Proceedings of the 33rd European Safety and Reliability Conference (ESREL 2023)
Edited by Mário P. Brito, Terje Aven, Piero Baraldi, Marko Čepin and Enrico Zio

doi: 10.3850/978-981-18-8071-1_P038-cd

The limits of organisational resilience

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This paper explores the limits of organisational resilience and introduces an alternative conceptualisation through the concept of 'temporary adaptive capacity'. The proposition is that networks of loosely coupled socio-technical systems can unite under a joint governance structure to increase their combined capacity to protect themselves against a time-limited common threat. This conceptual framework differs from contemporary approaches to organisational resilience by utilising networks of systems, contrary to what has traditionally been an organisational-centric understanding of resilience. The conceptual shift is found in the ability of otherwise unrelated socio-technical systems to combine their resources, management, and governance systems to increase their overall capacity to identify, manage, and recover from what would otherwise be a disastrous event. The proposition is that such an approach maintains the initiative during an event, as it can adapt when norms and practices no longer have agreed outputs. To illustrate the utility of such a network approach, an example from Greenland where six communities face a possible catastrophic landslide and tsunami event. While the communities, from a traditional resilience perspective, would be considered vulnerable, they do display temporary adaptive capacity that they can operationalise during a disaster. They develop solutions and workarounds using existing knowledge and resources to achieve desired results.

Keywords: Adaptive capacity, Resilience, Tsunami, Arctic, Socio-technical systems.

1. Introduction

On the 17th of June 2017, a 9-10 metre high wave hit two settlements in the Uummannaq fjord system, resulting in four dead and nine injured. Further investigations showed that a part of the Karrat mountain, around 38.5 million m^3, had slid into the fjord some 30 kilometres away, causing a tsunami that hit the settlement of Nuugaatsiaq in seven minutes and of Illorsuit in 13 minutes. Following the Uummannaq fjord event, the Greenlandic government, with support from Norway and Denmark, completed a survey revealing a significant danger from the same area that could produce a wave more than ten times larger (GEUS, 2021). In 2022, another unstable cliffside Kigarsima, was identified; it is smaller but closer to some of the settlements (GEUS, 2022a). A total of seven settlements and one town would face a possible life-changing event from a wave of up to 74 meters in height with only minutes of warning, if any. Maps, calculations of run-up heights and local observations in the area show that, in most cases, critical infrastructure, places of employment and homes will be destroyed, damaged, or impacted through secondary effects (GEUS, 2022b; Taarup-Esbensen, 2022a). The continued liveability in these communities relies on access to critical infrastructure and the possibility of making a living through places of employment. Damage and recovery are challenging for emergency preparedness efforts, as these services often are positioned below the potential flood line. In case of an event, this would mean that, even if evacuation plans worked, the communities would struggle to maintain essential functions as people would not have access to their place of employment, water, fuel and, in most cases, electricity. In addition, cellular towers in the towns would be disconnected from the telecommunication grid, as their internal batteries would run out within a few hours without external power from the local electricity plant.

2. Limits to organisational resilience

We tend to think of risk as something 'at risk', which implies that we can isolate a hazard from other variables and then manage the uncertainties associated with something happening that is not in our interest (SRA, 2021). This line of thinking also permeates our understanding of resilience and belief that socio-technical systems reduce vulnerability and overcome the negative consequences of a known or unknown disaster by focusing on developing systems, standards, and good governance. (Bergström et al., 2015; Patriarca et al., 2018; Rehak, 2020). Such systems comprise both the social such as legislation, standards and management and the technical, like infrastructure, machines, and vehicles that make the system produce something humans value (Gordon, 1998; Leveson, 2011). The premise of organisational resilience theories is that socio-technical systems can, in a continuous circle of improvement, increase their capacity to respond, monitor, learn, and anticipate how events unfold (Hollnagel, 2018; Woods, 2019). By displaying these features, a socio-technical system can become resilient to events that can potentially destroy something of collective value. This approach enables the enactment of a range of reactions, from individual decision-making to predictive reactions that reduce systemic vulnerabilities (Linkov et al., 2018). The aim is to engage in a virtuous circle of continuous improvement of prevention, absorption, recovery, and adaption (Rehak, 2020). Strategic foresight entails actors understanding parts of the future as it emerges, not as a pre-determined end but as a series of possible likely outcomes to which the system has developed the ability to react.

