Rather, they are meant to be broad and cross-cutting, since many of the articles touch on multiple themes. All are rooted in the hazards and disaster literature and are dedicated to advancing interdisciplinarity in the field.

4.1 THEORY

Theory provides a lens for viewing various problems and concerns, guides research questions, influences methodologies, establishes frameworks for research, and helps inform policy and practice (Jensen, 2010). Theory is integral to the entire research process, and the large number of disciplines involved in hazards and disaster research has encouraged the cross-disciplinary fertilization of ideas and perspectives (Peek et al., 2020a, 2020b). As Tierney (2007, 2019) has argued, however, the field has been limited in terms of its broader theoretical contributions. This is due, in part, to the event-driven nature of disaster research. Researchers tend to study specific disasters and social settings, with limited systematic, comparative research that could lead to stronger generalizations across hazard types, units of analysis, and geographic locations (Sherman-Morris, 2013; Tierney 2019). In addition, widely varying disciplinary assumptions and conflicting definitions of core concepts have also been major impediments to the advancement of interdisciplinary theory (Drabek, 1986). Devising theories drawn from several disciplines has made interdisciplinary integration difficult and has led to theoretical fragmentation in the field (Ingham et al., 2012). The four articles included in the first section of the special issue address these longstanding barriers and offer novel approaches to interdisciplinary theory development (see Table 1).

Table 1. Special Issue Section 1 – Theory

Article Title	Author(s)	Brief Overview
Theoretical matters: On the need for hazard and disaster theory developed through interdisciplinary research and collaboration	Kathleen Sherman-Morris, J. Brian Houston, and Jishnu Subedi	This article offers a systematic review of the challenges that have limited the development of hazards and disaster theory, while making the case for meaningful interdisciplinary theory development. The authors explore what is required to develop and test broad-scale interdisciplinary hazard and disaster theory that can bridge the divides between different disciplinary approaches and perspectives.
An approach for guiding the development and assessing the interdisciplinarity of new methodologies for community disaster resilience	Elaina J. Sutley	The article describes a four-step framework with a feedback loop for incorporating insights from social science into structural engineering for integrative interdisciplinary research. This framework involves: (1) identifying the research problem or topic and the appropriate team; (2) mapping out disciplinary interactions; (3) using the mapped interactions to drive a new interdisciplinary methodological approach; and (4) assessing the levels of integration and updating the interdisciplinary approach accordingly.
Interdisciplinary research as an iterative process to build disaster systems knowledge	Jishnu Subedi, J. Brian Houston, and Kathleen Sherman-Morris	Knowledge generated from a single discipline is not sufficient to understand the multiple systems involved in hazards and disasters. The authors therefore take the position that a comprehensive view of disaster is best achieved through collaborative work that involves multiple disciplines. They offer an iterative disaster systems knowledge framework that can help researchers better understand and articulate the reciprocal influences of built, natural, and human environmental factors that both shape and are shaped by disasters. With each successive cycle through the framework, interdisciplinary teams can deepen their knowledge within and across disciplinary boundaries.
Toward convergence disaster research: Building integrative theories using	Ali Mostafavi and N. Emel Ganapati	While simulation methods have been used to build theory in a range of recent studies, their full potential has yet to be realized in the context of convergence disaster research—here defined as research that is

simulation		interdisciplinary, problem-focused, and solutions-oriented. This article articulates four opportunities to use simulations to enrich convergence disaster research. Specifically, simulation methods could help researchers to model underlying mechanisms of disasters, specify and characterize the mechanisms, enable multilevel understanding of relationships and behaviors, and integrate theoretical elements across different disciplines.

4.2 METHODS

Although research methods are integral to the study of hazards and disasters, there are only a limited number of comprehensive textbooks and special journal issues dedicated solely to the topic (Frailing and Van Brown, 2020; Institute of Medicine, 2015; Norris et al., 2006, Phillips, 2014; Rivera, 2021; Stallings, 2002). These publications offer careful consideration of different disciplinary approaches to research—especially in the social and behavioral sciences and public health. But the available hazards and disaster literature dedicates scant attention to the methodological concerns and challenges specifically associated with interdisciplinarity. These difficulties often surface at the study design phase in interdisciplinary collaborations. According to Lach (2014, p. 88): "Obvious disciplinary differences… quickly emerge when it comes time to determine a methodological approach: questions to ask; appropriate methods for collecting data; what actually constitutes data; applicable analytic tools; what evidence looks like."

