THE SOCIAL DIMENSION

CHAPTER IV LESSONS FOR MINING FROM INTERNATIONAL DISASTER RESEARCH

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1. INTRODUCTION

When there is a major industrial disaster, there are a number of common reactions. People express shock or anger, empathise with victims, and applaud rescue efforts. Losses and damages are calculated, and forensic investigations ensue. Many people will ask how the disaster happened. However, while legal charges may be laid against individuals and organisations, and moral disapproval expressed towards those seen as responsible for the disaster, rarely do we insist that investigators look beyond immediate events and probe for deeper underlying causes. In the aftermath of a disaster – and before public interest wanes – popular media tends to centre on the drama, the tragedy, and the crimes of those who failed to fulfil their corporate responsibilities.

This sequence mirrors what has occurred after devastating failures of mine tailings facilities. Most recently, the world expressed shock at the torrent of sludge that wiped out villages and ecosystems in Brazil, watched in horror as the death count of employees and community members rose, and empathised with the families whose lives and livelihoods were shattered. Forensic studies of the tailings facilities were commissioned, examining their design, integrity and stability. The decisions that immediately preceded the failures and the sudden release of slurry were also scrutinised and flaws exposed. As prosecutors identified who was responsible, fines were issued, damages paid, and charges instituted against corporate executives.

There is a growing movement in contemporary disaster research that asks not only why a particular event occurred, but why it resulted in disaster. This approach pushes towards a deeply structural and systemic analysis on the basis that conventional investigations of catastrophic events provide only a partial explanation. The approach pivots away from conceptualising disaster as a spatially and time-bound event, and towards seeing the broader context as a potential cause of the disaster, and not simply as the backdrop against which disaster plays out. Re-framing disasters in this way has important practical implications, as it significantly broadens the focus of efforts to prevent catastrophic outcomes in the future.

In this chapter I draw on this body of work to demonstrate the value of viewing tailings disasters as resulting from a set of factors and forces that produce conditions of vulnerability that create or contribute to disasters, rather than a disaster being attributable solely to the hazard; or in the case of a tailings facility, the failure of an engineered structure. I also examine the challenges associated with mobilising forensic, broad-based research to conduct this form of analysis, and explore the implications for the global mining industry of viewing disasters from a perspective that includes people's vulnerability as a causal factor.

The first part of the chapter defines 'disaster' and 'disaster risk', and then reviews developments in international disaster research and practice. I then briefly elaborate five principles that define this contemporary approach to understanding and explaining disasters. In the concluding section I reflect on the benefits of taking a broad-based approach to analysing disaster risk in mining and discuss the challenges associated with changing how the industry views – and therefore seeks to explain – the causes of a tailings disaster.

A key aim of the chapter is to demonstrate that social, cultural, political and historical factors must be considered if the goals of the Global Industry Standard on Tailings Management (the 'Standard') are to be realised. Deeply technical knowledge from

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the physical sciences is crucial to the safe design, construction, management, and closure of tailings facilities. However, while such knowledge is essential, it is not sufficient for understanding and addressing the myriad underlying causes that give rise to tailings facility disasters. The Standard has succeeded in positioning other, non-technical considerations as relevant to risk reduction (e.g. local-level engagement, organisational management systems and internal culture), but further shifts in the mining industry's approach will be required to achieve the ultimate goal of preventing catastrophic tailings facilities failures.

2. DEFINITION AND KEY INTERNATIONAL INSTRUMENTS

The outcomes associated with recent tailings dam failures are commonly described as 'catastrophic'. This term features prominently on the Global Tailings Review (GTR) website. The ICMM likewise states that it is committed to achieving 'the safe and secure management of tailings facilities that *prevents catastrophic failures'* (emphasis added).

In common parlance, 'disaster' and 'catastrophe' are often used interchangeably, although they have different etymological roots, with the term catastrophe tending to signal a more far reaching, or permanent, disruption.[1] In this chapter I have opted to use 'disaster' as the key term, largely because it is grounded in an established literature, utilised by global bodies, and embedded in international instruments of policy and practice.