Several models have been presented for what constitutes resilience of socio-technical systems, what it should entail, and how communities, companies, and public organisations can increase their capabilities (Comfort, 2016; Luzuriaga, 2009; Pandey, 2019). These models can be broadly characterised through their technical, social, and management domains. The technical approach to resilience focuses on how technology can positively influence resilience by reducing vulnerabilities or transferring risks to other domains (Xerandy et al., 2016; Yoon et al., 2016). For example, building infrastructure will protect a socio-technical system from specific hazards but will have economic consequences as it prioritises investments. The social domain of resilience research focuses on the cohesion of society and the ability of socio-technical systems to adapt to and recover from disasters (Bergstrand et al., 2015; Imperiale & Vanclay, 2021; Lim & Nakazato, 2019). The resilience of social systems refers to how organisations can cope with, recover from, or adapt to hazards. The concept entails that any organisation has an inherent ability to 'bounce' back by recovering from adversity using its resources and points to capabilities which include personal and environmental characteristics but also a sense of community, feelings of efficacy, and coping strategies as variables. Management is possibly the largest domain within resilience theory and focuses on how social systems respond to disturbances in their context (Bergström et al., 2015; Harvey et al., 2019; Le Coze, 2019). The management of organisational resilience holds the promise that all aspects of uncertainty can, under the right circumstances, fall within the organisation's domain of control. By structuring resilience work, the socio-technical system can assert its control over external uncertainties and work systematically to reduce the probability that a change will have negative consequences.

Within resilience research, there is the promise that there are no limits to the ability of social systems to reduce their vulnerability to adverse effects of internal and external hazards. The idea of an unlimited and continuous learning and improvement system is engrained in its basic assumptions of how organisations function. However, such systems are prone to failure due to their increased complexity and when experiencing cascading events. This weakness in resilience theory, engenders a need to identify alternative approaches for socio-technical systems to reduce their vulnerabilities and approaches to how they can recover.

3. Method

The temporary adaptive capacity model was tested using fieldwork observations, maps and interviews with individual emergency response professionals in the Uummannaq fjord system from April to May 2022. The work was done with a deductive approach using the model to describe the ability of individual settlements to manage and recover from a catastrophic event like a tsunami. The data includes information on the preparedness level in Avannaata municipality, infrastructure, and the current state of the Karrat Fjord and Kigarsima cliff sides (GEUS, 2022b; Svennevig, 2019). National preparedness information came from the Greenlandic police, fire department, Avannata municipality, and the Greenlandic government (Avannaata, 2022; GEUS, 2021; Grønlands Politi, 2021; Naalakkersuisoqarfik, 2018). The onsite visits to four out of six communities confirmed the location of the particular infrastructure and emergency response capacity, which could not be identified using maps or other offsite information. The last remaining settlement was reached through local contacts and telephone, providing information on the placement of infrastructure and preparedness levels.

4. Temporary adaptive capacity

This paper presents an alternate approach beyond the organisation-centric perspective in resilience research. The proposition is that temporary adaptive capacity is the ability of loosely coupled socio-technical systems to unite under a joint governance structure to increase their combined capacity to protect themselves against a time-limited common threat to their existence. This conceptual framework differs from contemporary approaches to organisational resilience by utilising a network approach, contrary to what has traditionally been an organisational-centric and risk-specific understanding of how to build such capabilities (Bhamra et al., 2011; Herbane, 2010; Rehak, 2020; Woods, 2019). The conceptual shift is in the ability of otherwise unrelated socio-technical systems to combine their technical, social, and governace systems to increase their overall capacity to identify, manage, and recover from what would otherwise be a disastrous event. A network of socio-technical systems displays temporary adaptive capacity when, firstly, it maintains the initiative during an event, as it can adapt across socio-technical systems when norms and practices no longer have agreed outputs. Secondly, it develops innovative solutions and workarounds using existing organisational resources to achieve its desired output. Thirdly, the socio-technical systems can work independently without compromising the overall network goals. Finally, it can adapt by changing the technical, organisational, and management domains to meet the needs of

Figure 1. Model Temporary adaptive capacity

external systems.

