SWISS CHEESE IN BRAZIL:
DISASTER CULTURE AND SAFETY CULTURE IN DISASTERS

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Introduction

In February 1984 in Cubatão, São Paulo, a catastrophic petrol leakage from a Petrobras pipeline seeped under the houses of an informal settlement of some 2500 dwellings, Vila Socó. Aided by water on the ground and by a small stream, the leak spread, and as this flammable pool caught fire an inferno engulfed the area and resulted in between 93 and 500 fatalities, depending on which source you believe (CETESB). This event is amongst the most serious industrial accidents Brazil has witnessed. The year 1984 was also marked by other major incidents worldwide, such as the gas leak tragedy at Bhopal with over 4000 deaths, and a series of LPG tank explosions in Mexico City claiming some 650 fatalities (LEES, 2005).

On November 5th, 2015 in Bento Rodrigues near the town of Mariana, Minas Gerais, an iron ore tailings dam burst and another one overtopped. There were 19 fatalities and over 200 families made homeless. There was a release of 34 million m3 of tailings into the Rio Doce, a watershed the size of Portugal, which may be impacted for years, possibly decades, until its complete regeneration. The water supply was interrupted with 424 thousand people affected, alongside industries, fishing, energy production, tourism and other economic activities (Agência Nacional de Águas, 2016). Combined with high turbidity and low oxygen the silt killed much aquatic life for a 650 km stretch of river. The sludge reached the ocean where it impacted the coastline in Espírito Santo state. The disaster affected the "livelihoods of more than 1 million people in 41 riparian municipalities by reducing local access to fisheries resources, clean water, crop production sites, hydroelectric power generation and raw materials" (Fernandes, 2016). Apparently, there was no emergency preparedness and response plan in place, or if there was, it was not sufficient to mitigate the disaster. Again, the question that remains is: why was settlement permitted in a risky area, and why were warnings not forthcoming?

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Dams, as a closely coupled technology used in mining, are definitely accident-prone, just as are other structures and facilities present in power generation, oil exploration and production, aircraft, shipping and diverse industrial processes given their complexity of interactions (Perrow, 1999). Yet if sufficient countervailing safety measures are in place, such as, technical rigour, frequent inspections, regulations and drills, the risk of dam and pipelines leaks should be manageable.

Since the Vila Socó and Mariana disaster, however, very little seems to have been learned and changed. Many Brazilians have had a much more catastrophic disaster "deja-vu" experience than before. On January 25, 2019, Vale's tailings dam in Brumadinho, Minas Gerais, broke and buried the company's refectory, operating area and part of the local community. It is estimated to be the worst structure collapse disaster in world history, with up to 350 fatalities.

Disaster culture

Simplistically, risk can be expressed as the *probability* of an event times the *magnitude/ severity* of its consequences, but it can also be interpreted in a wider sense to cover the losses resulting from a hazard or activity, thus relating consequence with cultural interpretation of individual or collective value (SRA, 2018). *Exposure* considers the understanding and tolerability of sources of risk, hazard and/or their potential consequences in a specific area. If exposed people have a repertoire of responding collectively to an imminent event, the hazard may not turn into a disaster itself, as losses and sacrifices are considered tolerable. Preparedness can be achieved either through technical interventions to increase safety layers, such as the use of tougher materials and redundant process controls, or by adopting disaster social response measures, like emergency drills.

To understand disaster culture, we need to realise that human behaviour is primarily driven by perceptions rather than 'facts' as understood as facts by risk analysts and scientists (van Asselt & Renn 2008: 93). Behaviour in turn is fundamentally influenced by culture: what we have been socialised to do without thinking it over. Networks are important here. Disaster subcultures and disaster communities may form through shared (disaster) experience. People who interact a lot and feel a joint identity tend to cultivate elements that will enable them to understand and deal with events and prevent, as much as possible, distress. Immaterial aspects such as loss of trust and meaning strongly affect people's recovery and rehabilitation. Culture affects how people understand risks and guides the way they act when faced with them (Engel & Warner 2017). Disaster culture should also not be viewed as static or unchanging as it faces new constellations of risk.

