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Anticipating Breakdown: A Call for Interdisciplinary Futures in Cascading Crises and Speculative Risk Communication*

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This essay calls for an urgent reorientation of risk communication research and practice toward interdisciplinary futures in an era of cascading crises. Hazards today unfold across interdependent infrastructures, multiplying disruptions that no single discipline can address in isolation. The concept of speculative risk communication captures this challenge by emphasizing anticipation: messages that project possible breakdowns into the present, guiding publics to prepare before crises fully materialize. However, anticipatory communication also carries ethical, political, and strategic stakes that demand an integrated perspective. The central argument of this research agenda is that communication must be treated as core infrastructure, sustaining trust and coordinating action across strained systems. Knowledge infrastructures that often reinforce disciplinary silos must instead incentivize collaboration and cooperation. This essay issues a call to action for scholars, practitioners, and institutions: dismantle silos, integrate insights, and build interdisciplinary futures capable of anticipating breakdown with coherence and ethical responsibility.

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The twenty-first century has ushered in a new risk environment defined by cascading crises. Hazards once treated as isolated incidents now unfold in interconnected sequences that strain infrastructures, institutions, and publics (Pescaroli & Alexander, 2018). A wildfire may destroy homes and landscapes, but its consequences rarely stop there. Smoke spreads across regions, triggering respiratory illnesses and straining hospitals. Roads close, delaying emergency response. Electricity grids falter, cutting power to households that depend on cooling or medical equipment. Digital networks are filled with contradictory claims and misinformation, complicating protective action. What begins as a hazard expands into multiple disruptions across overlapping systems.

Similar dynamics unfold across hazards as varied as floods, hurricanes, heatwaves, and pandemics. Each illustrates how disruption in one system cascades into failures across others, multiplying consequences through interdependencies that are difficult to predict and even harder to manage. Scholars of hazards, geography, and systems science use terms such as cascading crises, compound events, or concatenated disasters to capture this interdependence. These frameworks emphasize how hazards trigger chains of consequences that amplify one another (Cutter, 2021). Related scholarship has described large-scale, system-wide emergencies as “mega-crises,” emphasizing their scope, duration, and capacity to overwhelm governance and response systems (Helsloot et al., 2012). Cascading crises overlap with this concept but differ in analytic emphasis. While mega-crisis highlights magnitude and institutional overload (Sellnow-Richmond & Lukacovic, 2026), cascading crises foreground the relational dynamics through which disruption propagates across interdependent infrastructures, organizations, and information systems. This focus on interdependency and sequence is central to understanding how breakdown unfolds and how communication must anticipate strain across systems rather than respond to a singular, bounded event. Focusing on relational propagation also clarifies why the metaphor of dominoes oversimplifies the phenomenon, since collapse rarely follows a straight line. Failures emerge through dense networks of dependency where one strain produces multiple fractures. Energy systems rely on water resources, hospitals require electricity, and information systems depend on both. A single disruption can trigger secondary breakdowns that exceed the original hazard in severity (Brunner et al., 2024).

This complexity presents a challenge for risk communication. Messages about hazards do not circulate in isolation. They are interpreted under stress, filtered through cultural and organizational trust, and refracted across digital platforms (Tierney, 2007). Confusion or contradiction in messaging can accelerate cascading dynamics by slowing protective action or undermining organizational credibility (Stephens et al., 2013). Warnings now spread instantly across multiple media channels, and missteps circulate far beyond intended audiences (Bean et al., 2016). Communication plays a central role in shaping how hazards are understood, how risks are prioritized, and how the public decides to act. Clarity, timeliness, and accuracy remain essential, but they are insufficient when infrastructures themselves are unstable. The public must be prepared not only for hazards but for the possibility that protective systems will fail (Stephens & Faust, 2026). Advisories about hospital capacity limits, warnings of potential power shortages, and guidance on evacuation

delays illustrate this shift. These are messages about strain, uncertainty, and possible failure.

To capture this communicative transformation, I use the term speculative risk communication. The literature generally defines speculative communication as the warnings, advisories, and calculated silences that circulate when infrastructures approach their limits (Boin & ‘t Hart, 2003; Pang et al., 2021; Palen et al., 2007). However, when considering risk perception, speculative communication enables us to project potential futures of breakdown into the present (Fischhoff, 1995). This form of communication asks the public to prepare for possibilities that may not yet materialize but demand attention (Watanabe & Fujimi, 2025). Speculative risk communication centers on anticipating the impact of hazards alongside the limits, breakdowns, and cascading failures of the infrastructures designed to manage them. It foregrounds what might occur when protective systems reach their breaking point (Ross et al., 2024).

Risk communication has long been understood as forward-looking, insofar as it addresses hazards that may or may not materialize into crises (Krimsky, 2007; Seeger, 2025). From this perspective, all risk communication entails some degree of uncertainty and projection. Speculative risk communication does not dispute this foundation. Instead, it identifies a distinct mode of risk communication that becomes salient when institutions must communicate not only about hazards, but about the potential failure of the protective systems themselves. This distinction matters because communicating the possibility of infrastructural breakdown introduces qualitatively different ethical, political, and strategic challenges than communicating probabilistic risk alone. Unlike crisis communication, which responds to realized breakdown, speculative risk communication operates in the liminal space whereby institutions must acknowledge strain and uncertainty without confirmation that failure has occurred.

Prior scholarship has also advanced the concept of multidimensional risk communication to describe how public discourse integrates multiple domains of risk during emerging crises, particularly in complex socio-technical environments (Gui et al., 2018). This work usefully foregrounds complexity and the interaction of diverse risk dimensions. Speculative risk communication differs in analytic focus. It does not center on the number or variety of risks communicated, but on how institutions invite the public to anticipate cascading breakdown across interdependent systems before crisis conditions fully unfold. The emphasis is not on additive complexity, but on anticipatory projection under infrastructural strain, where communication prepares publics for the possible failure of protective systems rather than discrete hazards alone. At its core, speculative risk communication refers to anticipatory messaging that prepares publics for the possible failure of protective systems under cascading strain, as well as communicating probabilistic hazards.

The stakes of speculative risk communication are sizable. Ethical questions arise when deciding which risks to emphasize and which to minimize. A message that stresses energy demand may signal to some residents that rolling blackouts are imminent, while others assume they are unaffected. A warning about strained hospital capacity suggests that some patients may not receive timely care. Each message reflects institutional judgments about whose safety matters, what uncertainties are tolerable, and how responsibility is distributed.

These judgments are ethical choices, even when delivered in technical language (Barbour & Manly, 2016; Kasperson, 2014).