Given the four abilities, networks of socio-technical systems display certain qualities (see Figure 1). It is proposed that such a network of systems has seven characteristics that enable it to show temporary adaptive capacity. Firstly, a shared risk culture involves the beliefs, customs, knowledge, and practices that members accept and identify as part of managing their safety (Burgess, 2006; Gephart et al., 2009; Lash, 2000). Secondly, trust and trustworthiness involve the willingness to be vulnerable to others based on the belief that the other is competent, honest, concerned, and reliable (Cox et al., 2006; Earle, 2010; Linsley & Shrives, 2009). Thirdly, Distributed sensemaking is a system's ability to organise in ways that enable it to identify changes in a context that it wants to keep stable and predictable. (Lundberg et al., 2012; Taarup-Esbensen, 2022b; Weick, 2005). Each socio-technical system can develop its temporary adaptive capacity through the ability to coordinate (provide unity of action to pursue common goals), cooperate (working with internal and external stakeholders), organise (establish a hierarchy based on roles, competencies, and capabilities), and assign responsibility (providing agency to specific tasks that the socio-technical system needs to perform) internally and with other systems. In such a system of systems, causal connections exist between individual socio-technical systems and the adaptive capacity of the overall network.

4. The temporary adaptive capacity of socio-technical systems

The 2017 event represented a shift in risk culture for the communities in the Uummannaq fjord system. Risk culture involves the beliefs, customs, knowledge, and practices members accept and identify as part of managing their safety. The economy in the fjord is based on fishery and its supporting businesses, which is also reflected in the local risk culture. People are not unaccustomed to the threats associated with living far away from formal emergency structures and are mainly self-reliant regarding food and necessities. The fundamental shift can be witnessed in the belief that living close to nature, far away from the majority of emergency response capacities, could be controlled by learning from experience and adapting to a life filled with uncertainty and doubt about the threats the communities faced. The communities hence started a process where they were developing plans for mustering points, survival boxes that would sustain life for up to three days and plans for evacuation. In this way, they strengthen their risk culture by taking the possible consequences of a catastrophic event into their own hands, built on their experiences living in the Arctic and Ummannaq fjord system.

It is possible to build trust and trustworthiness by showing that decision-makers are competent, honest, concerned, and reliable. Local preparedness levels vary significantly between the sites. Lack of training, access to full-time and volunteer personnel, and outdated or worn-out equipment limit the preparedness organisation's ability to respond at all levels (Naalakkersuisut, 2018). All communities lacked people and staff with the right qualifications. In the municipality, just over 33% of firefighters had basic training, 17% of stations had training in specific functions, and 50% of team leaders and just under 40% of incident commanders had necessary qualifications. In the Uummannaq fjord system, two trained police officers and two reserve officers are responsible for the settlements and the town. When there is a gap in formal competencies and incident commander training, it is possible that there will be less trust and that decision-makers have not been able to build trustworthiness among the socio-technical system members. While the communities lack the basic training to manage a possible event, the 2017 event showed that this might be a false picture of their capacity. When the tsunami hit the two communities, many skilled individuals rushed to help. These were people with technical knowledge about critical infrastructure in the communities, such as food storage, gas and generators, and people who knew how to live and survive in the Arctic. While formal emergency structures are missing or inadequate to manage a catastrophic event, the communities can trust that help will be provided.