The concept of disaster culture was coined by Moore in 1964 and developed further in the United States in the 1970s. Wenger and Weller (1972) stipulate that a disaster subculture develops when a community faces a recurrent threat and a community, *acknowledges its existence*, and uses its resources to act on it. Culture can be seen as a 'toolkit' that members of a community have at their disposal to solve different kinds of problems and construct appropriate 'strategies of action' (Swidler 1986: 273). Wider cultures that cover larger geographical areas…are generally unable to provide all its members with an

exhaustive assortment of appropriate hazard-related solutions' (Engel et al. 2014: 863). They are the tangible and intangible resources such as knowledge, attitudes, narratives, practices, and artefacts that enable people to respond swiftly to foreseen hazard-related challenges, and create space to engage with more unexpected or complex ones.

A well-developed disaster culture can be expected to increase resilience (Warner and Engel 2014). But not everyone can be resilient and even those who are resilient tend to consider risk an expert domain rather than an everyday concern. Blésius (2013), for example, notes that people will leave their house unprepared despite weather warnings and complain when help takes two hours to arrive. But it does not help if the risk officers (risk managers, regulators and 'ambassadors' in outreach) themselves do not have a 'community', especially with large turnover rates and uncertainty of tenure, or are considered a nuisance or necessary evil in high-risk industries.

People do not readily develop a disaster culture if they are not regularly exposed to it. This is a problem in light of low-incidence, high-consequence disaster risk, as mining incidents tend to be. Theys (1987, p. 24) moreover notes that a disaster itself is not necessarily pedagogical. Rather than instigating societies to reduce their vulnerability, people prefer to forget disaster events, especially after those who lived through a disaster have gone. "Tangible memories" refers to those that are visible, such as museums, archives, and memorials, while unattainable ones are less visible manifestations, such as tales, myths, rituals, and ceremonials (Engel and Warner, 2017). Tsunami-prone Pacific islands are "poster children" for how folk knowledge preserved the memory of tsunami events in the distant past, guiding appropriate courses of action when the 2003 Pacific tsunami hit. They had not lived through a disaster for decades but have passed on their disaster knowledge over generations through education, tales, songs, and artefacts – and are thus at an advantage when disaster strikes again. The Netherlands is another example of a disaster culture, as they keep alive the memories of their greatest flood, experienced in 1953, when a tragic combination of various adverse weather conditions killed over 1800 people.

Lack of cultural disaster memory, however, is not the only barrier to preparedness and response. Harries (2011) notes that people do not act on a risk if they do not see a course of action or if risk information clashes with their sense of security – their ontological security (feeling safe) does not match their objective security (being safe). If changing it is beyond their capacity, they may live in fear and ignore the risk, hoping it will go away. A study carried out before the dam break by Viana (2012) found 68% of community members in Bento Rodrigues, MG, close to the disaster site, were afraid of a dam break. Awareness (perception) was clearly there before the event happened, but no potential for action. Likewise, Paine (2002) has noted that playing down threats and denial of risk are coping mechanisms in the face of danger. But when these are translated into formal probability calculations about danger and hence, it leads to an underestimation of the 'cost' of a projected undertaking.

The disasters of dam ruptures in Brazil serve as a reminder of the hazardous of certain activities and the vulnerability of communities located in disaster prone zones. Hazards test the limits of complex technologies and also illustrate the absence of a 'culture

of disaster' (Taddei, 2014). Taddei identifies a culture of risk denial among professionals and experts from different areas. This is illustrated by meteorologists proclaiming that "there are no hurricanes in Brazil", as if this were something for Brazilians to be proud of, and despite Brazil having the world's second highest frequency of tornadoes, which can be more destructive than hurricanes. This contrasts with risk cultures of disaster-affected people, who are more conscious of the recurring risks of droughts, floods, landslides or hurricanes. Brazil has a culture of social protest against political and structural inequities, such as the "Movimento Feminista" (gender equality), "Movimento Sem Terra" (landless), "Movimento dos Trabalhadores Sem Teto" (urban homeless). The "Movimento dos Atingidos por Barragens - MAB" (affected by dams), although it emerged in the late 1970s, does not yet translate into sustained collective action for disaster preparedness and response.