Speculative risk communication also constructs futures by guiding the public to imagine breakdown and act in anticipation of strain. Institutions must present these futures credibly and persuasively, striking a balance between uncertainty and actionable guidance (Sellnow & Seeger, 2013). Too much emphasis on failure risks fatalism, while too little leaves people unprepared (Mileti & Sorensen, 1990; Paten, 2008). The challenge lies not only in tone but in anticipating how messages circulate across networks. Extant research shows that institutional messages rarely move directly to individuals, instead diffusing through journalists, social media platforms, civil society groups, and interpersonal networks, where meaning is reshaped through processes of amplification, reframing, and selective retransmission (Fellenor et al., 2018; Houston, 2012; Sutton et al., 2020). These patterns are especially pronounced among low-trust publics, who may rely on alternative intermediaries such as social media influencers rather than official sources (Schmuck & Harff, 2023). A message crafted for one audience may be amplified, reframed, or distorted by another (Stephens et al., 2020). Cascading crises magnify this complexity, as hazards, infrastructures, and information systems intersect in unpredictable ways. These dynamics underscore the themes of ethics, futures, and strategic complexity central to this special issue. Speculative risk communication highlights the ethical stakes of anticipatory messaging, the projection of possible futures into the present, and the challenge of guiding publics across multiple systems under stress (Bowen, 2016). Addressing this challenge requires confronting a deeper problem: the persistence of disciplinary silos.

Despite the interdependence of hazards and infrastructures, academic research remains segmented. Engineers and planners model vulnerabilities in physical systems, but rarely examine how the public interprets warnings. Social scientists study trust and behavior, yet often fail to incorporate technical constraints in energy grids or health systems. Health experts design protective measures but may overlook how misinformation distorts uptake. Communication scholars analyze meaning-making under stress but frequently neglect spatial or infrastructural data. Each field generates valuable insights, yet each remains partial. The fragmentation of disciplines mirrors the fragmentation of infrastructures. Silos of expertise replicate the very conditions that cascading crises exploit.

The concept of cascading crises also builds on earlier scholarship on risk society, which emphasized the growing complexity, interdependence, and reflexivity of modern risks (Beck, 1992). Beck argued that contemporary hazards increasingly emerge from the very systems designed to manage them, producing uncertainty that exceeds traditional institutional control. Cascading crises make this condition empirically visible by tracing how failures proliferate across infrastructures, organizations, and communication systems. Thus, cascading crises operationalize risk society by specifying how abstract systemic risk materializes through interconnected breakdowns that demand anticipatory communication rather than reactive response (Beck, 1999; Beck et al., 1994).

This fragmentation cannot continue. The risks of our time demand approaches that integrate across disciplinary boundaries. Cascading crises ignore academic divisions of labor, and knowledge must be created across fields in the same way that infrastructures

operate across systems. The future of risk communication depends on intentional, sustained, and central interdisciplinary collaboration. This requires a transformation in how research is conceived and practiced. The urgency of this shift is evident: communication functions as infrastructural upkeep. Messages sustain the connection between institutions and the public. They maintain trust, signal readiness, and distribute responsibility. When communication fails, infrastructures unravel more quickly. Treating communication as core infrastructure underscores the importance of interdisciplinarity (Stephens & Faust, 2026). Engineers cannot maintain power grids without understanding how the public responds to conservation advisories. Health experts cannot manage pandemics without insight into how trust and misinformation shape compliance. Communication scholars cannot theorize warnings without accounting for technical and institutional constraints. Each discipline depends on the others.

This essay advances the concept of speculative risk communication to argue that anticipating breakdown requires interdisciplinary futures. By framing communication as infrastructural upkeep and by recognizing that cascading crises expose the limits of siloed expertise, the essay calls for a new agenda in risk communication research.

The guiding research question behind this agenda is: *How can speculative risk communication be conceptualized as an interdisciplinary practice for anticipating breakdown in cascading crises?* This question underscores the importance of collaboration across disciplines. It asks scholars to confront the limits of disciplinary approaches and to imagine futures in which communication is integrated with technical, social, and institutional systems.

This manuscript presents a focused research agenda with a conceptual and integrative analytic approach. It advances theory through critical synthesis across risk communication, crisis communication, hazards research, infrastructure studies, and ethics. The analysis uses illustrative cases from recent disasters and public health crises to reveal recurring patterns of cascading breakdown and communicative strain. These cases serve as analytic reference points that sharpen theoretical insight, selected not for representativeness but for their capacity to reveal how anticipatory communication operates under cascading infrastructural strain across different domains. The agenda is guided by explicit analytic commitments to conceptual coherence, interdisciplinary integration, and normative relevance, which structure the synthesis and clarify the basis for assessing the theoretical contribution. As a research agenda, this work contributes by reframing problems, identifying gaps across disciplines, and articulating priorities for interdisciplinary futures in risk communication.

The remainder of the agenda develops this question in three parts. First, it outlines the nature of cascading crises and the consequences of disciplinary fragmentation. Second, it elaborates the features of speculative risk communication, emphasizing its ethical, political, and strategic stakes as a hinge concept for anticipating breakdown. Third, it issues a call to action for scholars, practitioners, and institutions to build interdisciplinary futures by treating communication as core infrastructure.

Cascading Crises and the Limits of Siloed Knowledge

Building on this framing, cascading crises expose the vulnerabilities of infrastructures, institutions, and information systems that appear stable when hazards remain isolated. Once disruption begins, it rarely stops within the boundaries of a single domain. Cascading crises encompass both the cascading consequences of an initial hazard and multi-hazard or compound events, where multiple hazards interact in sequence or simultaneously, as in the 2011 earthquake–tsunami–nuclear disaster in Fukushima. This understanding aligns with models of cascading effects that conceptualize disasters as sequences of interdependent events triggered by an initial hazard, producing amplified impacts across physical, social, and infrastructural systems due to their interconnections (Pescaroli & Alexander, 2015; Zuccaro et al., 2018). A wildfire may destroy homes and landscapes, and its impact radiates outward. Smoke spreads across states, causing respiratory illnesses and overwhelming hospitals already working at capacity. Roads close, cutting off mobility for both emergency responders and ordinary residents. Electricity grids weaken under stress, leaving households without cooling or medical devices. Digital networks are filled with contradictory claims, misinterpretations, and misinformation, eroding the clarity of official warnings. In this sequence, the hazard serves as the catalyst, and the crisis emerges when multiple systems fail simultaneously (Cutter, 2018).