The ability of a socio-technical system to make sense of changes in its environment and perform a risk analysis depends on the activities it is engaged in, the individuals making up the system, deployed sensory systems, and coordination technologies. In all communities, the activities centre on services, maintaining critical infrastructure and the dominant fishery industry. In the worst case, it will also be these activities that are the most impacted, as all structures near the coast and harbour area will be damaged or destroyed, including the local hospital, energy supply, oil storage, and all of the fish factories. Maintaining essential activities within each socio-technical system without significant disruptions will be difficult. During a tsunami event, decision-makers have tasks that they must complete to meet community expectations. The government of Greenland has deployed two sensory systems that shape sensemaking. One is an active system based on people employed as lookouts, who will watch if the sea retracts, providing a warning as to an impending tsunami, and another passive system is opposite the Karrat cliff side. The first requires much effort from the lookouts over an extended period, which can lead to fatigue and, thereby, lack of attention. The other system can only be used to monitor the movements on the cliff side of Karrat and is not a warning system that can be used in emergencies (GEUS, 2022b). The sensors deployed do not represent the most optimal solution to providing an effective early warning system. From a sensemaking perspective, it could lead to a lack of trust towards the early warning system and, in case of an evacuation, could lead to members not behaving per the information provided. Systems aim to improve continuous learning processes, embedding collective experiences as retrospective knowledge, best-practice, and past decisions into a uniform structure (Weick et al., 2005). Other coordination technologies providing input to the sensemaking process include the standards deployed by the different emergency response units (police, fire brigade, and hospital) and signs placed around the communities as to what direction they can find the mustering points. As the power stations at most places would be affected, there would only be a limited time window (between four and eight hours) in which the mobile phone system would work. From that point on, it would only be possible to communicate via VHF or satellite telephones. Support from outside the Uummannaq fjord system will take time and the communities know that most of the disaster management will have to be done by themselves. Members make sense by using their experience of life in the Arctic and knowledge about coping with situations that can arise there. They are adapted to a life without formal emergency structures, making adjustments based on the experiences and skills acquired over generations.

4.1 *The individual-socio technical system*

These overreaching domains (risk culture, trust and trustworthiness, and distributed sensemaking) feed into the adaptive capacity of the socio-technical systems that develop their abilities to coordinate, assign responsibility, cooperate, and organise. They can thereby utilise their resources across different systems, enhancing the adaptive capacity of the network as a whole.

Firstly, the ability to cooperate reflects the willingness of relational agents to work together when conditions require the better use of resources and effective identification of possible common threats. The local emergency response has only carried out a few exercises since the 2017 event focused on how the community should act during a tsunami. In 2021, the Greenland emergency staff and Arctic command conducted an exercise near the capital of Nuuk but without the participation of local response actors from the Uummannaq fjord system. There has not been any crisis management training for the coordinating resources in Uummannaq that would support cooperation between the three emergency organisations: police, fire department, and the local hospital. The ability to cooperate hinges on existing networks and individuals who would benefit from engaging with local businesses, public administration, the fishing industry, utilities, and other local actors to improve cooperation and optimise resource utilisation. A new tsunami event would likely transpire much like in 2017 when community members cooperated on utilising available resources mainly by their own initiative. The experience was that while the help was much appreciated, it was less effective and could be significantly improved. With an event that could be ten times larger, there is a high likelihood that the existing system would collapse.

Assigning responsibility within the socio-technical system strengthens individual activities that the system needs to perform and supports coordination between different entities. In case of a tsunami, the expectation is that telephones, electricity, and other utilities will be disconnected, and it can take hours or days to re-establish these. Based on the municipality's recommendations, local community members are encouraged to meet at a pre-determined mustering point to register so that a list of missing people can be generated for the search and rescue effort. Another initiative has been to prepare 'grab bags' with three days of supplies: a first aid kit, radio/VHF, flashlight, mobile phone, water, clothing suitable for the season, and canned food. The initiative will help the emergency response prioritise its effort and assign resources depending on local needs rather than assuming everyone in the fjord will be distressed. It carries several benefits to assign responsibilities to individuals outside the formal emergency structure, such as a local municipal representative. Such a system provides a temporary organisational structure, decision-making is close to the event itself, and there is room for local adaptation.

