Crisis Informatics: Human-Centered Research on Tech & Crises

Leysia Palen, Jennings Anderson, Melissa Bica, Carlos Castillos, John Crowley, Paloma Díaz, Megan Finn, Rob Grace, Amanda Hughes, Muhammad Imran, et al.

Crisis Informatics:
Human-Centered Research on Tech & Crises

A Guided Bibliography Developed by Crisis Informatics Researchers

Share using: *https://tinyurl.com/crisisinformatics*

First Released: May 26, 2020
Last Updated: May 29, 2020

ABOUT. This resource was created to support researchers who might be newly conducting crisis informatics research in light of the pandemic of 2020. It also might support creation of new course syllabi on related topics.

It has been produced by members of the crisis informatics research community in May 2020 to consolidate and organize the literature on informatics of disaster mitigation, warning, response, and recovery. This guided bibliography is a living resource, and will continue to be updated.

INSTRUCTIONS FOR NEW CONTRIBUTIONS. If you are a crisis informatics researcher and would like to contribute to this document, please add that research here as an initial step so that it can then be incorporated into the resource. If you have additional questions, please contact palen@colorado.edu as the corresponding contributor, or one of the other contributors.

CONTRIBUTORS		
Leysia Palen	University of Colorado Boulder	palen@colorado.edu ***(corresponding)***
Jennings Anderson	University of Colorado Boulder	Jennings.Anderson@colorado.edu
Melissa Bica	University of Colorado Boulder	melissa.bica@colorado.edu
Carlos Castillo	Universitat Pompeu Fabra	chato@acm.org
John Crowley	Future State	john@jcrowley.net
Paloma Díaz Pérez	Universidad Carlos III de Madrid	pdp@inf.uc3m.es
Megan Finn	University of Washington	megfinn@uw.edu
Rob Grace	Texas Tech University	rob.grace@ttu.edu
Amanda Hughes	Brigham Young University	amanda_hughes@byu.edu
Muhammad Imran	Qatar Computing Research Institute	mimran@hbku.edu.qa
Marina Kogan	University of Utah	kogan@cs.utah.edu
Nicolas LaLone	University of Nebraska at Omaha	nlalone@unomaha.edu
Prasenjit Mitra	The Pennsylvania State University	pmitra@psu.edu
Wendy Norris	University of Colorado Boulder	wendy.norris@colorado.edu
Katie Pine	Arizona State University	khpine@asu.edu
Hemant Purohit	George Mason University	hpurohit@gmu.edu

Christian Reuter	Technical University of Darmstadt	reuter@peasec.tu-darmstadt.de
Caroline Rizza	I3 Telecom Paris (UMR 9217 CNRS)	caroline.rizza@telecom-paris.fr
Lise St Denis	University of Colorado Boulder	Lise.St.Denis@colorado.edu
Bryan Semaan	Syracuse University	bsemaan@syr.edu
Valerie Shalin	Wright State University	valerie.shalin@wright.edu
Lea Shanley	University of Wisconsin-Madison	lshanley@wisc.edu
Patrick C. Shih	Indiana University Bloomington	patshih@indiana.edu
Robert Soden	Columbia University	rjs2236@columbia.edu
Kate Starbird	University of Washington	kstarbi@uw.edu
Keri K. Stephens	University of Texas at Austin	keristephens@austin.utexas.edu
Z O. Toups	New Mexico State University	z@cs.nmsu.edu
Tom Wilson	University of Washington	tomwi@uw.edu

CONTENTS

I. OVERVIEW ARTICLES OF DIGITAL DISASTER ISSUES

> "Concerned with the ways in which information systems are entangled with socio-behavioral phenomena connected to disasters, [the field of] crisis informatics offers a rich set of research methods and empirical opportunities for examining the consequences of the role of technology in mediating our relations with the world." (Soden and Palen 2018)

Crisis informatics examines how networked digital technology—particularly the social media-featured technologies of the 2000s and beyond—interacts with disaster management, with consideration of this interaction from a social science sensibility, which accounts for such disciplines as sociology, geography, anthropology, linguistics, psychology, and more. The expansion to include human systems in the consideration of technology use is what makes crisis informatics a field of research that includes computer science—especially in terms of some its data science techniques—but whose questions do not alone stem from it.