Similar dynamics occur across a wide range of hazards. A flood may disable a water treatment plant, leaving residents reliant on bottled supplies at the exact moment transportation systems are disrupted, and emergency deliveries are delayed. A heat wave strains electricity networks, forcing power companies to issue conservation advisories as cooling systems fail and hospitals admit a rising number of patients with heat-related illnesses. Hurricanes destroy critical infrastructure and disrupt health services, while also degrading the communication channels used to coordinate protective actions. Pandemics overwhelm health systems, and their impact extends into economies, governance, and public life. In each case, the hazard initiates the sequence, and the crisis unfolds when consequences accumulate across interdependent systems (Brunner et al., 2024).

These examples illustrate a defining characteristic of contemporary risks: failures rarely remain confined to one system. They move across infrastructures, institutions, and information systems in ways that are difficult to anticipate and even harder to manage. Scholars use terms such as cascading crises, compound events, and concatenated disasters to describe this interdependence (Alexander & Pescaroli, 2019; Cutter, 2018). Each label highlights how hazards interact with and amplify one another. The metaphor of falling dominoes oversimplifies the complexity of collapse. Crises rarely unfold in a straight line. They ripple through dense networks of dependency where one strain generates multiple fractures. Energy systems depend on water availability. Hospitals require electricity for life-saving equipment. Information systems rely on both. A single disruption can trigger secondary failures that surpass the severity of the original hazard.

Historical Lessons in Fragmentation

The 2021 blackout in Texas highlighted how the failure of one system can cascade across others (Busby et al., 2021). As the power grid faltered during extreme cold, millions of residents lost heat and electricity. Hospitals struggled to maintain care as backup generators failed. Water treatment facilities froze, forcing boil-water advisories. Conflicting information about outage durations and the reliability of backup systems circulated online, leaving residents unsure how to respond. Engineers identified the technical causes of the grid failure, health experts warned of hypothermia and carbon monoxide poisoning, and communication professionals scrambled to issue guidance. Each account contributed to the story, yet the lived reality was a convergence of all these failures (Flores et al., 2023). No single field could capture the crisis in its entirety.

The 2021 Texas power blackout offers substantial analytical value because it combines large-scale failure with detailed empirical evidence on communication during cascading infrastructure collapse. Survey research by Day et al. (2024) showed how power outages disrupted access to official messaging and complicated compliance with boil water notices, with perceived efficacy, income, and race shaping protective action. Infrastructure-focused studies further demonstrated that managed outages and system failures disproportionately harmed low-income and minority communities, clarifying how speculative advisories about energy conservation and water safety interacted with existing social vulnerabilities (Lee et al., 2021). Crisis communication data extended this picture beyond the immediate event, as analysis of crisis text line usage reveals sustained increases in mental health distress in high-impact regions for months after the blackout (Sugg et al., 2023). These studies show how speculative risk communication functions during cascading failure by projecting uncertainty about system capacity, unevenly allocating the burdens of anticipation, and carrying communicative consequences across time and social structure.

The COVID-19 pandemic revealed another dimension of fragmentation. Health experts generated protective guidance on masking, distancing, and vaccination (Malecki et al., 2021). Social scientists studied patterns of compliance, distrust, and politicization (Dada et al., 2021). Communication scholars analyzed misinformation flows across digital platforms (Yoo et al., 2023). Each line of inquiry produced valuable insight, but often without sufficient integration. As a result, protective guidance sometimes failed to account for the ways misinformation reshaped public decision-making (Zuo et al., 2025). Communication analyses highlighted the distortions of public discourse but often did not fully account for the organizational and infrastructural pressures driving health recommendations. The result was a fragmented response to a broad-based crisis.

The COVID-19 pandemic provides a powerful case for this research agenda, given its extensive empirical record of anticipatory communication under prolonged systemic strain. Studies using surveys, content analysis, platform data, and mixed-methods approaches show how the public interpreted and acted on forward-looking guidance on masking, vaccination, hospital capacity, and uncertainty (Dekker et al., 2025; Zhang et al., 2025; Unlu et al., 2023). Anticipatory messaging circulated across multiple channels simultaneously,

shaping perceptions and behaviors in distinct ways. Authoritative media reinforced institutional trust while reducing perceived risk. Social media heightened risk perception while fragmenting credibility. Platform-specific dynamics drove uneven patterns of mistrust and compliance. This body of research shows how speculative risk communication during COVID-19 brought imagined futures of breakdown into the present and unevenly distributed the burdens of anticipation across publics. As an illustrative case, COVID-19 reveals how speculative risk communication operates where infrastructure strain, uncertainty, trust, and circulation converge, underscoring the need for interdisciplinary approaches to understand how anticipatory messages shape behavior before crises fully unfold.

European heat waves underscore the costs of disciplinary silos. Meteorologists and climate scientists forecast temperature extremes with increasing precision (Korhonen et al., 2025). Urban planners model the vulnerabilities of infrastructure under sustained heat. Health experts warn of increased mortality among at-risk groups. Each of these insights often circulates separately. Communication about heat risks tends to emphasize immediate protective measures, such as staying hydrated or avoiding outdoor activities, while overlooking infrastructural limitations, including inadequate housing or overwhelmed healthcare systems (Robertson et al., 2024). The absence of integrated knowledge results in gaps in public guidance, leaving at-risk groups vulnerable.

Empirical research on European heat waves sharpens these dynamics. Survey and experimental studies show high awareness of heat warnings alongside uneven knowledge of current alerts and uneven confidence in how to respond, shaped by demographic, psychological, and contextual factors (Heidenreich et al., 2024). Comparative analyses of heat health warning systems across Europe reveal wide variation in alert thresholds, communication channels, and language accessibility, which weakens anticipatory guidance for mobile and at-risk populations (Casanueva et al., 2019). Governance-focused studies of national heat health action plans show that fragmented roles and unclear cross-sector responsibilities constrain the practice of anticipatory heat risk communication (Vanderplanken et al., 2021). Together, this research demonstrates how speculative risk communication during heat waves distributes future strain unevenly across publics and exposes the costs of disciplinary and institutional fragmentation when anticipating breakdown before systems enter crisis.

