13

SYSTEMIC PLANETARY RISKS

Implications for Organization Studies

Gail Whiteman and Amanda Williams

Environmental risks to humans are not new – history is replete with examples of societies that collapsed alongside ecosystem change (Diamond, 2005). We know that numerous societies have suffered because of environmental pollution from organizational operations (King & Lenox, 2000; Maguire & Hardy, 2009, Maguire & Hardy, 2013) and from industrial accidents (Gephart, 1984: Tsoukas, 1999).

However, the scale of environmental risks has changed over the course of the 20th century from locale-specific threats to those arising at a planetary level (Rockström et al., 2009a, 2009b; Whiteman, Walker, & Perego, 2013). Natural scientists now estimate that four of the nine essential planetary processes needed to sustain life have exceeded safe thresholds and now represent significant risks to humanity (Rockström et al., 2009a, 2009b; Steffen et al., 2015a). In particular, climate change and land-system change are well past safe thresholds and have entered the zone of increasing risk where the rate of biodiversity loss and phosphorus and nitrogen release pose high levels of planetary risk. In such a world, organizational "processes of risk calculation used in modern society fail to work in risk society because risks are no longer localized and are long term in nature" (Gephart, Van Maanen, & Oberlechner, 2009, p. 145).

Natural scientists further argue that there are solid data to suggest that organizational and economic activities over time have been the driving force behind the planetary shift away from the stable Holocene period into what has been called the Anthropocene (Steffen et al., 2015b) – what Nobel Prize winner Paul Crutzen and colleagues describe as period of time commencing with the industrial revolution where human impact on the environment became the paramount force of change (Steffen, Crutzen, & McNeill, 2007). The central role of organizations within these shifts seems likely.

However, the complex role of organizations as collective contributors to and recipients of systemic risks at the planetary level remains underexplored (Winn, Kirchgeorg, Griffiths, Linnenluecke, & Gunther, 2011). While the organizational risk management literature is vast, organizational studies of risk seldom integrate environmental threats into conceptual frameworks (cf. Bundy, Pfarrer, Short, & Coombs, 2017). In addition, the handful of studies on environmental risk within the corporate sustainability literature are firm-specific and focus more on supply chain or operational risks from specific natural events – in terms of extreme weather (e.g. Linnenluecke & Griffiths, 2013)– or risks to the natural world through organizational accidents such as Exxon Valdez (Shrivastava, 1994) or Deepwater Horizon

(Bozeman, 2011). Integration of planetary risks to, and from, collections of organizational actors over time is lacking.

The aim of this chapter is to address these gaps. We ask the question, 'How can researchers of organization theory collaborate with managers of organizations to better conceptualize systemic ecosystems risks and develop strategies to insure these are addressed?' Building upon advances in Earth System Science, we present a framework for analyzing systemic planetary risks and consider the role of collections of organizational actors. Our chapter is organized as follows: we first set the broader context by reviewing the literature on environmental risk at the planetary scale and on global business discussions on risk. We then review the organizational literature on environmental risks, and identify the gaps in the organizational literature evident from the issue addressed in systemic research on environmental risk at the planetary scale. To help address these gaps in our understanding of organizations and risk, we present a framework that encapsulates a systemic view of social-ecological risk and organizations. We close with a discussion of future research needs.

The Landscape of Planetary Risk

To support more effective risk management at the global level, earth system science indicates that there are nine key global ecosystem processes that collectively interact to create a 'safe operating space for humanity' (Rockström et al., 2009a; Whiteman et al., 2013). These processes include climate change, biochemical flows of phosphorus and nitrogen, freshwater use, land-system change, biosphere integrity (biodiversity); ocean acidification, stratospheric ozone depletion, atmospheric aerosol loading (air pollution); and novel entities (chemical pollution) (Figure 13.1).

