3RG REPORT

Factsheet
Expressions of Resilience: From 'Bounce Back' to Adaptation

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1 INTRODUCTION

Resilience is widely viewed as a desirable feature for systems that could be exposed to threats or disturbance. It implies strength and flexibility; elasticity and durability. Derived from the Latin word *resilïre* which literally means to 'spring' or 'bounce back', the early use of resilience in a threat or disturbance context encapsulated this fundamental meaning – where risk managers designed systems to preferably return to a normal functioning state quickly after a disturbance. The 'bounce back' has subsequently become an outward expression of resilience in many contexts, but the term and its meaning are not universally used.

Whether a system is resilient can only be observed following a shock to the system that forces it to respond or cope with an adverse event. For instance, following the 2011 multi-disaster in Japan, critics in the media viewed the tsunami affected communities as highly resilient – as expressed in their ability to evacuate communities, reach shelter, and deliver relief. Media headlines emerged noting Japan's ability to 'bounce back', and reference the human response in particular.[1] However, during the same event, there was also the technical breakdown of Japan's Fukushima nuclear power plant, which was not able to 'bounce back' quickly from the event and thus subsequently led to a partial meltdown and release of radioactive material. Of course, resilience can be influenced before an event, using interventions or actions that are aimed at increasing resilience, but these processes can only influence the inherent or antecedent resilience. It is this antecedent quantum of resilience that will determine the positive or negative response of the entity to disturbance.

The Japan case brings to light the lack of clarity surrounding what 'bounce back' actually means within the concept of resilience. Is resilience about returning to a pre-disturbance state quickly? Or does resilience also involve change and transformation, which might result from experiential learning and the development of adaptive capacities? Framed this way, 'bouncing back' appears to have two conceptualizations. On the one hand, it implies a static outcome, where the objective is to return to existing function previous to a shock. On the other hand, it implies change through transformation and adaptation. To deepen our understanding will use this report to critically engage such questions and in doing so examine what this term means and how it is used (or not) in the context of resilience, particularly in homeland security. We continue by first defining 'bounce back', engaging the two aforementioned questions. From here we further problematize the term relative to complex social systems, outlining three key issues: the different expression of resilience between system components; the temporal aspect of resilience; and, the influence of disturbance characteristics (*e.g.* severity, duration) on resilience. Section 3 draws on the resilience literature to examine how the term 'bounce back' has been used and is understood in five core disciplines: engineering/technical, psychological (individual), business/economic, ecological, and community (hazards/disaster research). We then present a resilience typology that is developed along these disciplinary lines and explore the expression of resilience by applying the typology to the 2005 power outage in Switzerland. Finally, we conclude with a discussion of the relevance of the 'bounce back' for resilience policy making in Switzerland.

1 For example: "Japan will bounce back from this terrible disaster" Available at: *http://blogs.telegraph.co.uk/finance/jeremywarner/100009766/japan-will-bounce-back-from-this-terrible-disaster*; "Japan will bounce back quickly from the Great East Earthquake" Available at: *http://www.oecd.org/document/52/0,3746,en_21571361_44315115_47694900_1_1_1_1,00.html*

2 UNDERSTANDING THE BOUNCE BACK

2.1 Resilience as bounce back or adaptation

Much of the discussion concerning resilience contrasts bouncing back from a shock to a pre-defined state with resilience through adaptation. The former implies that resilience is gained when a system or entity returns to normal functioning following a disturbance. The latter suggests that system is changed as a result of disturbance, providing the same service or filling the same operational niche as before the disturbance, but through an adaptive response to the disturbance.[2] In fact, *both* are forms of resilience expressed in different ways. However, as a continuum, resilience is by no means established, and discussion about, and research concerning what resilience is, the processes that influence it, its benefits and expression are on-going and widely debated. For instance, Aaron Wildavsky classified resilience as "the capacity to cope with unanticipated dangers after they have become manifest, learning to bounce back"[3] – outwardly this seems to conflate the outcome-oriented resilience through 'bounce back' with the process oriented resilience through learning and adaptation, and exemplifies the confusion around the concept of resilience.

Defining exactly what resilience is, and gaining an understanding of how resilience in a given system is expressed, is important because it can guide the way managers of that system generate or encourage resilience. However, whether entities (or system components) bounce back from disturbance, or develop resilience in an adaptive manner is highly dependent on the entity, the discipline, and context within which the conceptualisation of resilience is explored. For example, resilience in engineered structures is attributed when those structures recover quickly in response to disturbance.[4] In ecology, resilience of a linked socio-ecological system encompasses the ability to absorb shocks while maintaining function, but also highlights the necessity of adaptation, which accounts for 'renewal, reorganisation and development', and the possible opportunities that might accompany these features of the system.[5] Clearly these conceptions are related, but their construction results in discrete processes for developing resilience and exploring the outcomes. Table 1 provides a summary the important features of the 'bounce back' and adaptation expressions of resilience.