Historical disasters reinforce the point. Hurricane Katrina in 2005 revealed how infrastructural breakdown, organizational failure, and communication missteps converged to magnify harm (Leavitt & Kiefer, 2006). Engineers debated the failure of levees. Emergency managers tracked logistical bottlenecks. Communication professionals criticized the conflicting and delayed messages that left residents confused about evacuation orders. Each field produced analyses of what went wrong, but the disaster itself unfolded as a single, converging chain of events. Similarly, Hurricane Maria in 2017 devastated Puerto Rico through physical destruction and prolonged failures of energy, health, and information infrastructures (Andrade et al., 2020). Months after the storm, inconsistent communication about death tolls, service restoration, and federal response eroded trust. The disciplinary fragments of analysis explained parts of the story, but the crisis itself exceeded those boundaries.

Studies of Hurricane Katrina show why these disasters remain analytically instructive. Failures in information and communication technologies disrupted interorganizational coordination and reduced the public sector networks' ability to adapt as conditions deteriorated (Comfort et al., 2007; Davis et al., 2015). Research on Hurricane Maria shows a similar pattern. The collapse in power and telecommunications infrastructure weakened crisis communication, fueled rumor circulation, and damaged institutional credibility because contingency planning for cascading failures was absent (Andrade et al., 2020). Katrina and Maria stand as critical empirical cases that expose how anticipatory communication falters as systems near failure and demonstrate the need for speculative risk communication that addresses infrastructural strain, organizational uncertainty, and the limits of institutional control.

Limits of Single-Discipline Approaches

Across these empirical cases, siloed research proves insufficient for anticipating breakdown when communication operates under infrastructural strain and uncertainty. Engineers and planners excel at modeling vulnerabilities in physical systems. They can forecast when energy grids may reach their limits or when storm surges may overwhelm levees. These models are sophisticated and indispensable for identifying points of strain. However, they rarely address how the public interprets technical information or how organizational credibility influences compliance with advisories.

Social scientists study trust, behavior, and perception. They analyze how organizational credibility shapes protective action and how social networks facilitate the dissemination of information. Their research explains why some publics respond quickly to official warnings while others resist or reinterpret them. However, this work often lacks grounding in the physical constraints that shape the possible responses. A household may want to comply with evacuation guidance but find that routes are blocked or fuel is unavailable. A community may trust a warning but lack the resources to act on it. Without integrating infrastructural realities, behavioral insights remain incomplete.

Health experts design protective measures that translate technical knowledge into actionable guidance. They develop protocols to reduce exposure, manage disease spread, or protect at-risk groups. These measures often assume that the public can follow instructions as intended. They may not account for how misinformation distorts uptake or how infrastructural collapse renders protective guidance difficult to implement. Advisories to boil water, for example, fail when electricity is unavailable to power stoves.

Communication scholars examine how meaning is constructed in the face of uncertainty. They study framing, amplification, and distortion, revealing how publics interpret and reframe messages under stress. This work sheds light on why some warnings are trusted and others are dismissed. However, communication research often neglects the infrastructural and organizational conditions that shape why warnings are issued in the first

place, why inevitable silences are chosen, and why some messages spread more rapidly than others.

Each of these disciplinary perspectives provides a partial view of cascading crises. The challenge is that they remain siloed. Engineers, social scientists, health experts, and communication scholars generate knowledge that is internally rigorous but externally incomplete. This fragmentation of scholarship mirrors the fragmentation of infrastructures. Silos of expertise replicate the very weaknesses that cascading crises exploit.

Why Interdisciplinarity Is Urgent

The consequences of disciplinary fragmentation are measured in organizational failure and public harm. A blackout becomes a health crisis when hospitals lose power, and patients are left without care. A communication crisis arises when the public receives mixed messages about what to expect and how to prepare. A flood becomes an infrastructure crisis when roads collapse, a health crisis when sanitation systems fail, and an information crisis when digital networks are disrupted. A pandemic becomes a governance crisis when public authorities and related governance organizations struggle to maintain legitimacy and coordinate a response across interdependent public, private, and nonprofit systems, a dynamic documented in comparative analyses of COVID-19 governance across Germany, Sweden, and the United Kingdom (Hanson et al., 2021). In each case, the hazard is only part of the story. Crisis conditions intensify as weaknesses across multiple interdependent systems accumulate and converge, allowing localized disruptions to propagate across infrastructure networks and scale into system-wide strain (Pescaroli & Alexander, 2016).

This reality makes interdisciplinarity a requirement. Cascading crises do not respect disciplinary boundaries, and scholarship cannot afford to maintain them. Knowledge must be generated across fields in the same way that infrastructures operate across systems. A power grid depends on a water supply. A hospital depends on electricity. Risk communication research relies on integrating knowledge across various disciplines, including engineering, health, and other social science fields. Without this integration, research produces insights as brittle as the infrastructures it seeks to explain.

Interdisciplinary collaboration must be intentional, continuous, and central to risk scholarship. It cannot be limited to occasional joint projects or symbolic gestures toward integration. It requires frameworks that actively combine methods, theories, and insights into shared practices. Engineers must understand how the public interprets conservation advisories. Social scientists must recognize the infrastructural thresholds that constrain protective action. Health experts must anticipate how misinformation will shape the uptake of guidance. Communication scholars must situate message design within the technical and organizational systems that issue warnings. Each discipline must rely on the others, not as an afterthought but as a condition of effective research.

Communication makes the urgency of this shift especially visible. It serves as infrastructure maintenance rather than merely as a means of information transfer. Messages

sustain the link between organizations and publics: they maintain trust, signal readiness, and distribute responsibility. When communication falters, infrastructures unravel more quickly. Engineers cannot stabilize a grid if households ignore or misinterpret advisories. Health experts cannot manage a pandemic if misinformation reshapes protective behaviors. Communication scholars cannot analyze warning systems without accounting for the infrastructural thresholds that dictate when alerts are issued. Each discipline holds a piece of the puzzle, but only their integration produces a coherent response. Cascading crises also remind us that risks are system-wide. They reveal that failures in scholarship parallel failures in infrastructure. The silos of academia perpetuate weaknesses in the very systems they seek to secure. The urgency of interdisciplinarity is therefore both intellectual and practical. It is about producing knowledge that reflects the realities of contemporary risks. It is about ensuring that scholarship does not replicate the very conditions of fragmentation that hazards exploit.

Speculative Risk Communication and Interdisciplinary Convergence

Recognizing the limits of siloed knowledge sets the foundation for the next step. If cascading crises demand integrated perspectives, then risk communication must be reconceptualized as a site where interdisciplinary insights converge. This is where the concept of speculative risk communication becomes critical. It highlights how warnings, advisories, and silences about infrastructures under strain serve as anticipatory practices that both depend on and reveal interdisciplinary knowledge. Speculative risk communication is where engineering models, social and behavioral insights, health protocols, and communication strategies intersect. This form of communication demonstrates how breakdown is anticipated, managed, and made meaningful before it occurs entirely. The following section develops this concept as the hinge between cascading crises and interdisciplinary futures. By examining speculative risk communication, it becomes possible to see why collaboration across fields is indispensable for anticipating breakdown in an era defined by cascading risks.