At present, there is no systematic inventory of interdisciplinary methods for hazards and disaster research. In fact, there is a dearth of available literature that clearly defines what constitutes an interdisciplinary method for the field. The six articles in this second section of the

special issue begin to fill that void by describing and advancing explicitly interdisciplinary methodologies (see Table 2).

Table 2. Special Issue Section 2 – Methods

Article Title	Author(s)	Brief Overview
Agent-based models as an integrating boundary object for interdisciplinary research	Allison C. Reilly, Robin L. Dillon, and Seth D. Guikema	This article makes the case for a central modeling framework—or boundary object—to enhance communication among researchers from diverse disciplinary backgrounds to further interdisciplinary integration. The authors describe four requirements for boundary objects that were developed through their use of agent-based models in interdisciplinary projects. The requirements for the boundary object include that it must: (1) be flexible but grounded in theory; (2) allow for inclusion of stochasticity and relevant antecedent events; (3) allow for both qualitative and quantitative information; and (4) allow for temporal dynamics.
Reflective listening visualization: Enhancing interdisciplinary disaster research through the use of visualization techniques	JoAnne DeRouen and Kari Smith	This article introduces a new method for interdisciplinary disaster research that combines contributions from sociology, architecture, and urban planning. Reflective listening visualization refers to an iterative process of conducting in-depth interviews, performing thematic analysis, using emergent themes as the basis for designing visual representations of the interview, and then presenting the representations to the interviewees to confirm, refine, or re-create the visualization. The authors conclude that this method is useful for conveying complex interview and graphical information to study participants. Moreover, these visualizations can help improve communication between researchers from different disciplines, thus moving multidisciplinary teams closer to true interdisciplinary integration.
Potential of citizen science for enhancing	Nasir Gharaibeh, Isaac Oti, Michelle	Citizen science projects involve volunteers in data collection efforts and other scientific activities. This

infrastructure monitoring data and decision-support models for local communities	Meyer, Marccus Hendricks, and Shannon Van Zandt	article describes a particular set of citizen science projects focused on collecting infrastructure data in flood-prone communities in Texas. These projects are coordinated by interdisciplinary teams of engineers and social scientists and culminated in an expanded interdisciplinary definition of infrastructure data quality that extends beyond accuracy to also include currency, timeliness, completeness, and equity. The authors demonstrate that interdisciplinary citizen science projects can result in more robust decision support models for socially marginalized communities at risk of natural hazards.
Integrative interdisciplinary approaches to critical infrastructure interdependency analysis	Diana Mitsova	This article offers an overview of various tools and methods that can foster more robust interdisciplinary research in infrastructure interdependency analysis. Specifically, the article identifies three promising methodologies that bridge engineering, the social sciences, geospatial technologies, and computer science. These include approaches to integrate engineering models with social science research, simulation models to encourage participatory community engagement and social learning, and interactive simulations to improve situational awareness, decision-making, and response capabilities in disasters.
A decision-centered method to evaluate natural hazards decision aids by interdisciplinary research teams	Gabrielle Wong-Parodi and Mitchell J. Small	Decision aids, which are often developed by interdisciplinary teams, are designed to help people make informed decisions about the natural hazard threats they face. Most available decision aids to date, however, have gone unevaluated and it is therefore unclear if they work in the ways that scientists intend. This article helps to fill this knowledge gap using the presentation of a decision-centered method for evaluating the impact of hazards decision aids on decision maker preferences and choice. The authors illustrate how this framework can inform the content, complexity, format, and overall evaluation process by applying the method to a decision aid meant to help

		users address storm surge and coastal flooding.
The frontiers of uncertainty estimation and communication in interdisciplinary disaster research and practice	Roshanak Nateghi, Jeannette Sutton, and Pamela Murray-Tuite	Characterizing and clearly communicating the uncertainties involved in interdisciplinary disaster research is imperative since misrepresenting uncertainty can lead to myopic decisions and harmful societal outcomes. Despite its importance, uncertainty assessment remains understudied. This article aims to advance scholarship in this area through the consideration of several key concepts related to uncertainty assessment for interdisciplinary disaster research methods. The authors explore the specific challenges associated with the lack of focus on Type III and Type IV errors in research; the difficulties with meaningfully aggregating various types of information; the pathologies inherent in frequentist statistical models that are often used in interdisciplinary research; and the complexity of communicating uncertainty to the public.