This psychological mindset is reinforced by structural material considerations favouring risks. Since the 1970s an influential school of thought rooted in what is now called political ecology, has shown that disasters are the consequences of structural vulnerabilities, and that disasters are not very 'natural'. Internal power differentials, where particular social groups, powerless to influence dynamics controlled by the powerful (politicians, developers, or mining corporations, for example), are accompanied by irresponsible governance and land-use governance, which build up to and perpetuate a degree of vulnerability that an environmental event can then spark into a disaster. Sudden events can then easily overwhelm capacity. "*Nothing is a disaster until it intersects with a specific society that has vulnerabilities that are the result of decisions made over decades … often, decisions that were made without really thinking,*" says Joseph Trainor, from the University of Delaware's Disaster Research Center.

While the disasters literature indicates that temporary social networks play an important role and solidarity bonds are revived during or after floods and other disasters, voluntary associations are not a prominent feature of Brazilian urban society, and 'disaster communities' may not form even between people affected by the same disaster (Borba, Warner and Porto 2016). For those living in chronically precarious conditions, for whom life is full of disasters, degrees of freedom to escape them are limited, as amply discussed in social vulnerability literature (Hewitt 1983-2014; Blaikie et al. 1994).

On the administrative side, however, denying or minimising risk seems to be the standard response. Catastrophic disasters threaten the very fabric on which the state is built and can call the social contract between state and citizens into question. For a disaster manager, minimising a risk in the face of its enormity is an all-too-human coping mechanism. Failing that, the tendency to respond rather than to prepare and to blame others for disasters as much as possible has been well sketched (Olson 2000; Leiss and Chociolko, 1996).

The disaster culture of public authorities is also partly constituted of memories of the public officials who witnessed the events, but mostly made up of data and information stored in models, scenarios, protocols of action, etc. While community flood culture is experience based and a form of unorganized knowledge, institutional culture represents systematically stored and organized knowledge. As risk parameters

change, community knowledge may become obsolete, and new knowledge may be hard to incorporate.

Safety culture

There nonetheless exist cases in which a disaster culture is present, but a deficient safety culture can be noted, such as when decisions are left to a single stakeholder, such as the government or private sector. A negative trend is observed when both disaster and safety cultures are absent, where the chance of the undesirable unfolding of an event increases substantially, even for those that if occurring separately would have a low consequence.

At the company level, a similarly defensive mechanism of denial and blindness to structural risk factors appears to be at work. Acknowledging risk and incorporating it in your company's basic operations means you have to do something about it, which will take many energies and entail high costs, while the evidence on the ground tells them the company has a no-incident record. As Pereira et al. (2014) notes, the absence of incidents in the past is no predictor for future accidents.

Weick et al. (1999) gives five characteristics of a High Reliability Organisation: preoccupation with failure, reluctance to simplify interpretations, sensitivity to operations, commitment to resilience, and deference to experience. Hofstede and Hofstede (2005) found South American countries to score high on power distance, strong uncertainty avoidance and collectivism.

Tellingly, Filho et al (2010) consider Fleming's Safety Culture Model unsuitable for Brazil, given the non-compliance with its main criteria, which are: the existence of a safety system or barrier; understanding that most accidents are not only caused by technical failures but also by lack of adherence to health and safety laws; and, a gap in policy on accident prevention. Risk acceptance itself does not need to be considered a negative trait. The 'fear of everything' that has led to an excessive health and safety culture in the United Kingdom is not a model inviting universal adoption (Spielman, 2017). Although the Brazilian mining industry reports that it adheres to national dam safety regulations, its safety culture is still inadequate, as the criteria followed in risk management falls a long way short of protecting those who face the risks.