The United Nations Office of Disaster Risk Reduction (UNDRR), defines a disaster as:

A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.[2]

According to this definition, a cyclone that remains off-shore in an unpopulated area is not a disaster; it only warrants this label once it makes landfall and causes widespread damage. If we apply the same approach to the mining industry, structural failures to tailings facilities become disasters when there

Box 1: The Components of Disaster Risk

The foundational definition of 'disaster risk' is DR = H x V. This formulation (Blaikie et al. 1994) represents disaster risk (DR) as a function of hazard exposure (H) and people's vulnerability to hazard (V). Later versions (Wisner et al., 2003), include other elements, such as people's capacity to cope (C), which is linked to the concept of 'disaster resilience'.

$$DR = \frac{H \times V}{C}$$

are major long-term consequences for people and the environment. It is these 'disastrous' failures that have garnered public attention and provided the impetus for commissioning a global review of the industry's approach to managing tailings facilities.

As the UNDRR definition indicates, contemporary disaster studies are mainly concerned with hazards and hazardous events that cause, or have the potential to cause, significant harm and disruption to people, either directly or indirectly.[3] In a similar vein, Oliver-Smith and Hoffman (2002, p.4), in the opening chapter to their volume *Catastrophe and Culture*, define disaster as:

A process/event combining a potentially destructive agent/force from the natural, modified or built environment, and a population in a socially and economically produced condition of vulnerability, resulting in a disruption of the customary relative satisfactions of individual and social needs for physical survival, social order and meaning.

From this perspective, disasters are defined not only by hazards that carry the potential for loss of life, injury or damage, but also by those processes that set hazards in motion, exposing them to people and places.

Since the 1990s, the United Nations (UN) has been working to change the prevailing paradigm of disaster research by challenging the notion of a 'natural disaster'. A new way of conceiving of disaster and disaster risk is now embedded in international instruments of the UN. This perspective holds that

1. In engineering, the term 'catastrophic failure' is often used to describe 'a rapid and irreversible structural failure'. This is a narrower formulation that characterises the failure event itself, rather than its consequences.
2. See: UNDRR's knowledge platform for disaster risk reduction, *PreventionWeb*. https://www.preventionweb.net/terminology/view/475

3. This is not to discount the significance of impacts on other types of populations (e.g. the widespread loss of wildlife as a result of a massive wildfire) but that is not the primary focus of disaster studies, or of this chapter.

disasters are, in fact, created and are not at all a natural outcome. This way of thinking about disaster is encapsulated in the *Sendai Framework for Disaster Risk Reduction (2015–2030)*, which was adopted by member states in early 2015 at the World Conference on Disaster Risk Reduction held in Sendai, Japan and endorsed by the UN General Assembly later that same year.[4] The first goal of the framework is to ensure that disaster risk reduction policy and practice is based on understanding of people's vulnerability to hazards, and how that vulnerability comes about. The framework also recognises the constructive role that the private sector can play in this arena.

The *Sendai Framework* applies to a full range of disaster risks, including small and large-scale disasters, frequent and infrequent events, rapid and slow-onset disasters, as well as tectonic, climatic, technological, engineered, chemical, and biological hazards and risks. In effect, the framework recognises that smaller, isolated and remote mining communities can be devastated by a tailings facility failure and, in effect, experience a 'disaster'.

The *Sendai Framework* also recognises that disasters are not limited to sudden events, and can involve, for instance, chronic impacts – such as the long-term health effects of tailings dust or water contamination. By contrast, the mining industry's current focus is on tailings facility failures that take the form of sudden and acute events, rather than other types of failures that have slow-moving and chronic impacts. The *Sendai Framework* also recognises that industrial disasters can arise from compound interactions, such as those associated with climate change. For a tailings facility, this includes the compounding effects of extreme weather events, both in contributing to the failure of facilities and in exacerbating the consequences of these failures.

3. FIVE PRINCIPLES OF CONTEMPORARY DISASTER RESEARCH

This section elaborates on five principles that characterise contemporary developments in international disaster research. For each principle, I note the relevance to tailings facilities, and potential implications for the mining industry.

3.1 DISASTER EVENTS AS CONDITIONED BY SOCIAL PROCESSES

According to Oliver-Smith and Hoffman (2002), disasters do not just happen. Rather, they occur through the interaction of two factors: the presence of a human population and a potentially destructive agent. Both of these elements, and the relationship between them, are in turn embedded in broader natural, economic and social processes. Oliver-Smith and Hoffman (2002) approach disasters as processes that reach backwards in time and space, and that are linked to issues that exist beyond the site, and beyond the decisions and actions of those who were implicated in immediate events. They note that the roots of disasters also track forward in time, to impact on future loss of assets and income; political mobilisation (e.g. growth of opposition to large-scale mining); and the time it takes for social and environmental systems to recover from disaster.