The distinction here with respect to the timeline—post 2000s—emphasizes the networked quality of software systems that *enables interaction across sites and across people*. It accounts for the rise of social media and other peer-to-peer platforms that enabled the *informal response*—that is, members of the public—to become involved in disaster response in various ways that were beneficial or not. Some such socio-behavioral phenomena predate the 2000s in localized group activity that were harbingers for what was to come. These flourished and then became more widespread with the advent of blogs, mobile phones and then social media. However, though social media and social media features dominate much of the crisis informatics research, they do not alone define it.

As such, it is hard to draw the line at where crisis informatics work begins and ends. Many people do work in digital technology that is aimed at disaster work. This includes for example, software platforms that support Emergency Operation Centers (EOCs) and supply chain management, and machine-enhanced ways of doing search and rescue, all of which predate the 2000s. This important work deserves its own bibliographies. Further, some work, including from data and computer science, uses social media data similar to crisis informatics researchers, but may not stem from a practical or social science orientation to the particular disaster domain under study. This bibliography aims to include that work when it has a social science orientation and commitment to the long history of disaster studies.

Important work not marked as "crisis informatics" is easily, albeit unintentionally, overlooked. The international group of researchers who have assembled this bibliography strive to be inclusive of all research in this vein that could help inform research about the SARS-CoV2-2 (COVID19) pandemic.

A. Crisis Informatics Definitions

Crisis informatics is an evolving field, with sometimes blurry boundaries that we welcome. As an academic field, it examines the role of Information and communication technology (ICT) in crises, and as such, it strives to apply its work to practices in disaster management. However, significant innovation in this field often comes from practitioners rather than researchers, whose innovations stem from deep expertise about the needs of disaster warning, mitigation and response. In some of these cases, the practice is then brought to additional research investigation. Synergy between research and practice is an ongoing goal, and though is sometimes difficult to achieve, remains a pursuit nonetheless.

Some definitions about crisis informatics that have been employed including the following. Crisis informatics...

- “addresses sociotechnical concerns in large-scale emergency response. Additionally it expands consideration to include not only official responders (who tend to be the focus in policy and technology-focused matters), but also members of the public. It therefore views emergency response as a social system where information is disseminated within and between official and public channels and entities. Crisis informatics wrestles with methodological concerns as it strives to develop new theory and support informed development of ICT and policy.” (Palen, Anderson, Mark, Martin, Sicker, Palmer, Grunwald, 2009)
- “is broadly defined as the interconnectedness of people, organizations, information and technology during crises/disasters. Crisis informatics examines the intersecting trajectories of social, technical and information perspectives during the full life cycle of a crisis: preparation, response, and recovery.” (Hagar 2014)
- “examines the relationship between human behavior & information technology during crises” (Soden 2019)
- “views emergency response as an expanded social system where information is disseminated within and between official and public channels and entities” (Palen, Vieweg, Liu and Hughes 2009)
- “includes empirical study as well as socially and behaviorally conscious ICT development and deployment. Both research and development of ICT for crisis situations need to work from a united perspective of the information, disaster, and technical sciences.” (Palen, Vieweg, Sutton, Liu and Hughes, 2007)
- “is a multidisciplinary field combining computing and social science knowledge of disasters; its central tenet is that people use personal information and communication

technology to respond to disaster in creative ways to cope with uncertainty" (Palen & Anderson, 2016).

B. History of Social Media-Focused Work in Crisis Informatics

For a historical account of the rise of social media in disaster work that also provides a thematic organization of the wide-range of topics, see Palen and Hughes' *Social Media and Disaster Communication* (2017). In addition, Reuter, Hughes and Kaufhold's *Social Media in Crisis Management* (2018) provides a chronology of social media empirical research, with a table that highlights the different conditions for the empirical investigations. Both articles offer an extensive bibliography of the literature up to the time of their writing.

C. The Range of Crisis Informatics Research in Terms of Hazards Type

Crisis informatics scholars have covered a broad range of hazards. Those hazards include disasters arising from *natural* hazards that are atmospheric and meteorologic (e.g., hurricanes, tornados, droughts, heat waves), geologic (earthquakes, volcanos, tsunami, landslides), hydrologic (e.g., flooding, storm surge), and biologic (epidemics and public health crises). Hazards can be anthropogenic with widespread effects, including *technological* hazards (nuclear accidents). Wildfire can be a natural hazard arising spontaneously from particular weather conditions, but can also be instigated by a person. In addition, crisis informatics researchers have studied crises that arise from criminal acts (terrorist attacks, bombings and school shootings), political uprisings, and war.