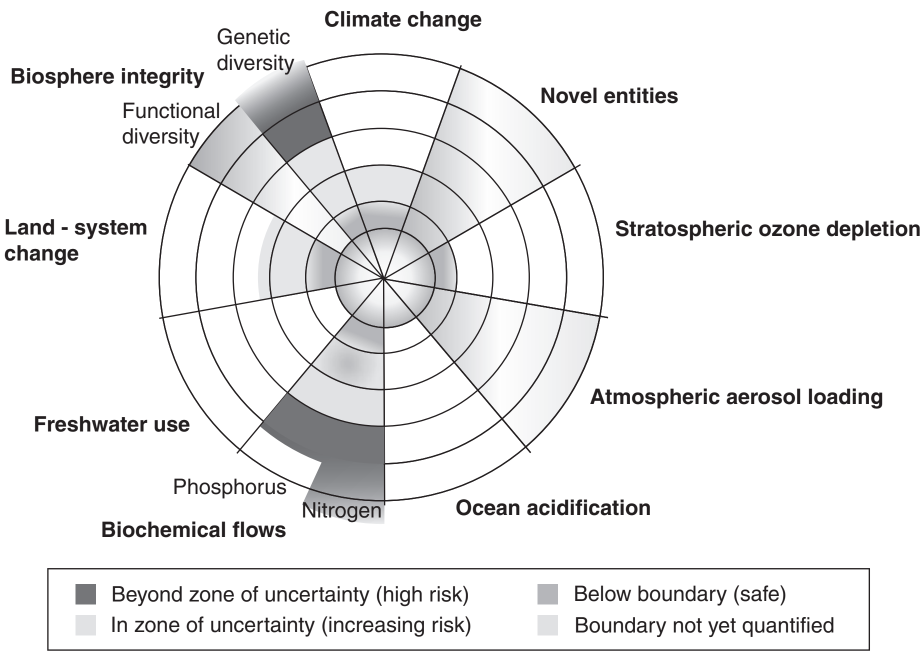

Figure 13.1 Planetary Boundaries and Safe Thresholds

Source: Steffen et al. Planetary Boundaries: Guiding Human Development on a Changing Planet, *Science,* 16 January 2015a. (Credit: F. Pharand-Deschênes /Globaïa).

The nine boundaries are dynamically interconnected, so risks in one area will trigger increasing risks in others. An analysis of systemic risk factors at the planetary level, which captures both spatial and temporal dimensions, is thus important. For some parts of the world, including the Arctic and drought-ridden parts of Africa, the United States and Australia, climate change impacts are happening already (2018) (droughts, floods, fire, etc.; cf. IPCC, 2015) alongside of degradation of land, water, and air pollution (see Le De and Shrestha, 2018, this volume). In other parts of the world, planetary risks are the most serious under future scenarios – thus, risks may be mitigated to some extent if deep de-carbonization occurs in the near-term. While the highest risks of climate change or ocean acidification have not yet materialized into catastrophic tipping points, the window of opportunity to address the increasing (and significant) risks of climate change is closing fast (Figueres et al., 2017). Thus, planetary risk management requires that the world deal urgently with the emissions crisis in the near-term, in order to provide us with a safer space to tackle other entrenched ecosystem problems.

Scholars have identified the period since World War II as the "Great Acceleration," whereby industrial processes dramatically accelerated their impact on the structure and functioning of key ecosystem resources including rapidly increasing levels of carbon dioxide, nitrous oxide, methane, stratospheric ozone loss, surface temperature, ocean acidification, tropical forest loss, and terrestrial biosphere degradation (Steffen et al., 2015b).

While causality has yet to be conclusively proven, given the complexity of these effects, it is highly plausible that cumulative and collective organizational action is correlated with or related to systemic degradation of the planet's key ecosystem processes. Furthermore, these human-led impacts have, over time, introduced a new landscape of planetary risk that poses complex and uncertain threats for humanity and for the organizations that collectively make up the world as we know it (see Rockström et al., 2009a, 2009b; Steffen et al., 2015a; Whiteman et al., 2013). Natural science data thus support the social science argument (Beck, 1992; Beck & Holzer, 2007) on risk societies: that "the success of the wealth-generating industrial society has produced a situation in which the risks and problematic by-products of wealth generation have become the new basic organizing principle and a key concern for society (Lupton 1999b, p. 59)" (in Gephart et al., 2009, p. 145). We argue that this is an area ripe for conceptual and empirical development for organization studies.

Organizational Literature on Risk and the Natural Environment

The literature on risks and the natural environment has shown that organizations can reduce vulnerability to risks by preparing for potential disturbances and by developing coordination techniques within organizations and with other stakeholders (Williams, Gruber, Sutcliffe, Shepherd, & Zhao, 2017). Two main streams of research explain how managers prevent crises through effective risk management. The internal perspective focuses on organizational preparedness and how managers build capabilities to manage unexpected events (Bundy et al., 2017). For example, research on high-reliability organizations demonstrates that effectively correcting errors and remaining flexible can prevent crisis (Weick & Sutcliffe, 2001). The external perspective suggests that relationships with stakeholders influence managerial capacity to manage risks (Bundy et al., 2017). Relationships with stakeholders can provide the knowledge and resources necessary to facilitate recovery after a crisis (Williams & Shepherd, 2016; Le De & Shrestha, Chapter 3).