Speculative risk communication differs from traditional notions of hazard messaging because it directs attention toward anticipation rather than the aftermath. The conventional model assumes that risk communication begins once a hazard has been identified and quantified, then moves outward to the public through warnings, advisories, or instructions (Heath & Gay, 1997). Speculative risk communication unsettles this timeline. It introduces a vocabulary of strain, of systems approaching their thresholds, of possible futures pressing against the present. A conservation advisory issued during a heat wave signals not only a current hazard but also the potential collapse of the grid. A notice about hospital bed availability conveys more than just the current capacity. It signals the likelihood that protective measures may fail under demand. These forms of communication do not simply report conditions. They should ideally construct futures, ask the public to prepare for them,

and redistribute responsibility across institutions and residents (Muiderman et al., 2023; Sandstig & Eriksson, 2024).

Understanding speculative risk communication in this way reveals its power as a hinge. It makes visible the interdependence of disciplines that often work in parallel but rarely in concert. Engineers provide the models that predict strain on power networks. Social scientists trace how publics interpret advisories and warnings. Health experts translate exposure thresholds into guidelines for protective behavior. Communication scholars analyze how these guidelines are framed and reframed as they move across networks. The communicative act sits at the intersection of all these practices. A conservation advisory is only meaningful if the public understands and complies with it. Compliance is shaped by trust, cultural context, and material capacity, a consistent finding across risk and crisis communication research (Mileti & Sorensen, 1990; Paton, 2008; Sellnow & Seeger, 2013). Trust, in turn, is shaped by past performance and credibility. Credibility rests on whether the advisory reflects real infrastructural conditions. The advisory itself is a communicative artifact that emerges from engineering analysis, health risk thresholds, social patterns of interpretation, and strategic communication design. No single discipline can account for all these dimensions, and yet the communicative moment depends on their convergence.

The Ethical, Political, and Strategic Stakes of Anticipation

This dependence highlights the ethical stakes of anticipation. Institutions decide which futures to emphasize and which to withhold (Fathollahzadeh et al., 2024). A message about strained hospital capacity might underscore the urgency of vaccination campaigns, but it also risks panic among vulnerable populations. A warning about limited evacuation routes may encourage early departures, but also overwhelm traffic systems before they are necessary. Every anticipatory message involves judgments about uncertainty, responsibility, and consequence. These judgments are rarely framed as ethical choices, but they carry ethical weight. They allocate visibility to some risks while leaving others in silence. They distribute burdens unevenly across populations. They shape whether the public prepares with agency or waits in fatalism. Ethical analysis is therefore inseparable from the practice of speculative risk communication.

One ethical consequence of speculative risk communication lies in how the public processes anticipatory messages under uncertainty. Research on risk perception using the Extended Parallel Process Model (EPPM) shows that when messages emphasize threat without a corresponding sense of efficacy, individuals are more likely to engage in fear control rather than danger control, dismissing or avoiding the message rather than acting on it (Witte, 1992; Witte & Allen, 2000). Speculative risk communication is especially vulnerable to this dynamic because it asks the public to prepare for futures that have not yet materialized and for failures that institutions themselves may not fully control. If anticipatory messages foreground breakdown without articulating feasible pathways for action, they risk overwhelming audiences, eroding perceived self-efficacy, and producing disengagement

rather than preparedness or compliance. The ethical weight of speculative risk communication, therefore, lies not only in what futures are projected, but in whether publics are positioned as capable agents within those futures. Communicating about infrastructural strain carries an obligation to balance uncertainty with actionable capacity, ensuring that anticipation mobilizes adaptive behavior rather than resignation.

Speculative risk communication also highlights the political dimensions of futures (Rabe et al., 2024; Li et al., 2025). Messages do not only report conditions. They shape imagination. A conservation advisory envisions a future where energy scarcity is a possibility. A pandemic guideline envisions a future in which contagion can spread unchecked unless collective action intervenes. These constructions are political because they privilege certain risks, specific interpretations, and particular publics. They emphasize one possible trajectory of crisis while sidelining others (Bhuller & Trevithick-Sutton, 2024). The act of communication does not simply describe reality; it also shapes it. It performs reality by making certain futures actionable. This privileged power to choose one future over another reinforces the need for interdisciplinary collaboration. Without it, speculative risk communication may only highlight the blind spots of a single discipline. A grid advisory framed without behavioral insight is likely to be disregarded or resisted. A health guideline crafted without infrastructural awareness risks impossibility in practice. A message about evacuation that neglects social inequality risks exposing vulnerable populations to heightened danger. The political stakes of anticipation demand the breadth of disciplinary insight that only collaboration can provide.

Speculative risk communication also reveals the strategic complexity of circulation. Research in risk and crisis communication shows that messages rarely travel directly from institutions to individuals, instead moving through journalists, social media platforms, community organizations, and interpersonal ties, where meaning is reframed, amplified, or distorted (Fellenor et al., 2018; Houston, 2012; Sutton & Fischer, 2021; Sutton et al., 2020; Slater et al., 2024). Each stage alters meaning and introduces new interpretations. Anticipating circulation is therefore as important as anticipating breakdown. Institutions must ask not only what to communicate, but also how the communication will be received. Without interdisciplinary perspectives, these questions remain unanswered. Engineers may know the limits of the grid but not how conservation messages resonate with different cultural groups. Social scientists may understand the dynamics of trust but not how technical thresholds drive decisions to issue warnings. Health experts may understand the biological consequences of heat exposure, but they may not be aware of the infrastructural barriers to implementing protective measures. Communication scholars may know how frames circulate but not why institutional silences occur. Anticipating circulation requires integrating all of these insights into a communicative strategy.

From Hinge to Imperative: A Call to Action for Interdisciplinary Futures

The hinge function of speculative risk communication directly leads to a call to action. Interdisciplinary collaboration is essential. It is the condition of effective communication in an era defined by cascading crises. The fragmentation of scholarship mirrors the fragmentation of infrastructure. When each discipline operates in isolation, the result is brittle. The blackout becomes a metaphor for academic silos. The pandemic reflects the costs of fragmented expertise. The hurricane illustrates how disciplinary limits compound public harm. These crises deliver the same lesson: anticipation without integration lacks traction.