From this perspective, tailings dam failures become disasters when people are directly harmed by a failure (e.g. through loss of life or shelter, serious damage to property) and/or there are significant impacts on places to which people have attached value, significance or meaning. These can include places of economic, ecological, cultural and spiritual meaning and value. This perspective positions tailings disasters as imbued in a history and politics, and embedded in a range of issues that exist beyond the time and place that the disaster occurred.

Contemporary scholars argue that, while disasters may be triggered by natural phenomena (e.g. earthquakes, cyclones), the impact of these hazardous events is a function of socially constructed conditions (Santos and Milanez 2017). For example, whether or not people living downstream from a tailings facility have escape routes, access to transport, or dwellings that can withstand an inundation from a flow failure is mainly determined by the societal context, including economic and political processes at different scales. Likewise, these same processes determine where people live and work, their access to information, and their level of protection and preparedness, and therefore who is most vulnerable to or 'at risk' from a tailings facility failure.

Most research about tailings facility failures focuses on the engineered structure and the properties

4. The Sendai Framework follows the Hyogo Framework, which was the global blueprint for disaster risk reduction efforts between 2005 and 2015.

of the materials stored in it, and why the facility failed to contain water and waste. More recently, some research has focused on how organisational factors contributed to failure, with several studies concluding that organisational structure and culture had a significant role to play. However, contemporary disaster research would go further than this and also examine the ways in a broader set of off-site and supra-organisational factors interacted to produce the conditions of disaster. This approach does not deny the significance of the hazard, the engineering or organisational factors of a facility failure, but reminds us that engineered structures and organisations are created by people whose decisions and actions are shaped and constrained by the context in which they operate. This broader context includes processes of governance, law, regulation, policy, enforcement, cultural attitudes towards risk, and a range of micro and macro power structures.

Focusing on the broader context of a disaster highlights that: (i) social and political systems create hazards and the entities that manage them, and (ii) these systems place different people at different levels of risk from the same hazard. The risk status of different groups of people, and their experience of a hazard or a disaster event, is differentiated on the basis of social attributes such as wealth, class, race, ethnicity, language, gender, age, education, health, and immigration or citizen status. Contemporary disaster research demands that developers, states and other 'producers' of hazard examine these factors and understand how they contribute to disaster risk and occurrence.

In short, disasters, should always be seen as a reflection of *existing* social and political processes, rather than as *exceptional* events that sit outside what a society may consider to be 'normal'.

3.2 VULNERABILITY AS A POWERFUL EXPLANATORY VARIABLE

Contemporary disaster research positions the vulnerability of people as a key determinant of whether an event becomes a disaster. The commonplace meaning of vulnerability is the propensity or predisposition of an individual or group of people to suffer damage and loss, including loss of life, livelihood and property or other assets. For the purposes of disaster research, vulnerability refers to those social characteristics and conditions that place people at risk in terms of their ability to anticipate, respond to, and recover from a hazard event (Oliver-Smith *et al.* 2016). As argued above, insofar as vulnerability and people's capability to cope under adverse conditions is socially produced, it is also the case that disaster risk is unevenly distributed across the social spectrum. It is important to recognise, however, that vulnerability to a hazard is not solely defined by poverty and disadvantage. Even though disasters so often affect this demographic, people can be vulnerable to a hazard in many different ways, and for different reasons, not just because they are poor.

In applying the notion of vulnerability to disaster studies, Wisner *et al.* (2003) include a temporal dimension whereby vulnerability is measured in terms of loss and damage to past, present and future livelihoods. Vulnerable individuals and groups are those who would find it hardest to reconstruct their lives and livelihoods, and to recover in the aftermath of a disaster. The same factors in turn make them more vulnerable to the effects of subsequent or compound hazards. The word 'livelihood' is important in this definition, with Wisner *et al.* referring to the command that an individual, family or social group has over their income and the bundles of resources that they can use or exchange to satisfy their needs. These resources may include information, knowledge, social networks, and legal rights, as well as land and other tangible and intangible assets. For these reasons, understanding livelihoods is critical to understanding vulnerability.