4.3 APPROACHES

How is interdisciplinary hazards and disaster research actually *done*? The eight articles in the third section of the special issue address this question by drawing on insights from their own collaborative research projects, the Science of Team Science literature, and other scholarship concerned with creating and sustaining interdisciplinary teams (see Table 3). The articles in this section provide concrete guidance for how researchers, research team leaders, institutions, and funding agencies can best cultivate and support interdisciplinary research projects. The recommendations included in these articles can improve the experiences of researchers in interdisciplinary teams and amplify the impact of interdisciplinary research.

Table 3. Special Issue Section 3 – Approaches

Article Title	Author(s)	Brief Overview
Cultivating metacognition in each of us: Thinking about "thinking" in interdisciplinary disaster research	N. Emel Ganapati and Ali Mostafavi	This article introduces *metacognition*—or thinking about our thinking—as a tool for researchers and institutions to use to promote and advance interdisciplinary research on risk, hazards, and disasters. The authors define what metacognition is and illustrate how it can advance interdisciplinarity by (1) overcoming disciplinary barriers to reveal cognitive abilities and inabilities for each team member; (2) dealing with wicked problems that characterize disaster contexts; (3) overseeing team functioning; and (4) monitoring and evaluating progress in meeting project goals and objectives. The authors offer several examples of the benefits of metacognition for individual researchers as well as research teams. They also describe how institutions and funding agencies can systematically support the integration of metacognition practices.
Building an interdisciplinary team for disaster response research: A data-driven approach	Yue "Gurt" Ge, Christopher W. Zobel, Pamela Murray-Tuite, Roshanak Nateghi, and Haizhong Wang	This article introduces a typology to describe the ways that disaster research teams are typically formed. The first approach focuses on teams that are rapidly mobilized in the aftermath of disaster. These teams tend to be multidisciplinary, ad hoc, and grant driven. The second approach involves research center- or institute-based teams that strive toward interdisciplinarity and focus on big research questions, longer-term partnerships, and innovation. The third approach is also interdisciplinary and is oriented toward matching research expertise to broader, longstanding research issues. The authors also advocate for a fourth data-driven approach to interdisciplinary team formation, one that could lead to the development of an integrated research protocol for the field.
The "inter" within interdisciplinary research: Strategies	Rebecca E. Morss, Heather Lazrus, and	Researchers, institutions, and funding agencies report a lack of guidance for systematically implementing interdisciplinarity throughout the research lifecycle.

for building integration across fields	Julie L. Demuth	This article works to address this gap by focusing on how to encourage integration in the context of interdisciplinary teams. Specifically, it provides a framework for guiding interdisciplinary projects and programs to achieve their full potential. Examples of practices that can help to sustain integration include regularly sharing and discussing ideas, investing time and effort in listening and synthesizing, engaging different areas of expertise interactively, translating emerging integrative ideas into text and visuals, exhibiting a strong commitment to and respect for interdisciplinarity, and being patient and persistent. The authors also inventory some of the signs of successful interdisciplinary integration, which can help teams to monitor and improve their processes and approaches to interdisciplinarity.
A sharing meanings approach for interdisciplinary hazards research	R. Dean Hardy	Drawing on key insights from studies of interdisciplinary research, this article proposes a sharing meanings approach for improving collaboration in hazards and disaster research. This approach emphasizes the process of sharing about worldviews, language, research design, and project goals. The interactive process itself, which is designed to encourage researchers to carefully articulate implicit meanings, is more important than developing a single, universal set of shared meanings among interdisciplinary team members. By engaging in the sharing meanings approach, interdisciplinary teams can overcome many of the common barriers to achieving depth and breadth in integration.
Expertise across disciplines: Establishing common ground in interdisciplinary disaster research teams	Jonathan Gilligan	Researchers are often selected for or join interdisciplinary teams based on their contributory expertise, or their ability to make original contributions to a discipline. However, as this article argues, interactional expertise, or the ability to understand other disciplinary foundations and communicate effectively with contributory experts and practitioners in those disciplines, is also crucial to advancing