At the core of this challenge lie knowledge infrastructures that act as gatekeepers of what scholarship is valued and legitimized. Universities are entrenched sites of disciplinary division, where tenure lines, budgets, and evaluation metrics reward insular excellence while discouraging cross-field collaboration. Funding agencies shape which projects flourish, and when they privilege single-discipline proposals, they reinforce silos. Professional associations and journals also serve as boundary-setters. Editorial criteria, publication practices, and conference structures often replicate disciplinary divisions by marginalizing interdisciplinary work. Together, these three arenas (universities, agencies, and associations) form the institutional framework that either enables integration or perpetuates fragmentation. Recognizing them as interconnected knowledge infrastructures highlights the need for structural change across the entire ecosystem. Without this reorientation, the systems responsible for guiding research and practice amplify the vulnerabilities they seek to study.

Beyond the academy, institutions that manage risks must treat communication as infrastructure. Energy companies must recognize that conservation advisories are lifelines. Hospitals must see bed availability notices as signals of possible collapse. Governments must understand that evacuation advisories are acts of collective imagination. Speculative risk communication functions as the connective tissue across systems: maintaining trust, coordinating action, and distributing responsibility. Institutions must integrate communicative strategy into every stage of risk management. They must staff interdisciplinary teams that combine technical experts, behavioral scientists, health professionals, and communication specialists. They must treat message design as infrastructural planning. They must anticipate circulation as much as they anticipate strain. Without this integration, institutional communication fails under stress.

At the heart of this call to action is a recognition that speculative risk communication is a product of the convergence of disciplines. This concept emerges at the intersection of technical knowledge, behavioral insight, health expertise, and communicative design. Its success will depend on the integrity of this intersection, and its failure could reflect the absence of collaboration. Speculative risk communication is both a concept and a demand. Scholarship must move beyond silos. Institutions must invest in integration. The public must be treated as active participants in shaping their futures. Risk communication must be understood as essential infrastructure maintenance, as vital as the systems it sustains.

The urgency of this demand is escalating. Cascading crises are accelerating. Climate change intensifies the frequency and severity of hazards. Globalization accelerates the spread of failures across systems. Digital platforms amplify the circulation of misinformation on an unprecedented scale. The twenty-first century is already defined by systemic risks that exceed disciplinary boundaries. The future will be determined by whether scholarship and practice effectively address those risks through equal systemic integration. Delay leaves the public vulnerable. Fragmentation replicates failure. Integration anticipates breakdown with coherence and ethical responsibility.

I hope that this call to action presents a challenge to scholars, practitioners, and institutions alike. Studying communication about risks must be paired with practicing it as risk management. Analyzing infrastructures must go hand in hand with treating communication as infrastructure. Disciplinary silos must be critiqued and dismantled in practice. Interdisciplinary futures must be built to withstand cascading crises. This is the purpose of speculative risk communication, and it is the imperative of our time.

Biographical note

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References

Alexander, D., & Pescaroli, G. (2019). What are cascading disasters? *UCL Open Environment, 1*. https://doi.org/10.14324/111.444/ucloe.000003

Andrade, E. L., Barrett, N., Edberg, M. C., Rivera, M. I., Seeger, M. W., & Mercado, R. (2020). Mortality reporting and rumor generation: An assessment of crisis and emergency risk communication following Hurricane María in Puerto Rico. *Journal of International Crisis and Risk Communication Research, 3*(1), 15-48. https://doi.org/10.3316/INFORMIT.101283164195893

Barbour, J. B., & Manly, J. N. (2016). Redefining disaster preparedness: Institutional contradictions and praxis in volunteer responder organizing. *Management Communication Quarterly*, *30*(3), 333-361. https://doi.org/10.1177/0893318916629101

Bean, H., Liu, B. F., Madden, S., Sutton, J., Wood, M. M., & Mileti, D. S. (2016). Disaster warnings in your pocket: How audiences interpret mobile alerts for an unfamiliar

hazard. *Journal of Contingencies and Crisis Management*, *24*(3), 136-147. https://doi.org/10.1111/1468-5973.12108

Beck, U. (1992). *Risk Society: Towards a New Modernity*. Sage.

Beck, U. (1999). *World Risk Society*. Polity Press.

Beck, U., Giddens, A., & Lash, S. (1994). *Reflexive Modernization: Politics, Tradition and Aesthetics in the Modern Social Order*. Stanford University Press.

Bhuller, Y., & Trevithick-Sutton, C. C. (2024). Risk communication: lessons from an ethnographic, pragmatic, and Canadian regulatory perspective. *Frontiers in Communication, 9*. https://doi.org/10.3389/fcomm.2024.1235055

Boin, A., & Hart, P. T. (2003). Public leadership in times of crisis: Mission impossible? *Public Administration Review*, 63(5), 544-553. https://doi.org/10.1111/1540-6210.00318

Bowen, S. A. (2016). Clarifying ethics terms in public relations from A to V, authenticity to virtue: BledCom special issue of PR review sleeping (with the) media: Media relations. *Public Relations Review*, *42*(4), 564-572. https://doi.org/10.1016/j.pubrev.2016.03.012

Brunner, L. G., Peer, R. A. M., Zorn, C., Paulik, R., & Logan, T. M. (2024). Understanding cascading risks through real-world interdependent urban infrastructure. *Reliability Engineering & System Safety*, *241*, 109653. https://doi.org/10.1016/j.ress.2023.109653

Busby, J. W., Baker, K., Bazilian, M. D., Gilbert, A. Q., Grubert, E., Rai, V., Rhodes, J. D., Shidore, S., Smith, C. A., & Webber, M. E. (2021). Cascading risks: Understanding the 2021 winter blackout in Texas. *Energy Research & Social Science, 77*, 102106. https://doi.org/10.1016/j.erss.2021.102106

Casanueva, A., Burgstall, A., Kotlarski, S., Messeri, A., Morabito, M., Flouris, A., Nybo, L., Spirig, C., & Schwierz, C. (2019). Overview of existing heat-health warning systems in Europe. *International Journal of Environmental Research and Public Health*, *16*. https://doi.org/10.3390/ijerph16152657

Comfort, L., & Haase, T. (2006). Communication, coherence, and collective action. *Public Works Management & Policy*, *10*, 328-343. https://doi.org/10.1177/1087724x06289052

Cutter, S. L. (2018). Compound, cascading, or complex disasters: What's in a name? *Environment: Science and Policy for Sustainable Development*, 60(6), 16-25.