Natural hazards, anthropogenic hazards, and criminal hazards might need to be treated sociologically differently, depending on what aspect of them is a focus, as their genesis can differ in intent and scale, and demand their own disciplinary treatment, especially in terms of subsequent social psychological impacts and phasing. However, because crisis informatics considers how people respond online to such events, the unifying element that brings these different crises together is the online response, which demands computing methods to study. Nevertheless, it is important to understand that just because the online response happens through in-common platforms, the socio-behavioral responses to different kinds of crises can be different and therefore can be reflected in the information space surrounding the event.

Hazards will have different temporal and spatial scales, and differentially disrupt the social order. Though a majority of crisis informatics work has examined information behaviors arising from natural disasters, work has been done across a range of crises described above. Moreover, in the sociology of disaster, scholars have developed models delineating the social activities that often emerge across different phases of disaster arising from natural hazards, from pre-crisis and warning to where the resumption of routine activities takes place. Scholars exploring the ongoing nature of some crises, such as war, epidemics, and climate change have shown a need for models that account for how and when people experience ongoing, chronic uncertainty.

D. Classic Disaster Scholarship

Crisis informatics research draws upon seminal work in the social sciences on natural and technological hazards. This is a century of work, and cannot be done justice here. To help new readers, we suggest drawing from EL Quarantelli, RR Dynes, K Tierney, J Kendra, T Wachtendorf, M Lindell, R Perry, R Stallings, D Mileti, T Drabek, H Rodriquez, L Comfort, B Phillips, G Kreps, W Peacock, C Fritz, and many others. Searching these surnames with "disaster" in Google Scholar will help seed a strong bibliography. Lindell's *Disaster Studies* paper may be a helpful starting place.

Bibliography of Overview and Definitional Papers of Crisis Informatics as Mentioned in Section 1

II. THE SOCIO-BEHAVIORAL PHENOMENA OF SELF-ORGANIZATION

A. Reporting by Members of the Public: Sensors, Journalism and Cultural Heritage

The early work of ICT for crisis informatics addressed the growing practice of "public reporting" using the new technologies that supported peer-to-peer connection. This was variously described as "citizens as sensors" and "citizen journalists." Note that we recognize that the word "citizen" is problematic in its use, especially to the extent that it was adopted by early researchers, as not every person is a citizen of the country in which they are reporting, nor even of that where they live. It is a privileged stance to assume, and one that presumes that certain rights of participation are accorded the persons being described.

The ideas of "person as sensor"—people who detect, measure, and report local emergency information—as well as journalists —people who collect, report, analyze, and disseminate information as news—were used to explain outgoing reporting via blogs, mobile phones, texting, online maps, and social media apps. The idea of first-hand reporting—particularly in the form of visual documentation through the use of camera phones and photo-sharing sites—made an indelible early impression of what the future of public participation could bring to both the immediate, tactical aspects of response, as well as the longer-term aspects of a community's longer-range cultural heritage—their remembrances of the event. Studies of disaster events around the world have documented instances of reporting, as well as the ubiquity of this kind of reporting, and research prototypes have supported and further explored this behavior.

List of Research Papers for Reporting by Members of the Public

B. Features of Self-Organizing, Coordination and Convergence in Online Interaction

Many groups that converge in disaster response are self-organizing. Research here examines the nature of convergence and self-organizing, focussing on how and why coordination

happens. Some work deeply examines the mechanisms of distributed work in tightly organized groups, considering division of labor, specialized language and turn-taking, and generation of information artifacts. Other work explains how features of people's experience generate different informational relationships across many people who are in looser coordination. For example, both qualitative and quantitative investigation shows that people who have a close relationship to the region where a disaster is taking place make use of social media differently than those who are global onlookers. Social media directed at locals by locals tends to focus on issues that are timely, action-oriented, and contextual with respect to local matters. People who are removed from the event, on the other hand, tend to share high-level abstract descriptions that garner interest. When such abstractions include images, "globals" tend to share more dramatic photos of suffering and destruction than locals do, with communications that are designed for the global gaze rather than the local one.