Filho et al. (2010) define safety culture to be about organisational collective practices rather than about values, which is more customary in cultural analysis. They follow the model proposed by Hudson (2001) composed of criteria to identify the stage of development of the organizational safety culture, going from: the Pathological Stage (worst), where safety is seen as a problem caused by workers; to the generative stage - where there is active participation at all levels and security is perceived as an inherent part of the business; to the calculating stage - security is driven by data-intensive management systems imposed by management rather than labour; reaching the Proactive Stage (best) - where the unexpected is viewed as a challenge and workforce engagement begins to push the initiative away from a purely top-down approach. Elements to assess a company's score on this continuum involve information, orga-

nisational learning, involvement, communication and commitment. A problem with the methodology, however, is that it is self-ascribed, and can easily be manipulated to make the company 'look good'.

Labonne (2016) laments the resistance of the mining industry to regulation. This incidentally is not unique to Brazil, but may be universal. Brazil however may be unique in the degree companies are protected by government. Santos and Milanez (2017) claim a case of *regulatory capture*: the regulator is beholden to those supposed to be regulated. Brazil has good environmental laws, but implementation is poor. They cite St Laurent and Le Billon who see a move from government-industry negotiation to 'multistakeholde-rism' such as information, and informal shaming processes. Previously Samarco had been fined 18 times in 20 years (1996-2015) but at a low fine level and scant enforcement. According to Santos and Milanez (2017) *"... while environmental licensing and monitoring of tailings dams remain subject to a fragile, formal type of State control; the monitoring and auditing of recovery and environmental compensation actions resulting from the disaster have been transferred to a private foundation and to third-party consulting firms hired by the former"*. The Brazilian state is beholden to maximum resource exploitation at minimal production cost, and with state developmentalism in the driving seat, socio-environmental safeguards remain at a clear premium.

The propensity to take decision to deal with risk is studied in the "Protection Motivation Model". According to Gore and Barack (2005), response efficacy is the belief in the effectiveness of the recommended response to deter the threat, and self-efficacy is the perception of their ability to perform the recommended response to forestall the threat. These two appraisals can result in one of the following three outcomes: 1) no response; 2) the message is accepted; or 3) the message is rejected. If there is a high level of threat, the fear is provoked and the threat appraised. However, if the threat is assessed as not relevant or as low, then there is no motivation to process the message, efficacy will not be evaluated, and there will be no response. When the level of threat and efficacy is high, an individual will follow the danger control process-pathway, meaning they will deal with the threat and possible solutions to avert it. When threat is high and efficacy is low, individuals will follow the course of fear control, meaning that the message will be rejected (Gore & Bracken, 2005).

After a disaster, people will look for single actors or factors that 'did it' and look for remedies. Evaluations unfortunately tend to be blaming devices and *'safety cases become documents to satisfy regulation rather than instruments to reduce risk'* (Ale, 2005).

It is tempting to blame variously nature, operator error, or structural defects within technology or capitalism for the dam breaks in Minas Gerais. Blame attribution may not be the best way of dealing with accidents: whatever the linkage between poor industrial behaviour/governmental regulation with their occurrence, it is unlikely to create immediate confessions of guilt and thus better practice. Like individuals, organisations rarely intentionally cause harm; it tends to be a systemic effect. It may be more fruitful to look for mishaps and errors going down the chain leading from hazard to accident, and the structural reasons for this. A more effective evaluation should understand the roots of vulnerability production. Safety culture begins at the top of the organisation, it begins

with the management believing in its importance – not just a mining company's senior management, but also the governmental agencies that it is imbricated with.