The ability to coordinate includes complementary actions by agents contributing to shared value creation and what is considered favourable outcomes for the system. On a local level, this entails that individuals and organisations agree on what activities within the socio-technical system they will collectively work towards recovering. Depending on the extent of destruction and the critical infrastructure affected, such a list of priorities could focus on the limited resources available towards a fast recovery of critical value-adding activities. None of the settlements or the town will be affected in the same way, and some will be able to recover fast, while others will find themselves in a situation where all, or almost all, infrastructure is destroyed. Cooperation is encouraged when members of the socio-technical system trust that by investing in the recovery of others, they will be in a situation where they will receive help. As trust exists between individuals in the communities, creating plans to prioritise emergency efforts and the subsequent recovery of critical infrastructures is possible.

Organising includes the ability of the socio-technical system to create locally adapted standards that will ensure that their members are prepared before, during, and after the event. Over the years, each community has acquired skills and the necessary resources to cope with the most common breakdowns in old technologies such as diesel engines, fresh water and sewage. Each community needs a local inventory to sustain people and components for critical infrastructures, such as diesel engine parts, chemicals, filters, and parts for wastewater treatment. While little formal organising exists in the communities, most members know whom to contact if something does not work or needs repair. Local initiatives such as the three-day supply box and evacuation signs support the immediate need for safety. However, it will mainly be the individuals within each settlement making decisions and organising the recovery of critical infrastructure.

5. Discussion and conclusion

The paper set out to discuss the limits of organisational resilience and promote the idea of temporary adaptive capacity based on a network approach as an alternative to the dominant organisation-centric view dominating the resilience literature. From a resilience perspective, the communities face significant challenges. Their ability to enter into a continuous circle of improvement that would increase their capacity to respond, monitor, learn, and anticipate is limited by their remoteness, lack of resources and formal training. Lives, critical infrastructure and cultural and social structures would be affected or destroyed. A lack of trained emergency response personnel that could coordinate locally makes the communities even more vulnerable to disruptions. Half the settlements would lose their administrative office, and most would lose access to the local shop or kiosk, impacting both the access to necessities. Also, most would lose their electricity supply and gas and oil storage, significantly affecting liveability, especially during the winter. Implementing an effective warning system would provide much improvement in saving lives, but would only be enough to ensure that inhabitants could move to higher ground or the designated meeting point. In this way, the ability to muster an adequate response is limited to saving lives and less so to the effectiveness of barriers to destruction or in preparing communities to recover. Some exercises have been organised, but these have typically been internal training within one agency or do not involve the local response within the settlements. None of the communities in the Uummannaq system has resources available to help it overcome and recover from a tsunami event. They have essentially met their limits of resilience.

A risk culture based on self-reliance, trust, and the ability to make sense in the Arctic context is shared across settlements and creates a solid foundation to adapt, at least in the short run, to the impending disaster. The Uummannaq fjord communities have internalised unidentified resources, capabilities and competencies that will enable them to show temporary adaptive capacity. A governance structure that considers that these systems can and will be able to manage a coming event will help the government in Greenland to prioritise their effort, knowing that not all communities will be in immediate distress but are using their adaptive capacity. Help will come, but it can take many hours and even days after the event. Further developing and practising the existing capacities to coordinate, assign responsibility, cooperate, and organise will strengthen the response and recovery process. Building depots of essential spare parts will also help the settlements repair broken equipment and critical infrastructure. Using temporary adaptive capacity as a framework for making the best use of limited resources will, in the end, make the recovery effort less complex and will reduce the time needed to re-establish critical functions within the communities. Such an approach can include and efficiently use private companies, volunteer organisations, and public organisations not officially part of the emergency response structure, which will support overall adaptive capacity and strengthen the organisational resilience of all the socio-technical systems.

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