List of Research Papers for Features of Self-Organizing, Coordination and Convergence

C. Collective Intelligence and Distributed Problem-Solving

"Collective intelligence" was a term coined in the early days of social media to explain new socio-behavioral phenomena around information collation and joint problem-solving by many people towards a common goal. "Crowdsourcing" and "open innovation" are related terms. Many studies investigated how complex problem-solving was articulated and accomplished quickly under different conditions.

"Collective intelligence" in part arose to describe what might be possible when the "distributed problem-solving" capacities of human networks were enabled through social media and other coordination technology. Sometimes these views were utopianistic; sometimes cases of collective intelligence were offered as a way to dispute that information should only be mistrusted. Because there was much resistance to acknowledging that informal communication was happening in parallel to formal communication about an event, a purpose of such early work was to show the power of informal communication (to whatever ends) and that it would not cease; it could not be ignored in research or in practice. Later, mis/disinformation behaviors emerged as a specific concern and is now its own research area (see below).

List of Research Papers for Collective Intelligence and Distributed Problem-Solving

D. Digitally-Organized Relief

This subsection is intended to capture how people communicate online to request, offer, or exchange different forms of assistance as a particular form of self-organization. This is a vast category; what you see here is one cut through to help organize papers, though the topics themselves are overlapping. For those working in this space, we recommend reviewing papers that are currently listed across categories to ensure coverage.

1. Community-Level Organizing and Concerns.

With respect to the observation that “all disasters are local,” a body of research has investigated the relationship between informatics and communities. Beginning with early instances during 2005’s Hurricane Katrina, the 2007 Southern California Wildfires, and then the many-year Iraqi war and beyond, we see how people attend to their geographical community activities in the digital sphere. Several studies since have looked at community-level involvement, including how digital connectedness helps with solidarity, social support, and restoration of normalcy.

List of Research Papers for Community-Level Organizing

2. Digital Volunteerism

Research into digital volunteerism investigates the socio-technical structures and processes of emergent volunteer networks that arise during emergencies to support the formal humanitarian aid system, the means by which they envision and arrange their activities, recruit and sustain volunteers, and persist (or don't) from one crisis to the next. This is sometimes called “digital humanitarianism.” These studies investigate genesis, organizing and work activities. Prior research in this area has looked at the origins and evolution of the Humanitarian OpenStreetMap Team, the work of the Standby Task Force, Ushahidi, and similar groups. Today, some of these volunteer initiatives have been incorporated into the formal aspects of crisis management, though challenges remain for how they are incorporated into “chains of command.”

List of Research Papers for Digital Volunteerism

3. Humanitarian GIS, mapping, and Volunteered Geographic Information (VGI).

Geographic Information Systems (GIS), a form of mapping technology, is frequently deployed by humanitarian responders. Crisis informatics research has examined how these technologies and their users interact with, and are assisted by, digital humanitarian networks.
People may also provide geographically-tagged localized and distributed reports—known as volunteered geographic information or VGI. Volunteers can then map and collate geographic information and data for disaster response (“crisis mappers”) using open source mapping software, such as Ushahidi, which in turn uses an OpenStreetMap basemap. In addition, a subset of the global OpenStreetMap volunteer mapping community has completed maps of regions that are affected by disaster but previously did not have complete geospatial data, so that emergency responders have accurate information from which to make decisions and plans.

List of Research Papers on Humanitarian GIS, mapping and VGI

III. RELATIONSHIPS BETWEEN THE FORMAL (AUTHORITIES) AND INFORMAL (PUBLIC) RESPONSE

A. Examination of formal-informal relationships in disaster activity

How the public (the informal response) and the formal response in emergencies interact is a topic of investigation that examines how information is diffused between the two, how they work together, and the challenges that exist. Communication between the formal and informal response has proved to be advantageous in terms of expediting in some aspects of warning and response and in building the social capital of communities. However, despite the potential added value of public involvement, it also gives rise to specific challenges to emergency services and crisis management. The public may expose themselves to danger, or emphasize resources needed in one area without knowledge of the needs of others. The incorporation of social media analysis into formal crisis management remains unsettled, and is a site of ongoing experimentation and exploration about emergency work practice.

List of Research Papers for Formal-Informal Relationships in Disaster Activity

B. Risk Communication

Risk communication for crises now commonly occurs in online spaces, especially social media. In early disaster research, risk communication was understood as a one-way process of transmitting information from authorities to the public. It is now understood as a two-way exchange of information between these groups that considers both the needs and values of citizens along with the expert knowledge of authorities. Crisis informatics research in this area has examined how risk communication has occurred online for a variety of hazard types, including the roles of both authorities and members of the public in risk communication. It also has begun to examine how people encounter risk through other information artifacts and presentations, including maps.