A review of the management literature suggests: (1) the natural environment is notably absent from leading organizational risk frameworks (see, e.g. Figure 1 in Bundy et al., 2017,

Table 13.1 Overview of Organizational Risk Literature Concerning the Natural Environment

Risk type	Studies focused on threats from the natural environment to organizations	Studies focused on organizational threats to the natural environment	Systemic studies examining the feedback loops across organizations and between socio-ecological systems
Discrete events	- Mann Gulch (Weick, 1993) - Victoria Bushfires (Linnenluecke & Griffiths, 2013) - Climate risks (Beerkhout et al., 2006; Beermann, 2011) - Droughts and floods (Gasbarro, Rizzi, & Frey 2016) - Pollution (Dobler, Lajili, & Zéghal 2014) - Hurricanes (Delp, Podolsky, & Aguilar 2009)	- Bhopal (Shrivastava, 1992) - Oil spills (Pauchant & Mitroff, 1992) - Fukushima - Other toxic releases - High risk technologies (Gephart, 2004)	- Firm contribution to climate change and climate impacts on the firm (Weinhofer & Busch, 2012)
Processes over time	- Supply chain risks (Hofmann, Busse, Bode, & Henke 2014) - Chemical industry supply chain risk (Kleindorfer & Saad, 2005) - Mann Gulch (Whiteman & Cooper 2011) - Social and environmental practices (Ortiz-de-Mandojana & Bansal, 2016) - Climate change (Hahn, Reimsbach, & Schiemann 2015; Pinkse & Gasbarro, 2016)	- Climate risks (Kolk & Pinkse, 2005) - Sustainable energy (Kondoh, 2009) - Eco-certification (Melo & Wolf, 2005)	- Toledo water supply and Lake Erie phosphorus bloom (Whiteman & Kennedy, 2016)

p. 1665) due to the implicit assumption of a stable natural environment, or one that faces linear change, (2) risk studies from the corporate sustainability literature are either focused on episodic threats from natural environment (e.g., through extreme weather) or are focused on organizationally produced risks to the natural environment through industrial accidents, and (3) there are limited studies that examine systemic feedback loops between organizations and dynamic ecosystem processes facing threats (see Table 13.1). In Table 13.1, we provide an overview of the literature along two dimensions. First, we examine if environmental risks are considered at a discrete point in time or a risk that unfolds as a process over time and space. Then we consider the directionality of the threat.

On the positive side, organizational researchers recognize that numerous companies, including the insurance sector, have begun to seriously consider the threat of climate change over the last ten years, but have failed to integrate climate change risk into corporate governance structures (Thistlethwaite, 2012; Thistlethwaite & Wood, 2087). Despite a relatively late recognition of the need for corporate sustainability research to focus on climate change (Goodall, 2008), there is now a good understanding of drivers of carbon reporting and lobbying, clear knowledge of institutional drivers of carbon accounting regimes, evidence of financial risks for a firm from climate change (Hahn et al., 2015), and a growing understanding of the physical risks from climate change such as those from extreme weather (Linnenluecke & Griffiths, 2013; Weinhofer & Busch, 2013). There is also continuing research focus on managing the risks from natural disasters or extreme weather events – fires, floods, drought – both in terms of supply chain risk and response (Linnenluecke & Griffiths, 2013) and philanthropic disaster response (Muller & Whiteman, 2009). In addition, the organizational adaptation literature has focused on building organizational resilience in the face of changing climate conditions (Linnenluecke & Griffiths, 2010; Williams, T. A. et al., 2017). Collectively, these studies provide new insights into risk management, noting that organizations can build resilience and adaptive capacity by creating network responses and sensemaking capabilities and encouraging flexibility (Linnenluecke & Griffiths, 2013).

Research also shows that risk perception is an important factor in determining a firm's selective attention to climate change risks; however, firms tend to focus on short-term risks that are of immediate concern for business decisions (Pinkse & Gasbarro, 2016). A temporal bias thus prevents firms from considering risks that will materialize in the distant future (Pinkse & Gasbarro, 2016). Managers tend to overlook risks when the temporal and spatial attributes, or scale of the processes related to the risk being observed, are not aligned with their cognition (Bansal, Kim, & Wood, 2017). Corporations that operate in more dynamic and competitive environments are more likely to implement adaptation strategies in the face of climate risks (Berkhout, Hertin, & Gann 2006). Companies that perceive long-term organizational survival is threatened by climate change are more likely to invest in risky environmental technologies to enhance organizational resilience (Kolk & Pinkse, 2008). Climate change may jeopardize long-term organizational survival. Nuclear power reduces carbon dioxide emissions but increases the nuclear threats such as exposure to radioactivity creating a risk tradeoff (Kondoh, 2009). In addition, if nuclear waste storage zones are in geographic areas which may be affected by rising sea levels or extreme weather, then new risks may arise.