In Brazil, the collusion between the state and private sector moreover puts a premium on the sole reliance on technical rather than integrated disaster management. Technical works, such as, transposing water (interbasin transfer) are the government's standard response to a water crisis, such as that ravaging São Paulo, Belo Horizonte and Rio de Janeiro in 2013 through 2015. Technical solutions also characterise the responses to the calamitous landslides in the states of Rio (Teresópolis, Nova Friburgo and Petrópolis), Minas Gerais and São Paulo in 2011. With a thousand deaths and 300 thousand affected in the mountainous region of Rio de Janeiro. This constituted Brazil's most serious recorded disaster to date (Banco Mundial, 2012). Yet Coates and Garmany (2017) show for one of the worst landslide-affected localities, Nova Friburgo, that technical measures were implemented that left social differences and vulnerabilities intact. After World Bank and United Nations reports concluded that risk management should be incorporated into public policy, the Brazilian government vowed to improve disaster management and sought to join efforts to reduce risk. Disaster risk reduction in Brazil is a decentralised, municipality responsibility (Barrionuevo, 2011) yet at the time, 1 in 4 cities did not have a Civil Defence. While a disaster law was passed in 2012 and research funds were awarded, Brazil's disaster management system is still awaiting a substantial overhaul.

Complex adaptive systems: "Swiss Cheese" in Brazil

In complex adaptive systems, system behaviour is emergent, and esults from the interactions between the components of that system. A 'complex adaptive system' (CAS) is a collection of individual agents with freedom to act in ways that are not always predictable, and whose actions are interconnected so that one agent's actions change the context for other agents (Reiman *et al,* 2015). Control is distributed, there is great diversity in such a system and no one can claim to understand the system in its entirety. While this brings creative potential, it also makes it harder to control or change. Instead, one can seek to make interventions that have positive feedbacks, reverberating through the system.

To be sure, a culture is not easily changed; old habits die hard[4]. A deficient safety culture however is no excuse not to tackle structural technical defects. Organisational issues may add to the technological vulnerabilities. Culture and technology in turn should work in tandem (Reiman & Rollenhagen 2014). The Mariana dam, built by the "upstream" method, had already demonstrated its potential to cause damage, but in 2015 the deactivation and decommissioning of such dams had not been considered. The Brumadinho disaster is expected to bring about real and significant changes in the safety culture.

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4.   Two examples: in the USA's 'tornado alley', which receives a series of destructive tornados every year, only 15% of houses have underground shelters and when in 2010 the sirens went off in the Netherlands town of Helmond after a chemical leak was detected, nobody responded; people remained in their gardens enjoying the fine weather.

Weick *et. al.* (1999) pointedly note that organisations are often more characterised by what they ignore than what they attend to. Indeed, it is all too human to assume that the absence of a negative incident is 'proof of safety' (Reiman *et. al.*, 2015), but if we accept that failure is emergent, we will need to prepare for failure. It is illusory to think a rational risk culture can be arrived at through rational decision making and optimising organisation (Blésius, 2013). Rather, all aspects need to be paid attention to, to prevent opening the door to catastrophic risk. With this rationale, James Reason developed the 'Swiss Cheese' model shown in Figure 1 (Reason, 2000), also known as the cumulative act affect model, to explain accidents in organisations, seen as complex adaptive systems. Recognising that risk is never zero, the model represents a disaster defence system as a not particularly solid fortress: a cheese with holes. It assumes that holes appearing in any "layer" are inevitable, but as long as the "holes" do not align, a disaster will not happen.

Dam technology has proven to be accident-prone, but if sufficient safety and compensatory measures were in place, the risk of dam failure could be manageable. Although certain technologies currently employed in the mining sector could be modernized or even replaced with less impactful and less risky ones, what is noticed in practice are very thin layers of protection, which facilitates the breaching of defenses, barriers and safeguards[5].