Cutter, S. L. (2021). The changing nature of hazard and disaster risk in the Anthropocene. *Annals of the American Association of Geographers*, *111*(3), 819-827. https://doi.org/10.1080/24694452.2020.1744423

Dada, S., Ashworth, H. C., Bewa, M. J., & Dhatt, R. (2021). Words matter: Political and gender analysis of speeches made by heads of government during the COVID-19 pandemic. *BMJ Global Health*, *6*(1). https://doi.org/10.1136/bmjgh-2020-003910

Davis, G., & Robbin, A. (2015). Network disaster response effectiveness: The case of ICTs and Hurricane Katrina. *Journal of Homeland Security and Emergency Management*, *12*, 437-467. https://doi.org/10.1515/jhsem-2014-0087

Day, A., O'Shay, S., Islam, K., Seeger, M., Sperone, F., & McElmurry, S. (2024). Boil water notices as health-risk communication: Risk perceptions, efficacy, and compliance

during winter storm Uri. *Scientific Reports*, *14*. https://doi.org/10.1038/s41598-023-50286-y

Dekker, R., Engbersen, G., Snel, E., & De Boom, J. (2025). The effect of institutional trust on the relationship between social media as an information resource and policy non-compliance: Dutch survey evidence from the COVID-19 pandemic. *International Review of Administrative Sciences*, *91*, 259-274. https://doi.org/10.1177/00208523241306410

Fathollahzadeh, A., Babaie, J., Salmani, I., Morowatisharifabad, M. A., & Khajehaminian, M. R. (2024). Challenges of disaster risk communication from the perspectives of experts and affected people: A conventional content analysis. *International Journal of Disaster Risk Reduction*, 108, 104553. https://doi.org/10.1016/j.ijdrr.2024.104553

Fellenor, J., Barnett, J., Potter, C., Urquhart, J., Mumford, J., & Quine, C. (2018). The social amplification of risk on Twitter: the case of ash dieback disease in the United Kingdom. *Journal of Risk Research*, *21*, 1163-1183. https://doi.org/10.1080/13669877.2017.1281339

Fischhoff, B. (1995). Risk perception and communication unplugged: twenty years of process. *Risk Analysis*, *15*(2), 137-145. https://doi.org/10.1111/j.1539-6924.1995.tb00308.x

Flores, N. M., McBrien, H., Do, V., Kiang, M. V., Schlegelmilch, J., & Casey, J. A. (2023). The 2021 Texas power crisis: Distribution, duration, and disparities*. Journal of Exposure Science & Environmental Epidemiology, 33*(1), 21–31. https://doi.org/10.1038/s41370-022-00462-5

Hanson, C., Luedtke, S., Spicer, N., Sörensen, J., Mayhew, S., & Mounier-Jack, S. (2021). National health governance, science and the media: drivers of COVID-19 responses in Germany, Sweden and the UK in 2020. *BMJ Global Health*, *6*. https://doi.org/10.1136/bmjgh-2021-006691

Heath, R. L., & Gay, C. D. (1997). Risk communication: Involvement, uncertainty, and control's effect on information scanning and monitoring by expert stakeholders. *Management Communication Quarterly*, *10*(3), 342-372. https://doi.org/10.1177/0893318997010003004

Heidenreich, A., & Thieken, A. (2024). Individual heat adaptation: Analyzing risk communication, warnings, heat risk perception, and protective behavior in three German cities. *Risk Analysis*, *44*, 1788-1808. https://doi.org/10.1111/risa.14278

Houston, J. B. (2012). Public disaster mental/behavioral health communication: Intervention across disaster phases. *Journal of Emergency Management*, *10*(4), 283-292. https://doi.org/10.5055/jem.2012.0106

Kasperson, R. (2014). Four questions for risk communication. *Journal of Risk Research*, *17*(10), 1233-1239. https://doi.org/10.1080/13669877.2014.900207

Korhonen, N., Balen, D., Prill, F., Salonen, M., Venäläinen, A., & Bär, M. (2024). The probabilistic skill of extended-range heat wave forecasts in Europe. *Natural Hazards and Earth System Sciences, 25*, 1865–1884. https://doi.org/10.5194/nhess-25-1865-2025

Krimsky, S. (2007). Risk communication in the internet age: The rise of disorganized skepticism. *Environmental Hazards*, *7*, 157-164. https://doi.org/10.1016/j.envhaz.2007.05.006

Leavitt, W. M., & Kiefer, J. J. (2006). Infrastructure interdependency and the creation of a "normal disaster": The case of Hurricane Katrina and the City of New Orleans. *Public Works Management & Policy, 10*(4), 306–314. https://doi.org/10.1177/1087724X06289055

Lee, C., Maron, M., & Mostafavi, A. (2021). Community-scale big data reveals disparate impacts of the Texas winter storm of 2021 and its managed power outage. *Humanities & Social Sciences Communications*, *9*. https://doi.org/10.1057/s41599-022-01353-8

Li, N., Zeng, W., Yin, S., & Zhao, L. (2025). How risk communication affects public trust in government: The moderating role of policy expectations. *Frontiers in Public Health*, *13,* 1557786. https://doi.org/10.3389/fpubh.2025.1557786

Malecki, K. M., Keating, J. A., & Safdar, N. (2021). Crisis communication and public perception of COVID-19 risk in the era of social media. *Clinical Infectious Diseases*, *72*(4), 697-702. https://doi.org/10.1093/cid/ciaa758

Mileti, D. S., & Sorensen, J. H. (1990). Communication of emergency public warnings: A social science perspective and state-of-the-art assessment. *Oak Ridge National Laboratory*. https://doi.org/10.2172/6137387

Muiderman, K., Vervoort, J., Gupta, A., Norbert-Munns, R. P., Veeger, M., Muzammil, M., & Driessen, P. (2023). Is anticipatory governance opening up or closing down future possibilities? Findings from diverse contexts in the Global South. *Global Environmental Change*, *81*, 102694. https://doi.org/10.1016/j.gloenvcha.2023.102694

Palen, L., Hiltz, S. R., & Liu, S. B. (2007). Online forums supporting grassroots participation in emergency preparedness and response. *Communications of the ACM*, *50*(3), 54-58. https://doi.org/10.1145/1226736.1226766

Pang, A., Jin, Y., Seo, Y., Choi, S. I., Teo, H. X., Le, P. D., & Reber, B. (2022). Breaking the sound of silence: Explication in the use of strategic silence in crisis communication. *International Journal of Business Communication*, *59*(2), 219-241. https://doi.org/10.1177/23294884211046357