Most contemporary disaster research now defines disaster risk in terms of hazard *and* vulnerability. These factors are considered to be interdependent in the sense that exposure to a hazard reflects how social relations of production unfold in territory and geography, including within and across mining landscapes. In short, vulnerability to disaster is characterised by a range of social, economic, political and cultural conditions that increase people's propensity to experience loss and harm. It is increasingly common for people's capabilities to be factored into the equation; that is, their ability to manage a hazard and cope under adverse conditions. This reflects an increasing focus on 'resilience' and represents a distinct point of convergence between human development and disaster research.

3.3 THE PRESSURE AND RELEASE MODEL

The search for deeper explanations as to why disasters unfold has led to the development of models based on analysing people's vulnerability in specific hazardous situations. The Pressure and Release (PAR) Model (Wisner *et al.* 2003) is useful in this regard (Fig. 1). The PAR is not a complete model for understanding the root causes of disaster, but rather, a model for analysing how people become vulnerable to a hazard. This model helps to bring into frame other root causes of disaster, aside from the precursors and factors driving and mobilising the hazardous event. I introduce the PAR model here not as a replacement for studies of the engineered structure, or studies of organisational factors, but as a complement that might help to build a more complete picture of why a tailings disaster unfolded.

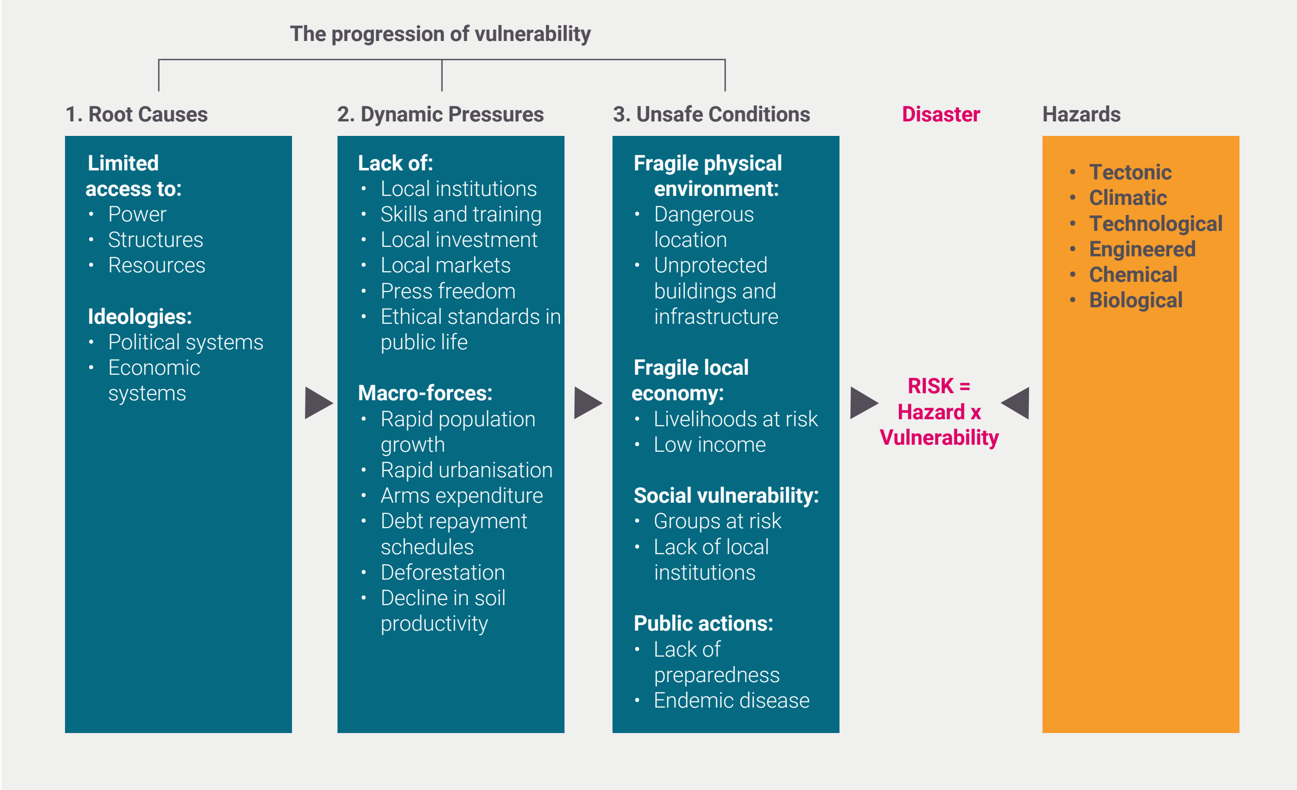

Figure 1. The Pressure and Release (PAR) Model. Adapted from Wisner et al. (2003).