The neglect of culture adds to people's vulnerability (Cannon, 2015). The above-mentioned disasters in Brazil point to the absence of a 'culture of disaster' and 'culture of security'. So it is necessary to build up these cultures that will act as layers of protection, avoiding the coincidence of failures in the "Swiss cheese".
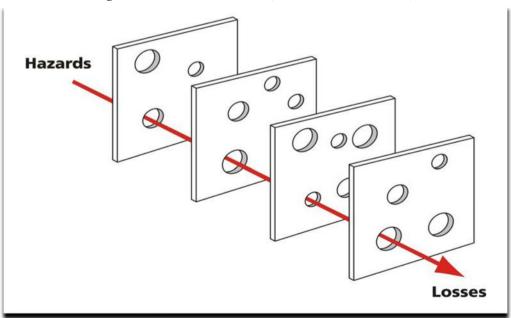
Fig. 1. Swiss Cheese model (Source: Reason, 2000)

5. The attributes of the slices can be technical, organisational, political, etc., but in Smith's (2009) adaptation model the four failure domains are organizational influences, supervision, preconditions, and specific acts.

References

AGÊNCIA NACIONAL DE ÁGUAS. **Encarte especial sobre a Bacia do Rio Doce: rompimento da barragem em Mariana/MG. Conjuntura dos recursos hídricos no Brasil informe 2015.** Agência Nacional de Águas. [S.l.]. 2016.

ALE, B. Living with risk: a management question. **Reability Engineering & System**, v.90, 2005. 196-205.

ASSELT, M. B. A. V.; RENN, O. **Risk Governance**. Journal of Risk Research. [S.l.], p. 431-449. 2011.

BANCO MUNDIAL. **Avaliação de perdas e danos: inundações e deslizamentos na região serrana do Rio de Janeiro de 2011**. Rio de Janeiro, p. 63. 2012.

BARRIONUEVO, A. Brazil to step up plans for preparedness. **New York Times**, January, 2011.

BLAIKIE, P. et al. **At risk:** Natural hazards, people's vulnerability and disasters. [S.l.]: [s.n.], 1994.

BLESIUS, J.-C. Discours sur la culture du risque, entre approches négative et positive. Vers une éducation aux risques ? **Géographie et cultures**, 88, 2013. 249-265. Available in: <https://journals.openedition.org/gc/3141>.

BORBA, M. L.; WARNER, J. F.; PORTO, M. F. A. Urban stormwater flood management in the Cordeiro watershed, São Paulo, Brazil: does the interaction between socio-political and technical aspects create an opportunity to attain community resilience? **Journal of Flood Risk Management**, v.9, 2015. p.234-242.

BRESSAN, D. Ancient Stories Preserve The Memory of Tsunami In The Pacific Ocean. **Forbes**, Mar 2018. Available in: <https://www.forbes.com/sites/davidbressan/2018/03/23/ancient-stories-preserve-the-memory-of-tsunami-in-the-pacific-ocean/#58c4aa854347>. Access in: 25 August 2019.

CANNON, T. Disaster, vulnerability and the significance of culture. In: KRUEGER, F., et al. **Cultures and Disasters:** understanding cultural framings in disaster risk reduction. New York: [s.n.], 2015. p. 282.

CETESB. Análise de Risco Tecnológico. Available in: <https://cetesb.sp.gov.br/analise-risco-tecnologico/grandes-acidentes/vila-soco-cubatao/>. Access in: 25 August 2019.

COATES, R.; GARMANY, J. The ecology of citizenship: understanding vulnerability in urban Brazil. **International Development Planning Review**, v.39, 2017. p.37-56.

DURRANT, T. P. **Cognizing Crisis:** Environmental Disasters and The Social Creation of Risk and Vulnerability. [S.l.]: Tesis of Master degree in Art of Antropology, California University, 2017.

ENGEL, K.; WARNER, J. How to recognize culture. In: ENGEL, K.; WARNER, J.

EDUCEN Culture & Urban Disaster: a Handbook. [S.l.]: [s.n.], 2017. Available in: <http://educen.cultureanddisaster.eu/handbook/1.1-recognize-culture>.