To date, there is little crossover between the corporate sustainability literature and the organizational literature on risk and crisis management, which implicitly assume a stable natural environment (cf. Gephart et al., 2009; Bundy et al., 2017). Overall, most studies are firm- and industry-focused, and few, if any, attempt to analyze cumulative, interrelated systemic risks at global, regional, and local levels over time (Whiteman et al., 2013. Integrative frameworks of organizational crisis and risk implicitly assume a stable (and therefore invisible) natural environment, which is not identified as an explicit variable or dynamic context shaping risk (Bundy et al., 2017). Firms' individual and collective actions also contribute significantly to global warming and other planetary boundaries, and co-create the threats that increase risks to their operations and financial stability. In the next section, we propose an integrative framework (Figure 13.3) to help organizational scholars examine feedback loops across organizations and between social-ecological systems.

A Framework for Analyzing Systemic Planetary Risks

The outstanding question for organizational scholars is how can we contribute to the conversation about systemic planetary risks? The answer, from our perspective, is threefold:

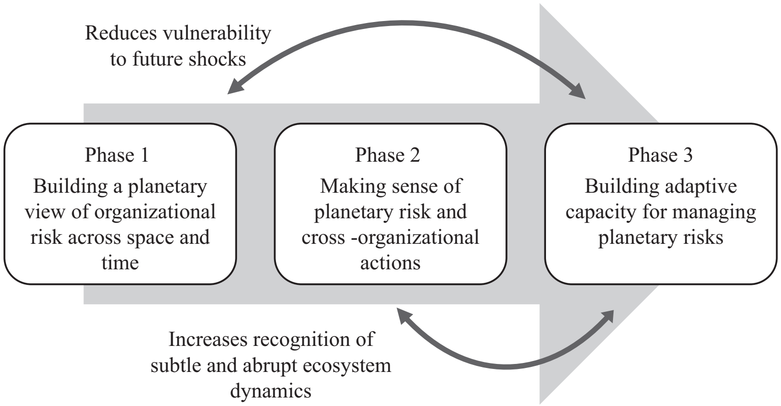

Figure 13.2 A Framework for Analyzing Systemic Planetary Risks

we can incorporate planetary risk into our view of organizational risk; second, we can help organizations make sense of planetary risks; and third, we can identify how managers can build more adaptive capacity through systemic risk management programs across scale, and across organizational actors. To do so, we offer a framework (summarized in Figure 13.2) which consists of three iterative phases (1) building a planetary view of organizational risk across temporal and spatial scales, (2) making sense of organizational actions in the context of planetary risks, and (3) building adaptive capacity to mitigate planetary risks.

Phase 1: Building a Planetary View of Organizational Risk across Temporal and Spatial Scales

Risks from climate change, lack of fresh water, land use pressures, air pollution (aerosol loading), ocean acidification, and chemical pollution (or more broadly, the release of hazardous entities) pose significant material risks to companies and societies – and critically can be tied back to economic activity across companies and organizations over temporal and spatial scales (Steffen et al., 2015a; Clift et al., 2017). Planetary risks are systemic in nature and need to be examined at local, regional, and global levels (Steffen et al., 2015a; Whiteman et al., 2013).

We therefore suggest that risk management decisions today need to be influenced by an understanding of these ecosystem risks which are interconnected at global, regional, and local scales overtime. Figure 13.3 depicts safe and unsafe risk pathways in relation to planetary boundaries, shows trends in global, regional, and local risks over time, and provides the background for the discussion that follows.

Companies should take a long-term perspective to evaluate which risks could materialize at different time scales, and assess both the materiality of those risks to firm operations, and unintended externalities that arise from organizational actions which may amplify planetary risks. Integrating the planetary boundaries framework to risk management ensures that a more systemic approach is adopted which incorporates cross-organizational, cumulative organizational actions. This also reflects the growing systemic perspective of global economic actors, such as the World Economic Forum which argues that "[a] key characteristic of global risks is their potential systemic nature – they have the potential to affect an entire system, as opposed to individual parts and components" (WEF, 2014).