The PAR model represents disaster risk as the interaction of 'hazard' and 'vulnerability', with disaster being the 'crunch point' between these two sides of the equation. The model is weighted to the left, as it is designed to promote an examination of vulnerability at different depths and scales. This model was originally designed to examine vulnerability in the face of natural hazards. Nonetheless, in evaluating the disaster risk of a tailings facility, the model helps to identify the links between the impact of a failure, and those processes that generate conditions of vulnerability.

The PAR model traces the connections that link a disaster with a series of social processes that produce vulnerability. This series starts with deeply structural, generalised and often distant 'root causes'. These causes are 'distant' from the disaster in one or more ways: spatially (arising in a distant centre of economic or political power); temporally (based in the past); or by being so bound up with cultural assumptions, ideology, and established knowledge systems that they have become 'invisible' or 'taken for granted'. These underlying causes are usually connected to the function (or dysfunction) of the state and other economic and political systems that reflect the exercise and distribution of power.

The second link in the chain of causality are 'dynamic pressures', which serve to translate or 'channel' generalised root causes into specific 'unsafe conditions'. These dynamic pressures can include, for example, migration or patterns of production and consumption. Dynamic pressures are not always negative, but in certain circumstances will manifest as 'unsafe conditions'. These conditions may include people having to live or work in hazardous locations, or survive through dangerous or precarious work. The 'crunch point' – the disaster – comes when those conditions combine with a hazardous event in a specific time and place.

3.4 CONTEXT AS POTENTIALLY CAUSAL TO DISASTER

Despite the utility and availability of the PAR and other similar models, the dominant initial response following tailings-related disasters has been to commission studies to identify why the facility failed, rather than inquire why and how people, or things they value, where made vulnerable to the failure. For example, following the 2014 Mount Polley disaster in Canada, the provincial government, with the support of two First Nations, commissioned an independent investigation on the cause of the dam breach. Investigators attributed the cause of the disaster to flaws in the original site characterisation and other technical failures (Morgenstern *et al.* 2015). An investigation by the British Columbia Chief Inspector of Mines (2015) focused on organisational factors that contributed to the dam failure. Neither study considered why First Nation, and sites of importance were at risk, as these broader considerations were not within the scope of either review.

For the more recent 2019 Bruhmidino disaster in Brazil, the operator (Vale SA) commissioned two studies. First, there was a technical review, which concluded that a series of design and engineering flaws created the conditions for failure (Robertson *et al.* 2019). Second, an examination of the organisation concluded that a series of internal factors, such as corporate culture, faulty information sharing, and a skewed compensation structure, had a significant role to play in the failure (Nasdaq 2020). In PAR terms, these studies focussed on the hazard and the hazard-producing entity, rather than also examining why people and significant sites were vulnerable to a large-scale tailings facility failure, how they were affected, what is needed to support recovery, and how this situation might be averted in future. Ideally, a third study would be commissioned, bringing these broader issues into focus.

Brief background descriptions in the academic literature of the Samarco disaster (Demajorovic 2019; Santos and Milanez 2017) provide a sense of the deep historical issues that accompany technical failure. Contributing factors included, for instance: weaknesses in state and voluntary regulation, ritualised licencing processes, structural asymmetries that favoured developers, weak state enforcement capacity, lack of public participation, and limitations of public accountability in the absence of disclosure. In light of these findings, the industry's propensity to focus on the technical hazard is akin to conducting a narrowly scoped 'Bow Tie' analysis of the top event and removing other factors. While it is critical to understand the engineering aspects of a top event, focusing only on this aspect can create blind spots in other areas.

The root causes of vulnerability, and therefore disaster, will always be entangled with underlying problems that are embedded in a society's history, politics, structure, culture, organisation, and the nature of human-environmental relations. These factors will play out in each and every location where a tailings facility is situated. While there may be similarities between cases and contexts, differences must also be understood.

The aim of delving into these aspects is to identify the features of a host context that cultivate and energise the drivers that manifest in patterns of vulnerability. When these patterns are affected by a hazard event, or multiple hazard events, they combine to produce disaster. Identifying the specific features of each situation – at multiple scales of analysis – requires a shift from an exclusive focus on the facility and its failure, to a more inclusive focus that also examines the context in which laws, policies and other frameworks for resource extraction, human rights protection and environmental safeguards are negotiated, developed and governed.