FERNANDES, G. W. et al. Deep into the mud: ecological and socio-economic impacts of the dam breach in Mariana, Brazil. **Natureza & Conservação**, 14, n. 2, July-December 2016. p.35-45.

FIHO, A. P. G. et al. A safety culture maturity model for petrochemical industries. **Safety Science**, 48, 2010. 615-624.

GORE, T. D.; BRACKEN, C. C. Testing the theoretical design of a health risk message: reexamining the major tenets of the extended parallel process model. **Health Educ Behav**, v.32, 2005. p.27-41.

HEWIT, K. **Regions of risk:** a geographical intoduction to disasters. 1. ed. [S.l.]: Routledge, 1997. 410 p.

HOFSTEDE, G.; HOFSTEDE, G. J.; MINKOV, M. **Cultures and Organizations:** Software of the Mind. 2. ed. [S.l.]: New York: McGraw-Hill, 2005.

HOPKINS, A. **Safety, culture and risk:** the organisation causes of disasters. Australia: [s.n.], 2005. 171 p.

HUDSON, P. Safety Management and Safety Culture: the long, hard and winding Road. **Centre for Safety Research. Leiden University.**, 2001.

LABONNE, B. Mining dam failure: Business as usual? **The Extractive Industries and Society**, 3, n. 3, 2016. p.651-652.

LEES, F. P. **Loss prevention in the process industries**. 3a. ed. Texas: Elsevier, 2005.

LEISS, W.; CHOCIOLKO, C. **Risk and responsability**. [S.l.]: McGill-Queen's University Press, 1994. 424 p.

MOORE, H. E. And the winds blew. **Social forces**, Austin, Texas, 1964.

MORGAN, G.; GOMES, M. V. È.; PEREZ-ALEMAN, P. Transnational governance regimes in the global south: Multinationals, states and NGOs as political actors. **RAE - Revista de Administração de Empresas**, 56, n. 4, July-August 2016. p.373-379.

OLSON, R. S. Toward a Politics of Disaster: Losses, Values, Agendas, and Blame. **International Journal of Mass Emergencies and Disasters**, 18, n. 1, March 2000. p.265-287.

PAINE, R. Danger and the no-risk thesis. In: G. V. BUTTON, C. L. D. V. G.-A. S. M. H. J. T. M. M. E. M. A. O.-S. R. P. S. R. R. S. S. **Catastrophe & Culture:** the anthropology of disaster. [S.l.]: School for Advanced Research Press, 2002. p. 67-89.

PEREIRA, R. F. et al. Safety analysis of the Deepwater Horizon blowout based on the functional resonance analysis model (FRAM). In: AREZES, P.; CARVALHO, P. **Advances in human factors and ergonomics**. Berlin: Springer, 2014. p. 327-337.

PERROW, C. **Normal accidents:** living with high-risk technologies. New Haven: Yale University Press. [S.l.]: [s.n.], 1999. 464 p.

REASON, J. A systems approach to organizational error. **Ergonomics**, 38, n. 8, 1995. p.1708-1721.

REASON, J. Human error: models and management. **The BMJ**, 18 March 2000. 768-770.

REIMAN, T. et al. Principles of adaptive management in complex safety-critical organizations. **Safety Science**, 71, 2015. 80-92. Available in: <https://pdfs.semanticscholar.org/97dc/b562e4b4baf49255eda741987676322290f3.pdf>.

REIMAN, T.; ROLLENHAGEN, C. Does the concept of safety culture help or hinder systems thinking in safety? **Accid. Anal. Prev.**, July 2014. p.5-15.

RENN, O. **Risk Governance. Coping with Uncertainty in a Complex World**. [S.l.]: Earthscan, 2008.