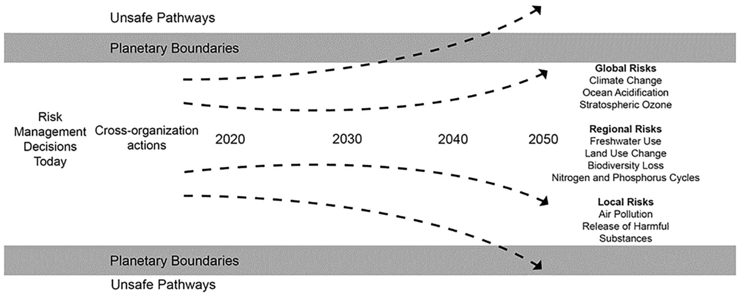

Figure 13.3 Cross-organizational View of Long-term Planetary Risks over Time and Space

The planetary boundaries framework (Figure 13.1) outlines the nine key ecosystem processes which collectively delineate the safe space for humanity. By incorporating this framework into our discipline, a key implication is to explicitly consider how organizational actions contribute (or detract) from pathways which may (or may not) lead to a safe space for humanity (Rockström et al., 2009a, 2009b, 2013; Whiteman et.al, 2013); Steffen et al., 2015a). Safe pathways are those that mitigate planetary risks. Unsafe pathways are those that (intentionally or unintentionally) amplify planetary risks.

A systemic perspective requires a cross-organizational collective view of planetary risks over both time and space. Issues of scale are important when managers identify risks (Bansal et al., 2017). We discuss these in more detail in the following section.

Temporal Scales

Temporal scale is "the patterned variations in processes over time" (Bansal et al., 2017, p. 12). Long-term organizational survival depends on managers capacity to manage intertemporal tradeoffs (Bansal & DesJardine, 2014). Inability to manage short-term and long-term risks exposes the firm to risks across scales (Bansal & DesJardine, 2014). Figure 13.3 adopts a ten-year time interval (up to 2050) given that global societal and economic risks have been defined as "an occurrence that causes significant negative impact for several countries and industries over a time frame of up to 10 years" (WEF, 2014). In Figure 13.3, we have suggested time intervals including 2020, 2030, 2040, and 2050. Most of these intervals have coincided with existing globally agreed-upon frameworks and scientific targets. The year 2020 has been proposed as the turning point for bending the global emissions curve in order to achieve the climate targets set by the Paris Agreement (Figueres et al., 2017). In addition, the UN Sustainable Development Goals (SDGs), agreed upon by 193 member states of the UN, set the global development agenda until 2030. The 17 SDGs and 169 targets set broad social and environmental goals. If seriously implemented by governments, regulations and investment flows are expected to align with the SDGs. To account for future risks and opportunities, managers should map their current operations against the SDGs and align their strategy with the SDGs. The SDG Compass, a guide for business action on the SDGs, provides advice for companies to understand the impacts of the SDGs (GRI, UNGC, & WBCSD, 2015). The guide suggests identifying high-impact areas and then evaluating the risks and opportunities that the prioritized areas present. The guide also identifies specific open-access tools and indicators for each SDG that can be useful during the process. By 2050, climate scientists agree that net zero emissions should be reached (Rockström et al., 2017).

Our framework explicitly identifies these four intervals given the need for firm behavior to collectively be aligned with global agreements and scientific thresholds to mitigate long-term social-ecological risks. Managers can, in collaboration with scientists, further identify and refine time intervals such that they are most pertinent and relevant for firm-specific operations. Nevertheless, the collective systemic targets and time frames remain relevant for each firm as it operates within the collective behaviors of multiple firms and societies. In order to effectively and robustly evaluate future risks to and from the natural environment, managers should also account for cross-scale feedbacks over time. For example, infrastructure decisions made by countries, cities, and companies cannot be assessed without a systemic appreciation of risks from the natural environment. There are some encouraging signs that this approach is being applied in cities like London, which are evaluating green infrastructure decisions on transport, water, and energy to both accommodate a growing population and make the city more resilient to the effects of climate change. In general, our framework suggests that organizational decisions made today will positively and negatively impact social-ecological systems over time and across different geographic scales. If the feedback from these decisions is not accounted for today, organizations will be left vulnerable to unexpected future shocks.

Spatial Scales

Achieving sustainability requires addressing interactions across spatial scales (Starik & Rands, 1995). Spatial scale is "the geographical area in which the dominant process(es) of interest manifest" (Bansal et al. 2017, p. 12). In Figure 13.3, we have identified a number of organizational risks that materialize at global, regional, and local spatial scales related to the planetary boundaries processes**.** In order to do so, we build upon prior transdisciplinary work that considers the spatial implications of planetary risks to organizational behavior (Whiteman et al., 2013).