		interdisciplinarity. Interactional expertise requires a foundation of trust and practice in effective group communication that attends to the technical vocabulary and jargon of a discipline, verbal and graphical analogies, and the use of dialect and metaphor to express ideas.
Stories for interdisciplinary disaster research collaboration	Mithra Moezzi and Lori Peek	Experience stories are stories that researchers and practitioners tell about something that happened during the research process, generally combining descriptive observation, some level of interpretation, and embellishment. Although these types of stories often do not make their way into formal published research accounts, telling experience stories can provide a common ground that helps research teams overcome disciplinary boundaries and span scholarly domains. This article provides practical recommendations for how experience stories can be used as tools to advance interdisciplinary hazards and disaster research.
Evaluating collaborative readiness for interdisciplinary flood research	Eric Tate, Valerie Decker, and Craig Just	This article offers a two-pronged approach to enhance team readiness for interdisciplinary flood research. First, the authors propose using four proximity dimensions to assess the potential for knowledge integration in interdisciplinary research. These include spatial proximity, cognitive proximity, social proximity, and institutional proximity. Second, they advocate for the use of program evaluation to assess change in these four dimensions over time. Integrating team readiness assessment into interdisciplinary hazards research can increase the potential for innovative and societally relevant knowledge production.
Trends in multidisciplinary hazard and disaster research: A 1982–2017 case study	Adam Behrendt, Kathryn Lukasiewicz, Daniel Seaberg, and Jun Zhuang	This article assesses trends in funding patterns, multidisciplinary team formation, and hazards and disaster-focused studies between 1982 and 2017. The authors analyze 539 awards, totaling approximately $450 million, supported through three relevant National Science Foundation programs. The authors identified a positive correlation between award

		funding and increasingly larger multidisciplinary teams, although teams of four or more principal/co-principal investigators account for only about 18% of all awards in the data set. There was also a shift over time toward teams that involve equal numbers of engineers and social scientists, although many teams remain fairly homogenous in terms of the disciplinary backgrounds of the investigators. This article concludes with recommendations for future studies in light of the growing number of funding agencies that support multidisciplinary and interdisciplinary hazards and disaster research.

4.4 INTERDISCIPLINARY RESEARCH PROJECTS

This fourth section of the special issue includes four articles that describe lessons learned from interdisciplinary research projects. These projects focus on community disaster resilience, building functionality, human-centered interdisciplinary research, and post-disaster school recovery. In each article, the authors include insights about interdisciplinary research coordination, problem formation, pre-event planning and coordination, and data synthesis. Each case study sheds light on the possibilities of interdisciplinary hazards and disaster research when attention is paid to team processes as well as the desired end product.

Table 4. Special Issue Section 4 – Interdisciplinary Research Projects

Article Title	Author(s)	Brief Overview
Getting interdisciplinary teams into the field: Institutional Review Board pre-approval	Lori Peek, Jennifer Tobin, John van de Lindt, and Anne Andrews	Research involving human subjects requires Institutional Review Board (IRB) approval. Receiving such approval in the immediate aftermath of disaster can be complicated and time consuming, especially when multiple institutions are involved in a

and multi-institution authorization agreements for rapid response disaster research		collaborative research effort. This article presents a case study that shows how researchers from different disciplines and institutions can come together before a disaster to develop plans, procedures, and pre-approved IRB protocols. The case study presented in this article illustrates the importance of having one institution serve as the IRB of record and demonstrates how an IRB Authorization Agreement (IAA) can foster more effective collaboration between academic and federal government researchers. The ultimate goal of this pre-disaster research preparation is to ensure that post-disaster interdisciplinary fieldwork is timely, ethical, and scientifically rigorous.
Interdisciplinary approach to building functionality for weather hazards	Amy A. Kim and Dorothy A. Reed	This article proposes a human-centric design approach to building functionality. Functionality is defined here as entailing a set of essential services—such as lighting, heating and cooling, ventilation, water supply, and wastewater management—that meet occupant needs for safety and well-being. The authors argue that to meet these occupant needs, it is crucial that social scientists, architects, and engineers work more closely together in a bottom-up, interdisciplinary fashion to promote iterative and holistic building design processes.
Critical time, space, and decision-making agent considerations in human-centered interdisciplinary hurricane-related research	Pamela Murray-Tuite, Yue "Gurt" Ge, Christopher W. Zobel, Roshanak Nateghi, and Haizhong Wang	The authors of this article take the position that when undertaking a new interdisciplinary effort involving protective or mitigation actions, the problem statement should be formulated around an agreed-upon decision-making agent, geographic scale, and temporal resolution. To achieve this goal, they present a data-driven approach that engages multiple disciplines and aligns various factors to advance human-centered interdisciplinary disaster research. To illustrate the proposed framework, the authors focus on hurricane evacuation behavior and the distinct but complementary contributions of socio-behavioral science, transportation engineering, power systems engineering, and decision support systems.