3.5 DEEPER INVESTIGATION AS CRITICAL TO PREVENTION

Understanding different modes of causality is critical for guiding decisions about investing in proactive disaster prevention and risk reduction measures. Around the world, the amount of investment in proactive strategies is eclipsed by the expenditure associated with reacting to disaster through emergency response and recovery efforts after the fact (Kyte 2015). Billions of dollars are committed to assist in emergency response efforts globally, but relatively little investment in research and programmatic interventions to avert future disasters. This is also the case in disasters involving natural and industrial hazards. For instance, the value of BHP and Vale's financial investment in the Renova Foundation, an independent entity designed to support the long-term recovery of affected communities, is likely to eclipse what might have been required to avert the disaster in the first place.

Building the case for addressing the underlying causes of disaster is a complex and multi-layered undertaking. Any call for investment must quantify disaster impacts, their spatial and social distribution, and the potential for loss and damage. The proposition must then address the immediate causes of those losses. This may include, for example, identifying that a loss of housing structures is due to poor building standards, or that loss of agricultural products is due to planting in the flood zone. However, to *prevent* a disaster, strategies must go further than calculating loss and damage and attributing impact to immediate cause. There must be an examination of *why* people were exposed to the hazard, and why conditions of vulnerability existed in the first place. The purpose of identifying deep causal chains and linkages is to identify which issues might be addressed by either long or short-term controls, and thus warrant proactive investment.

Understanding the underlying root cause of vulnerability, particularly multi-generational vulnerability, is not straightforward. Some aspects of the social environment are easily recognised, such as people living in adverse economic situations in hazard-prone zones (e.g. flood plains of rivers, earthquake prone areas). However, there are a myriad of less obvious political and economic factors that contribute to vulnerability to disaster. These factors relate to the manner in which assets, rights, income, and access to resources (such as critical information and data) are disclosed and distributed. People may also experience various forms of discrimination in the allocation of protections and availability of safeguards, including priorities in development, and in disaster relief and recovery efforts.

It is the less obvious factors that link a tailings facility and its associated risks to broader social and political processes. While addressing underlying root causes is unlikely to be the responsibility of a mining company, it is nonetheless a developer's responsibility to support and stimulate the generation of knowledge about the context and conditions in which they have chosen to build and operate a mine and a tailings facility. A commitment to knowledge building is vitally important for developers to know what will be disrupted through their decisions and actions, and to demonstrate how they are preventing or mitigating potential harm.

3.6 DISASTER RESEARCH AS INTER-DISCIPLINARY WORK

Given the complex processes leading to disaster risk and occurrence, it stands to reason that it is beyond the capability of any single group or discipline to analyse the full array of causes and effects that could be associated with a disaster. Disaster research must be a broad-based, collaborative and interdisciplinary undertaking that provides opportunities for a multiplicity of disciplines to engage at depth, while also creating opportunities for work that combines and synthesises different types of knowledge. Oliver-Smith *et al.* (2016) describe this process as broadening the 'circle of knowledge'. They also note that an absence of collaboration between natural, physical and social scientists has been a hindrance to mainstreaming a more integrated approach to disaster research.

Researchers, practitioners and advocates who argue for a deeper examination of vulnerability as a root cause of tailings facility disasters continue to make the point that their approach is not a *replacement* for technical investigations, or a diversion from the important work of engineers and other technical specialists. What they argue is that their approach is complementary and, in fact, essential to supporting the industry's goals of sustainable development and disaster prevention. Demonstrating to industry the value of understanding a diverse set of root causes for these disasters, beyond the engineered structure, needs experts who are willing to work across conventional boundaries. Moving beyond these boundaries also requires engagement with stakeholder groups to create an environment that is conducive to transformative work.

4. BENEFITS OF EXPANDING THE FRAME OF REFERENCE

The five principles discussed above are transforming international disaster research and practice and are helping to prioritise disaster prevention and risk reduction. The emphasis on disaster prevention is mirrored in the stated aims of the GTR and those of the ICMM and many of its members. However, stronger leadership is required to embed this approach in the mining industry, given the dominance of the engineering approach and the inclination to contain the investigative frame, rather than open it up.