Using a spatial application of the planetary boundaries concept to organizations in the natural environment, Whiteman et al. (2013, p. 324) show that "corporate sustainability is anchored within an analysis of how the company (and industry at a higher scale) affects all nine boundary processes within specific bounded geographies – at the local, regional, continental, and planetary level." One empirical example of this type of approach is an organizational analysis of cumulative cross-scale risks from phosphorus overload in Lake Erie (Whiteman & Kennedy, 2016). This study used the Lake Erie water system as the focal unit of analysis rather than starting with specific organizational actors (e.g., farmers or agricultural companies). A spatial and temporal analysis necessitates a broader investigation of the biophysical processes surrounding Lake Erie as well as the collective and cumulative actions of multiple actors shaping the agricultural sector (e.g., regulators, seed manufacturers, farmers, fertilizer manufacturers, retailers, transportation), as well as those from shipping, recreation, retail, and water management.

Figure 13.3 provides examples of risks that may arise at different spatial scales including global, regional, and local (summarized on the right side of Figure 13.3). Thus, cross-organizational actions must simultaneously consider spatial and temporal scales across social, ecological, economic, and organizational subsystems. A processual view collapses the notion that "crisis" can be avoided, but rather it is part of a complex process unfolding with risks to be limited or contained (Whiteman & Kennedy, 2016, Williams, T. A. et al., 2017).

Phase 2: Making Sense of Planetary Risk and Organizational Actions

Organizational studies indicate that knowledge and information about risks is important for framing and deciding upon courses of action (Sullivan-Taylor & Wilson, 2009).

When information is scarce, the level of risk and exposure to the risk increases (Sullivan-Taylor & Wilson, 2009).

Encouragingly, "real-world" discussions of global risk have begun to make sense of planetary risks. For example, each year, the World Economic Forum (WEF) issues an influential report on Global Risk. Based upon feedback from 750 global experts, WEF identifies the top risks facing world leaders, including the private sector (WEF, 2017). For much of its history, the WEF Global Risk Report has short-listed risks from civil unrest, war, market turbulence, and supply chain disruption. But in recent years, the global risk landscape changed, and WEF's reports (e.g., 2017) recognize the natural environment and extreme weather as the source of the top risk to humankind – the threat of climate change was ranked as the #1 risk facing the world because of both the growing likelihood of this occurring and the increasing scope of the potential impacts. "Research indicates that unbridled anthropogenic climate change would be most likely to play out in a disruptive and irreparable way" (Schellnhuber, Rahmstorf, & Winkelmann, 2016, p. 650). WEF actively supports work on other planetary risks like water, and has convened numerous workshops on the implications of planetary boundaries for various sectors, nations, and within various types of organizations (Rockström, personal communication).

Economic discussions of planetary risks are also a topic within the corporate boardroom. Unilever, for instance, has explicitly considered planetary boundaries risks to and from their value chain (Clift et al., 2017). Planetary boundary processes such as climate change, fresh water use, and nitrogen and phosphorus flows pose significant risks to food security at local and regional scales.

At the same time, such discussions remain more well developed on single-topic issues such as ozone depletion or the climate change front. For instance, Mark Carney, Governor of the Bank of England and Chair of the G-20 Financial Stability Board, argues that climate change poses physical, liability, and transition risks to markets and firms (Carney, 2016, pp. 2–4). More work is required to integrate the systemic nature of planetary risk into these arenas and to more effectively make sense of complex feedbacks across different spatial and temporal scales. Weinhofer and Busch (2012) suggest, for instance, that future research should examine a two-dimensional risk perspective on climate change including both an "inside-out" perspective which acknowledges the firm's contributions to climate change and an "outside-in" perspective which acknowledges the impact of climate risks on the firm. However, they do not discuss the interaction of inter-related risks over time.

We also know that risk sensemaking is critical to understanding the threat of high-risk technologies to the natural environment (Gephart, 2004). In general, organizational sensemaking contributes to effective crisis and risk management by helping organizational actors identify and develop a shared understanding and set of responses to emerging risks (cf. Williams, T. A. et al., 2017). But research on ecological sensemaking further suggests that ecological crises occur when individuals – and by extension, organizations – are disembedded from the natural environment (Whiteman & Cooper, 2000). "To the unseasoned, the dynamics of nature may appear as undifferentiated flux, but to the more experienced, this ecological flux contains important raw data that can signal danger" (Whiteman & Cooper, 2011, p. 891). Ecological sensemaking is "the process by which actors identify and make sense of complex ecological systems that unfold over space and time" (p. 890). Proponents of ecological sensemaking "explicitly recognize that the natural environment consists of material and physical elements" (p. 889) and the ability to make sense of subtle and abrupt ecosystemic dynamics across time and space can enhance organizational resilience at both the individual and collective levels: "if local actors are not routinely engaging in ecological sensemaking, and/or this expertise is not effectively transferred 'across scale,' hidden vulnerability can escalate into crisis" (p. 908).