SANTOS, R. S. P; MILANEZ, B. The construction of the disaster and the "privatization" of mining regulation: reflections on the tragedy of the Rio Doce Basin, Brazil. **Vibrant: Virtual Brazilian Antropology**, Brasília, 14, n. 2, 7 December 2017. p.127-149. Available in: <http://vibrant.org.br/downloads/v14n2/Capitulo3.pdf>.

SMITH, K.; N., D. N. P. Environmental Hazards: Assessing Risk and Reducing Disaster. **Geographical Research**, 47, n. 4, 2009. 454-455.

SPIELMAN, A. Health and safety culture in schools "harmful to children", Ofsted chief warns. **The Independent newspaper**, Agosto 2017. Available in: <http://www.independent.co.uk/news/education/education-news/school-health-and-safety-culture-harms-pupils-ofsted-chief-warns-amanda>.

SRA. **Society for Risk Analysis Glossary**. Society for Risk Analysis. [S.l.]. 2018.

TADDEI, R. Sobre a invisibilidade dos desastres na antropologia brasileira.**. WATERLAT-GOBACIT Network Working Papers: Thematic Area Series SATAD – TA8 – Water–related Disasters,1(1).**, 1, n. No 1, 2014.

VIANA, M. B. **Avaliando Minas: Índice de Sustentabilidade da Mineração**. Tese de doutorado apresentada para o Centro de Desenvolvimento Sustentável, Universidade de Brasília (UNB). [S.l.]. 2012.

WARNER, J.; ENGEL, K. Disaster Culture Matters. **Ambiente & Sociedade**, Campinas, Brasil, XVII, n. 4, Outubro-Dezembro 2014. 1-8. Available in: <http://www.scielo.br/scielo.php?pid=S1414-753X2014000400016&script=sci_abstractgure>.

WEICK, K. E.; SUTCLIFFE, K. M.; OBSTFELD, D. Organizing for High Reliability: Processes of Collective Mindfulness.. In: STAW, R. S. S. A. B. M. **Research in Organizational Behavior**. [S.l.]: Stanford: Jai Press, v. 1, 1999. p. 81–123

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Abstract: This article discusses points related to "disaster culture" and "safety culture" in Brazil, and debates how societal-structural factors influence the management of low incidence and high consequence disasters, such as dam breaks, which appear to provide limited evidence for preventive decision making. Discussion of the occurrence of disasters considers the "Swiss Cheese Model" of risk analysis proposed by James Reason. The article uses this to indicate some potential paths forward.

Key words: risk culture, safety culture, technological disaster, urban disaster, swiss cheese model.

O QUEIJO SUÍÇO NO BRASIL:
CULTURA DE DESASTRES VERSUS CULTURA DE SEGURANÇA

Resumo: A presente contribuição aponta razões estruturais no Brasil relacionados à "cultura de desastre" e "cultura de segurança" e como esses aspectos influenciam a gestão dos desastres, especialmente aqueles do tipo de baixa incidência e alta consequência, que não dão indícios para a tomada de decisão preventiva. A discussão sobre a ocorrência de desastres considera o "Modelo do Queijo Suíço" de análise de risco proposto por James Reason. Ao final são indicados alguns caminhos a seguir.

Palavras-chave: cultura de risco, cultura de segurança, desastre tecnológico, desastre urbano, modelo do queijo suíço.

QUESO SUIZO EN BRASIL:
CULTURA DE DESASTRES VERSUS CULTURA DE SEGURIDAd

Resumen: La presente contribución señala razones estructurales en Brasil relacionadas con la "cultura de desastres" y la "cultura de seguridad" y cómo estos aspectos influyen en la gestión de desastres, especialmente aquellos de baja incidencia y alta consecuencia, que no dan evidencia para la toma de decisiones preventiva. La discusión sobre la ocurrencia de desastres considera el "Modelo de queso suizo" del análisis de riesgos propuesto por James Reason. Al final se indican algunos caminos por recorrer.

Palabras clave: cultura de riesgo, cultura de seguridad, desastre tecnológico, desastre urbano, modelo de queso suizo