Paton, D. (2008). Risk communication and natural hazard mitigation: How trust influences its effectiveness. *International Journal of Global Environmental Issues, 8*(1), 2-16. https://doi.org/10.1504/IJGENVI.2008.017256

Pescaroli, G., & Alexander, D. (2018). Understanding compound, interconnected, interacting, and cascading risks: A holistic framework. *Risk Analysis*, *38*(11), 2245-2257. https://doi.org/10.1111/risa.13128

Pescaroli, G., & Alexander, D. (2016). Critical infrastructure, panarchies and the vulnerability paths of cascading disasters. *Natural Hazards*, *82*, 175-192. https://doi.org/10.1007/s11069-016-2186-3

Rabe, L., Sataøen, H. L., Lidskog, R., & Eriksson, M. (2024). Making risk communication in practice: dimensions of professional logics in risk and vulnerability

assessments. *Journal of Risk Research*, *27*(3), 389-403. https://doi.org/10.1080/13669877.2024.2328199

Robertson, B. W., Dow, K., Salinas, J., & Cutter, S. L. (2024). Heat risk perceptions and coping strategies of the unhoused. *International Journal of Environmental Research and Public Health*, *21*(6), 737. https://doi.org/10.3390/ijerph21060737

Ross, A. D., Siebeneck, L., Wu, H. C., Kopczynski, S., Nepal, S., & Sauceda, M. (2024). Seven challenges for risk communication in today's digital era: The emergency manager's perspective. *Sustainability*, *16*(24), 11306. https://doi.org/10.3390/su162411306

Sandstig, G., & Eriksson, M. (2024). Shared responsibility or not? A responsibility messages experiment during a cyber crisis in designing for risk communication. *Journal of Risk Research*, *27*(10), 1163-1179. https://doi.org/10.1080/13669877.2024.2387351

Seeger, M. W. (2025). History of crisis and risk communication: The development of a global community of multi-disciplinary research, theory and practice. In A. Schwarz, M. W. Seeger, S. Kim (Eds.), *The Handbook of International Crisis and Risk Communication Research* (pp. 15-27). Wiley. https://doi.org/10.1002/9781394180844.ch2

Sellnow, T. L., & Seeger, M. W. (2013). *Theorizing crisis communication.* Wiley.

Sellnow-Richmond, D., & Lukacovic, M. (2026). *Communication amid Mega-Crises*. Routledge.

Schmuck, D., & Harff, D. (2023). Popular among distrustful youth? Social media influencers' communication about COVID-19 and young people's risk perceptions and vaccination intentions. *Health Communication*, *39*, 2730-2743. https://doi.org/10.1080/10410236.2023.2286408

Slater, M. D., Coleman, S., & Freiberger, N. (2024). Using the "media as mediator" approach to understand the influence of communication channel trust on COVID-19 protective behaviors: England, January 2022. *Journal of Health Communication*, *29*(10), 635-643. https://doi.org/10.1080/10810730.2024.2404912

Stephens, K. K., Barrett, A. K., & Mahometa, M. J. (2013). Organizational communication in emergencies: Using multiple channels and sources to combat noise and capture attention. *Human Communication Research*, *39*(2), 230-251. https://doi.org/10.1111/hcre.12002

Stephens, K. K., & Faust, K. (2026). *The handbook of infrastructure communication*. Wiley.

Stephens, K. K., Robertson, B. W., & Murthy, D. (2020). Throw me a lifeline: Articulating mobile social network dispersion and the social construction of risk in rescue communication. *Mobile Media & Communication*, *8*(2), 149-169. https://doi.org/10.1177/2050157919846522

Sutton, J., & Fischer, L. M. (2021). Understanding visual risk communication messages: An analysis of visual attention allocation and think-aloud responses to tornado graphics. *Weather, Climate, and Society, 13*(1), 1–12. https://doi.org/10.1175/WCAS-D-20-0042.1

Sutton, J., Renshaw, S., & Butts, C. (2020). COVID-19: Retransmission of official communications in an emerging pandemic. *PLoS ONE, 15*. https://doi.org/10.1371/journal.pone.0238491

Tierney, K. J. (2007). From the margins to the mainstream? Disaster research at the crossroads. *Annual Review of Sociology*, *33*(1), 503-525. https://doi.org/10.1146/annurev.soc.33.040406.131743

Unlu, A., Truong, S., Tammi, T., & Lohiniva, A. (2023). Exploring political mistrust in pandemic risk communication: Mixed-method study using social media data analysis. *Journal of Medical Internet Research*, *25*. https://doi.org/10.2196/50199

Vanderplanken, K., Van Den Hazel, P., Marx, M., Shams, A., Guha-Sapir, D., & Van Loenhout, J. (2021). Governing heatwaves in Europe: comparing health policy and practices to better understand roles, responsibilities and collaboration. *Health Research Policy and Systems*, *19*. https://doi.org/10.1186/s12961-020-00645-2

Watanabe, M., & Fujimi, T. (2025). Causal effects of time-sensitive risk communication on disaster preparedness. *International Journal of Disaster Risk Reduction*, 105598. https://doi.org/10.1016/j.ijdrr.2025.105598

Witte, K. (1992). Putting the fear back into fear appeals: The extended parallel process model. *Communication Monographs*, *59*, 329-349. https://doi.org/10.1080/03637759209376276

Witte, K., & Allen, M. (2000). A meta-analysis of fear appeals: Implications for effective public health campaigns. *Health Education & Behavior*, *27*, 591-615. https://doi.org/10.1177/109019810002700506

Yoo, W., Oh, S. H., & Choi, D. H. (2023). Exposure to COVID-19 misinformation across instant messaging apps: Moderating roles of news media and interpersonal communication. *International Journal of Communication, 17*, 712-734. https://ijoc.org/index.php/ijoc/article/view/17594/4021

Zhang, H., Yang, C., Deng, X., & Luo, C. (2025). How authoritative media and personal social media influence policy compliance through trust in government and risk perception: Quantitative cross-sectional survey study. *Journal of Medical Internet Research*, 27. https://doi.org/10.2196/64940

Zuccaro, G., Gregorio, D., & Leone, M. (2018). Theoretical model for cascading effects analyses. *International Journal of Disaster Risk Reduction*, *30*, 199-215. https://doi.org/10.1016/j.ijdrr.2018.04.019

Zuo, T., He, L., Zheng, Y., Lin, Z., Xu, Z., & Li, N. (2025). Communication analysis of the COVID-19 infodemic by medical practitioners in China: A mixed methods study. *Social Science & Medicine*, *374*, 118051. https://doi.org/10.1016/j.socscimed.2025.118051