Here we argue that cross-organizational sensemaking of planetary risks can be facilitated by combining local data on ecosystem change, and by using science-based boundary objects to formulate a collective strategy to address pressing global environmental issues. Framing of global systemic risks may also be an avenue for organizational scholars to pursue. Bundy et al. (2017, p. 11), for instance, show that "leaders who frame crises as threats react more emotionally and are more limited in their efforts, while leaders who frame crises as opportunities are more open-minded and flexible."

Phase 3: Building Adaptive Capacity for Managing Planetary Risks

We explained how organizational risks in our complex planetary system can be understood, and we now suggest how managers could collectively build adaptive capacity to cope with long-term systemic risks.

When levels of uncertainty are high and information is scarce, management techniques which emphasize prediction and planning are insufficient (Sullivan-Taylor & Wilson, 2009). In order to cope with systemic long-term risks arising from transgressed planetary boundaries, managers can build long-term adaptive capacity to systemic ecosystem risks. A key implication of Figure 13.3 is for organization scholars to consider the interrelated risks of other social-ecological systems, such as biodiversity, nitrogen/phosphorus use, and ozone depletion on organizational adaptation strategies (Whiteman et al., 2013), over time (Bansal & DesJardine, 2014). An example of this approach to organizational studies of risk is found in Whiteman and Kennedy (2016) in their systemic analysis of the phosphorus threat facing the city of Toledo, Ohio.

The adaptive capacity of organizations within nested social-ecological systems is one of the key mechanisms to managing planetary risks. Adaptability is "the capacity of actors in a system to influence resilience" (Folke et al., 2010, p. 3), in order to "avoid crossing into an undesirable system regime, or to succeed in crossing into a desirable one" (Walker & Salt, 2006, p. 163). To respond effectively to systemic shocks arising from increasing volatility of the planetary system, organizations can build flexible and adaptive systems. Self-organizing systems tend to be highly adaptive. Heightened sensemaking of ecological risks may initiate organizational adaptation strategies to build the required resilience (Clément & Rivera, 2016). For instance, studies have shown that considering how to manage risks posed by climate change, mitigation can improve long-term resilience capabilities (Beermann, 2011). Yet adaptive capacity to climate change cannot be developed in isolation from other planetary boundaries. For example, land degradation, another planetary boundary, is affected by climate change. For example, a forest fire contributes to climate change by releasing carbon stored in the trees that are burned and leaves fewer trees for carbon storage in remaining woodlands. Such risks are intrinsically intertwined, and adaptive capacity is a cross-organizational and systemic phenomenon.

After an understanding of the planetary system is developed, managers may build adaptive or transformative capacity to cope with long-term risks. For example, managers of high-reliability organizations (HROs), or organizations in high-risks industries which never fail, build adaptive capacity for organizational resilience (Weick & Sutcliffe, 2001).

Research also suggests that the resilience of ecosystem services is enhanced when governance systems encourage learning and experimentation, foster an understanding of complex systems, promote participation, and implement polycentric governance (Biggs et al., 2012).

Managers can thus encourage diversity and redundancy as well as manage feedbacks and connectivity to enhance the resilience of ecosystem services (Biggs et al., 2012; Winn & Pogutz, 2013). More resilience is not necessarily better. Often systems that are too resilient become rigid and unable to undertake necessary change until it is too late (Walker, Holling, Carpenter, & Kinzig, 2004). When adaptation limits are reached, transformative change may be necessary (Walker et al., 2004; Clément & Rivera, 2016), which may, in turn, require the reduction in resilience within the old system. Resilience of existing structures and behaviors must be reduced in order to introduce new variables into the system to allow for transformative change (Walker & Salt, 2004). (Ecological) transformability is "the capacity to create a fundamentally new system when ecological, economic or social structures make the existing system untenable" (Walker et al., 2004). Organizations, including companies, have important roles to play within the transformation of market systems through eco-innovation and novelty (Loorbach, van Bakel, Whiteman, & Rotmans, 2010; Kennedy, Whiteman, & van den Ende, 2017).