List of Research Papers for Risk and Risk Communication

IV. VERACITY, MISINFORMATION, AND DISINFORMATION

Concerns around the veracity of information that comes through social media has been the genesis for research about how to assess truthfulness and trustworthiness. Some of this attempts to assess truthfulness by post; some by source. Some research asks about the framing of truthfulness with respect to who is viewing the post for what reason, as some people write emotional content not intending for their posts to be reused for a purpose that depends on eyewitness accuracy, something that is especially true of images shared in social media. Disinformation campaigns, including activity aided by bots, emerged as a means for deliberately tricking people to believe in information that is shared because the sources seem credible and consistent with their own messaging, and has drastically changed the landscape of digital

content and how people might engage with it. These can be slow persistent and pervasive efforts that gradually earn trust, and make content harder to evaluate.

List of Research Papers for Veracity, Misinformation and Disinformation

V. DIGITAL COMMUNICATIONS AS DATA SOURCE

A. Data Collection and Management for Information Processing

Social media use has become so widespread that during a major crisis, the vast amount of information available becomes difficult to monitor and analyze. For instance, during Hurricane Sandy (2012), the University of Colorado Boulder collected over 26 million publically available tweets in an attempt to comprehensively collect tweet communications from around the world about the warning, onset, and two-week post period of the hurricane. Such representative data sets enable rigorous data analyses of how social media were used during the event using a specialized infrastructure designed to handle large data sets—itself a research project on its own. It is almost impossible to make sense of the large amount of socially-generated data for applications to emergency management without adequate tools to filter, analyze, and visualize the data, including using machine-learning techniques. In response to this challenge, researchers have designed and built several algorithms and systems that filter and analyze social media streams in times of crisis, as well as visualizations that organize information to augment the ability of human intelligence to process huge quantities of heterogeneous data.

List of Research Papers for Data Collection and Management for Information Processing

B. Data Harvesting for "Situational Awareness"

Once social media are collected, a dominant target for application of content is to convert it into data for providing "situational awareness" for the informal response and/or the formal response. Situational awareness, in the emergency domain, describes human perceptions of the multifaceted circumstances around a crisis event that allow for interpreting situations, making decisions, and predicting future outcomes. Using natural language processing, machine learning, advanced data visualizations and human computation, several research groups have developed methods and tools for detecting and monitoring disasters through social media data analyses.

List of Research Papers for Data Harvesting for Situational Awareness

VI. EMERGENCY MANAGEMENT AND OPERATIONS

How digital technology has become a part of the formal response—emergency management and operations—is another significant arm of research. Use in police and sheriff departments, fire departments, emergency operation centers, incident command, field hospitals, NGOs, and

public information offices has been sites of investigation. Policy and research visioning meetings have attempted to bring the results of empirical research to policy, and for policy to help inform what the empirical research sees with respect to uptake or resistence to use.

List of Research Papers for Emergency Management and Operations

VII. DESIGN OF SYSTEMS, SOFTWARE APPLICATIONS, GAMES & PLATFORMS

Human-centered computing research has developed solutions for use in emergency situations that include software applications, training games, and platforms. In some cases these systems are designed for crisis informatics researchers to do analytics, with the thinking that the same techniques should be available to responders when the state of the art allows for it. In other cases, the solutions are designed with emergency managers as the end-users. Tools have also been developed for sharing, filtering and organizing this citizen-generated information that document how events and the response were perceived by those who experienced the disaster.

List of Research Papers for the Design of Systems, Software Applications, Games and Platforms

VIII. INFORMATION INFRASTRUCTURES & DISASTERS

Crisis informatics has drawn on science and technology studies (STS) and human-computer interaction (HCI) research into information infrastructures to understand how these complex assemblages of technologies, institutions, and practices enable, and give form to, knowledge about disasters. Infrastructure scholarship about disasters asks crucial questions about epistemic accomplishments and possibilities – that is, how do we know about disasters? What physical materials, institutional arrangements, social networks and other resources are marshalled to assist in bringing infrastructure into existence, and maintaining it over time? How is knowledge enabled and limited by infrastructural arrangements? What are the politics of knowledge production? Whose perspectives are prioritized? Whose are silenced? And with what consequence?