According to Andrew Maskrey (2016, p. 5), coordinator of the bi-annual UN Global Assessment Report (GAR) on Disaster Risk Reduction at the UNDRR:

Transforming the direction of disaster research in a way that reveals the social construction of risk could contribute to a profound re-definition of disaster risk management. This includes understanding that historical processes operating at different asynchronous spatial and temporal scales configure the specific circumstances in which disaster occurs.

The way disaster is framed makes a difference to whose interpretations of events are included or excluded in accounts of disasters (Rajan, 2003).

The aim of the UNDRR is to open the frame of reference, and to challenge convention. The ICMM was established to play a similar role; that is, to extend the industry's frame of reference towards sustainable development, and challenge conventional wisdom. From a UNDRR perspective, disasters must no longer be viewed as a single event, but a pivot around which multi-scalar, multi-stakeholder, and multi-disciplinary analysis should be conducted, and preventive and remedial strategies developed. Until we take account of multiple perspectives, and tackle a variety of underlying causes, patterns will re-occur, and the same problems will emerge, again and again.

Casting a broader analytical net is increasingly important given that new risks (and new connections between risks) are emerging in ways that have not been previously anticipated. In the context of climate change, the world is experiencing an ever-growing number of cascading and systemic risks across global and local systems for which predictive models do not yet exist. We have seen the burgeoning use of tailings facilities over the past decade, a trend which is likely to be maintained as demand grows, the mining industry expands, and grades continue to decline. We are also seeing an expansion of mining into remote and often sensitive locations, meaning that tailings facilities will increasingly be situated in complex landscapes that are characterised by a high co-occurrence of risk factors (Owen, *et al.*, 2019).

The UNDRR has challenged the public and private sectors to think in new and creative ways about development and disaster risk. For mining, a shift in perspective would align with existing corporate commitments to international frameworks such as the *UN Guiding Principles on Business and Human Rights*, and the *UN Sustainable Development Goals*. These and other internationally agreed frameworks are interconnected and interdependent in ways that the mining industry has yet to fully acknowledge. There is potential, for instance, for companies to integrate disaster risk reduction into development planning through these instruments. Mining companies could commit to a more coherent implementation of international instruments to which they already subscribe, and consider engaging with other frameworks, such as the *Sendai Framework,* that will help to establish linkages in far more explicit ways.

5. CONCLUSION: LOOKING TO THE FUTURE

If the goal is to prevent catastrophic tailings facility failures, there is little value to be had from confining the industry's attention to a facility focus, in isolation from considering people's vulnerability to that hazard. Yet, in response to recent events, the preference of some in the industry has been to narrow in on the facility, and advocate for other causes of disaster to be excluded from the field of vision. If this approach is maintained, tailings dam disasters are likely to affect human populations and the places they value in ever more profound ways. A broader and deeper analysis is needed – one that seeks to prevent disaster through a comprehensive understanding of the hazard and conditions of vulnerability. This type of analysis would help to ensure that industry efforts to manage risk are appropriate to each and every context in which a tailings facility is located. It would also demonstrate to a concerned public that the mining industry is committed to understanding the full extent of its disaster potential.

Looking to the future, the Standard can play an important role in promoting this shift in thinking. Currently, the Standard does not specify, for instance, that matters of vulnerability should be included in root cause analysis, or that incident investigation should include structural and systemic considerations that reach beyond the immediate proximity of the failure and consider the context in which the facility is situated. Incorporating such requirements into future iterations of the Standard, in line with the shifts that are now well under way in contemporary international disaster policy and practice, would assist the industry to better reconcile its dual potential for human development and disaster. The way in which the mining industry proceeds will be a defining feature of its own future, and that of the communities in which it operates.

KEY MESSAGES

1. Mining companies could improve their 'contextual intelligence' by paying greater attention to the social, environmental and local economic context in which a project is situated, and the project's effects on that context.
2. Including vulnerability as a relevant factor in root cause analysis would support mining companies to account for the structural and systemic aspects of disaster risk.
3. Mining companies could consider utilising other relevant frameworks, such as the *Sendai Framework for Disaster Risk Reduction 2015-2030*.
4. Better enabling of social specialists to contribute to tailings risk management (e.g. through participation in interdisciplinary processes) could help mining companies to avoid harm.
5. Both public and private sector actors should consider broadening the 'circle of knowledge' on disaster prevention, to include the natural, physical and social sciences, and the lived experiences of affected people.

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