Given the spatial scale of global risks (see Figure 13.3), we suggest organizations need to build adaptive or transformative capacity collectively. For example, research on recovery operations after New Zealand earthquakes finds that organizations embedded in strong networks are able to better organize after a disaster (Stevenson et al., 2014). If connectedness is low in networks of organizations, vulnerabilities to global risks may increase. Some network structures could be more vulnerable when a node is removed compared to others (van der Vegt, Essens, Wahlström, & George, 2015). Research on resilience in organizational networks would be particularly relevant for supply chains, where organizational connectedness is high. More knowledge is needed to understand cross-organizational resilience, adaptation, and transformation as responses to long-term global systemic risks.

Organizational scholars should also examine how cross-organizational governance structures influence responses to global systemic risks. Governance and compensation structure may influence the probability of a crisis (Bundy et al., 2017). Companies that wish to avert possible climate change risks may rely on changes in compensatory benefits (Kolk & Pinkse, 2005). Although research has yet to explore the impact of tying compensation structures to global risks or to assess the subsequent impacts on organizational resilience, the structure of corporate boards may need to be revised to include a role for chief climate officers or a planetary risk committee.

Conclusion

We proposed in this chapter that organizational studies of risk can benefit from the wealth of natural science insights on systemic ecosystem risks at the planetary scale. Hoskisson, Chirico, Zyung, and Gambeta (2017, p. 156) posit that the dominant organizational theories such as agency theory or the behavioral theory of the firm that are used to understand managerial risk-taking tend to focus on solely risks that are economic or financial in nature. The authors argue that the boundary conditions of risk theories should therefore be reconsidered. Alternative theories are needed to redefine risk-taking and consider risks beyond firm-level financial risks (Hoskisson et al., 2017). This chapter has contributed to the advancement of the literature on organizational risk by a long-term, systemic perspective on planetary risks that recognizes the embeddedness of organizations in the natural environment.

Further, given the ongoing escalation of planetary risks related to key ecosystem processes, we proposed a three-phase framework for analyzing systemic planetary risks (Figure 13.2) that can contribute to reduction of these risks by establishing ways for organizations to build a planetary view of organizational risk across temporal and spatial scales, make sense of organizational actions in the context of planetary risks, and build adaptive capacity to mitigate planetary risks.

Critically, our framework highlights the importance of making managerial decisions as soon as possible to take into consideration safe pathways within the boundaries of the planet (Steffen et al., 2015a). To manage the long-term systemic risks of organizations, we suggest principles of adaptive capacity and resilience can prepare managers for unanticipated risks from the natural environment and enhance managers collectively ability to respond to long-term planetary risks driven by feedback loops across local, regional, and global scales. One example is Action 2020, the collective strategy of the World Business Council for Sustainable Development, which utilized the planetary boundaries framework to develop science-based targets for collective business action in an effort to mitigate systemic risks from the natural environment.

We have also suggested several areas of research including sensemaking, organizational networks, and governance in the discussion that organizational scholars can undertake to contribute to a better understanding of planetary risks.

We also note that our framework has limitations. In particular, we pay little attention to social risks in our framework (Leach, Raworth, & Rockström, 2013). However, we recognize that planetary environmental risks are deeply intertwined with pressing societal issues, and the interaction between these systems needs greater exploration in terms of cross-organizational behaviors. In addition, future empirical research is needed to explore barriers and enablers to our collective framework, including a deeper analysis of the role of entrenched vested interests and power relations. Future research on bounded rationality in managerial risk perceptions across scales is required, especially given that prior research indicates that "risk perception in an important factor in determining a firm's selective attention to climate change risks; however, firms tend to focus on short-term risks that are of immediate concern for business decisions" (Pinkse & Gasbarro, 2016).

We thus encourage organizational scholars to research long-term systemic risks that have yet to receive scholarly attention. For example, the WEF's *The Global Risks Report 2017* found that social instability, migration, and water crises are the most critical societal risks for businesses in 2017 (WEF, 2017). Amongst the top environmental risks are biodiversity loss and ecosystem collapse. However, our review of the literature shows that these risks have received little attention. We urge organizational scholars to devote more attention to these pressing global risks.

Finally, we argue that a cross-organizational and transdisciplinary approach is necessary – organization scholars cannot effectively address planetary risks to and from organizations without collaborating with our natural science colleagues. We thus reiterate the long-standing call in sustainability research for greater transdisciplinary integration and closer collaboration between social scientists and natural scientists to help to fill these gaps. While it may be true that past societies have been surprised by catastrophic environmental risks, we argue that a transdisciplinary approach to organizational risk can help us learn from the mistakes of the past and collectively contribute to a safe space for humanity. There is no time to lose.

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