Research in this area considers infrastructure as a sociotechnical process. That is, infrastructure cannot be simply reduced to physical materials, but also includes people, organizations, practices and standards. As a result, infrastructures are never static “things.” Furthermore, infrastructure is relational because not everyone has the same access to the infrastructure. The relationality of infrastructure is important to consider because it helps us understand how infrastructures arrange relations of power. Data, information, and communication infrastructures are important to study during disasters because it is precisely during crises, in moments of great uncertainty, that these infrastructures help inform people about what has happened and what

has changed. People look to these infrastructures to help produce knowledge about what has happened.

List of Research Papers for Infrastructural Studies of Disaster Management

IX. ETHICAL, POLICY, AND LEGAL EXPLORATIONS IN CRISIS INFORMATICS

The convergence of crisis informatics, digital mapping, machine learning, and other technologies has helped to transform crisis management and create new capacity for community resiliency and self-reliance. These tools and approaches, however, raise numerous legal, ethical, and policy challenges, such as open access to data, privacy and safety, cybersecurity, and intellectual property. Legal and policy frameworks need to be adjusted, clarified, or built anew. Data privacy and sensitivity, as well as ethical concerns emerged as digital volunteers mobilized to help collect data in conflict zones. In these contexts, the lives of data informants and humanitarian workers could be put at risk if the information was made publicly available through open data portals. Early investigations also explored the legal ramifications of digital volunteerism, such as the potential liability risk of volunteers who contribute data or who directly interact with disaster victims via social media. The ethics of data reuse and professional codes of conduct, which were hot topics in the 1990s in the participatory mapping community, have re-emerged as important focus areas in the literature, and are seen throughout the landscape of crisis informatics concerns. The growth of social media challenges the preparedness of public institutions to respond to demand to assist and protect when needed, and to cultivate trust.

List of Research Papers for Ethical, Policy, and Legal Explorations in Crisis Informatics

X. OVERCOMING CHRONIC UNCERTAINTY

Because this resource was created during the 2020 coronavirus pandemic, we want to give special attention to hazards that create chronic uncertainty. By chronic uncertainty, we are referring to those hazards that are long-lasting, and lead to a prolonged period of flux with an uncertain end for all affected. These hazards are unlike natural disasters where many people set aside routines and respond to the crisis with reasonable anticipation of its closure (though many people facing disasters of this kind are differentially affected and face long-term disruption). Rather, when experiencing disruptions that create chronic uncertainty, there are ongoing dislocations to people's lives whereby they must simultaneously respond to emergent threats while also adjusting life routines and rhythms. Crisis informatics scholars have explored how people draw on technological resources to engage in myriad, often new, practices and social interactions to ameliorate chronic uncertainty.

List of Research Papers for Overcoming Chronic Uncertainty

OTHER RESOURCES

Major Centers, Professional Societies and Working Groups

- Disaster Research Center (Delaware)
- Natural Hazards Center (Colorado)
- Disaster Risk Management Knowledge Centre (EU Commission)
- ISCRAM (Information Systems for Crisis Response and Management) Digital Library
- Reports from DHS Science & Technology's Social Media Working Group for Emergency Services and Disaster Management

Groups that Support Digital Disaster Response

- Humanitarian OpenStreetMap (HOTOSM, or HOT)
- Standby Task Force (SBTF)
- GIS CORPS
- Humanity Road (one of the first to launch in 2010; disbanded in May 2020)
- CEDR Digital Corps
- CartONG
- CrisisCleanup
- CrisisCommons
- DataKind
- DirectRelief
- Disaster Tech Lab
- Info4Disasters
- MapAction
- Relief 2.0
- Statistics Without Borders
- Translators Without Borders
- National Student Response Network (NSRN)
- COVID-19 National Science Volunteer Database

Google Scholar searches using the following terms:

- "Crisis informatics"
- "Social media disaster"
- "Social media disasters"
- "Social media emergency management"
- "Technology emergency management"
- "Technology disaster"
- "Information disaster"
- "Information disasters"

- “Information hazards”
- “Epidemic social media”
- “Public health informatics”
- “Digital humanitarianism”
- “Crisis Technology Resilience”
- “Risk communication”
- “Risk communication public health”
- “Disaster studies”
- “Sociology of disaster”