Interdisciplinary approaches to examining postdisaster school recovery	Ann-Margaret Esnard and Betty Lai	Postdisaster school recovery is multi-faceted, complex, and occupies a space that is not dominated by any one discipline. This article offers a novel interdisciplinary conceptualization of school recovery, here defined as an operational state that enables the delivery of curriculum and services to children, families, and communities. The authors describe their project on school recovery following Hurricane Ike and use their experience to provide insight on the possibilities associated with integrating concepts, methods, and data. This work advances interdisciplinary school recovery research in the areas of integrative problem formulation and synthesis by providing a roadmap for exploring the recovery domains of child trauma, learning outcomes, school safety, and household and community recovery.

4.5 APPLICATIONS

From its inception, the field of hazards and disaster research has been unapologetically applied. In fact, the earliest field research teams were funded to answer urgent questions of great practical and societal importance (Quarantelli, 1987; Spence, 2014). Do people panic in a disaster? Why do buildings collapse? Will disaster-affected communities devolve into chaos or exhibit high levels of cooperation and social solidarity? As disaster researchers sought to answer these types of questions, they often worked in tandem with emergency management personnel and other practitioners. These cross-organizational partnerships have long helped to ensure the practical and policy relevance of hazards and disaster research.

Over time, the questions that researchers asked, the methods they used, and the teams they formed have evolved in terms of their scope and complexity. These shifts toward larger multidisciplinary and interdisciplinary teams opened up new opportunities for knowledge

production and created additional challenges for collaborations among researchers, practitioners, and policymakers. The three papers in the final section of this special issue focus on how to overcome these barriers to ensure the operationalization and application of policy-relevant interdisciplinary hazards and disaster research (see Table 5).

Table 5. Special Issue Section 5 – Applications

Article Title	Author(s)	Brief Overview
Lost in translation? integrating interdisciplinary disaster research with policy praxis	Alka Sapat	Limited scholarly attention has been paid to exploring the difficulties of integrating policy and practitioner perspectives into interdisciplinary disaster research. This article argues that to effectively incorporate policy-relevant goals into interdisciplinary projects, researchers need to recognize the many impediments that diverse practitioners face based on their institutional roles and organizational positionality. The article concludes with a series of people-based approaches and process-based recommendations for encouraging research, practice, and policy integration in interdisciplinary disaster research.
Integrated risk assessment and management methods are necessary for effective implementation of natural hazards policy	David R. Johnson	This article presents a case study of the Louisiana coastal master planning process. It describes how embedding policy makers in an interdisciplinary risk assessment process through the use of a participatory scoping exercise generated greater buy-in for the methods being used. This integration required continuous, intensive stakeholder engagement throughout the planning process. The time dedicated resulted in the actual co-production of knowledge and promoted acceptance of a wider range of policy alternatives—options that, without the collaboration, might have otherwise gone unconsidered. This case study offers numerous lessons for adopting interdisciplinary decision frameworks under conditions

		of deep uncertainty.
Addressing challenges to building resilience through interdisciplinary research and engagement	Philip Berke, Steven M. Quiring, Francisco Olivera, and Jennifer A. Horney	Proactive planning can anticipate, accommodate, and influence growth in response to increasing threats, providing an opportunity to minimize future risks by implementing an integrated network of plans and policies. This article asserts that successfully building adaptive capacity to combined stressors through proactive planning requires a balanced approach that includes interdisciplinary research and community engagement. Such an approach can address challenges and enhance the planning process by: (1) improving the characterization of hazards to which the community is exposed; (2) deepening the understanding of the vulnerability of natural, engineered, and social systems subject to hazards; and (3) capturing the potential synergies from interactions between plans and policies that govern the decisions leading to current and future hazard risk exposure. This article illustrates each of these points by presenting a case study of a collaborative effort designed to build resilience across the U.S. Gulf Coast.

5. CONCLUSION

When viewed as a whole, this special collection represents the most comprehensive currently available guidance for advancing interdisciplinary hazards and disaster research. The articles in this special collection offer clear definitions for what is—and is not—interdisciplinary research. They acknowledge the barriers inherent in this form of integrative and collaborative research, while sharing keen insights for improving the research process. The articles contribute new theoretical frameworks, innovative research methods, and empirically-grounded approaches to enhancing interdisciplinarity. The authors also describe compelling case studies involving numerous disciplines that are focused on a range of geographic settings and hazard types. As has always been a

hallmark of our field, the articles include practical guidance to ensure that interdisciplinary projects can influence practice and policy to ultimately reduce disaster risk.

Each article in this special issue makes a significant contribution in its own right. In the end, and as with all good interdisciplinary research, the sum of these articles is truly greater than the distinct parts. It has been an honor to work with these talented authors and to see these publications come to fruition. We hope that you find this collection helpful and that future work will continue to build on the contributions offered here.

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