In addition, resilience can mean different things for different components of a system. For example, the optic fibre cables and the operators of an optic fibre network are components within the same system, as is the community who enjoys the internet service made possible by this network. However, characterising the resilience of these system components cannot be accomplished using the same descriptors, measures, frameworks or processes. For the optic fibre network itself, the ability to come back online soon after disturbance as a result of inbuilt redundancy might be indicative of resilience through 'bounce back'. But resilience in the contexts of the operators or users of this network might be better characterised by the ability to recognise what might decrease resilience of the network in the first place, and communicating ways to compensate for the lost services – they learn from their experiences, and share solutions or concerns.

2 Manyena (2006) provide a useful reflection on the differences between the bounce back and adaptation to disaster.

3 Wildavsky (1988), p 77

4 Haimes (2009)

5 Folke (2006), p. 253

***Table 1:** Comparison between resilience expressed as bounce back or adaptation*

	Resilience: Bounce Back	Resilience: Adaptation
Results in:	Static outcome, where the objective is to return to existing function.	Dynamic process that results in an adaptive response to disturbance.
Temporal span:	Resilience is attributed if normal function is returned quickly.	Longer; characterised by social learning and reflection.
Applicable to:	Entities or system components whose value (or service) lies in a specific function.	Entities or system components whose value lies in the management and proper functioning of systems or system components.

2.2 Problematizing the 'bounce back'

Social systems are complex – made up of various actors, assets, interests, interactions and interdependencies, *etc.* More specifically, we define complex systems as comprising both human and non-human systems that include the following components: technical or physical, individuals, business/economic interests and assets, ecological systems and environmental characteristics, and communities. Though there is a general understanding of the concept of resilience, as already discussed, what this term means for the different components of a social system can vary considerably. This is particularly the case when it comes to discussing the 'bounce back' when a hazard event is realised. In this respect, three issues emerge. First, in what ways does bouncing back from a disruption or shock differ between the different components of a social system? In other words, how do conceptualisations vary between the technical (where physical and technological infrastructures and the like are concerned) and the individual dimension? In truth, they have different characteristics that cannot be understood by a standard, out-of-the-box measurement of resilience following a hazard event.

A second issue concerns the timeframe in which the bounce back occurs. How long does it (or even should it) take to bounce back from a hazard event? And what specifically does that look like? For example, in the case of a large scale natural disaster, have people 'bounced back' when they can return to their homes or when electricity is restored within a specific post-disaster period? Or is it when the entire community is functioning at full capacity? In addition, does this mean a return to a previous, pre-designated state or function (i.e. recover and restore), as it is referred to in the engineering domain? Or is it not so much about 'bouncing back', but about adaptation and transformation to a new, perhaps slightly altered state (i.e. recover, transform, and adapt), which reflects debates in relation to socio-ecological systems?

The third and final point deals more specifically with a hazards characteristics. In this respect, the ability to 'bounce back' (or adapt) also hinges on the *scale* and *impact* of the disaster. Indeed, some disasters wipe out entire communities, making it challenging (or impossible) for even the most resilient social systems to bounce back quickly. In other scenarios, disasters can have disproportionate effects on a community. Certain locations or groups within a given community can have different vulnerabilities that might be influenced by characteristics like demography, geography/topography, strong social ties and networks within a community (*i.e.* social capital).

Needless to say, such issues bring to light the simple fact that conceptualising the 'bounce back' within the discussion on resilience is not clear cut – especially when talking about highly complex social systems. In the following section we draw on the resilience literature to explore how 'bouncing back' is conceptualised between disciplines (and that loosely reflect components of social systems) in order to gain some clarity on the variation in understandings and expectations relevant to bouncing back from disturbance.

3 THE 'BOUNCE BACK' IN DIFFERENT DISCIPLINES

The discussion on resilience crosses and connects various disciplines. As a truly 'adaptable' concept, it has its footing in fields as diverse as engineering, technology, psychology and ecology. To understand what bouncing back means, and identify its relationship to the wider use of the resilience concept, it is important to examine the various research disciplines where its use has been prevalent. This provides some indication of its application and the associated debate, and can help to extend its use to the contexts of managing risks. This is not an exhaustive review, rather we selected five core disciplines – that also represent the dimensions of a social system – where resilience, and the notion of bounce back have been used (Table 2). These disciplines loosely follow those dimensions specified by Bruneau and colleagues,[6] but with a focus on the broader social system.

Table 2: *Research disciplines that are examined in this fact sheet.*

Dimensions of Social Systems	Engineering/Physical
	Psychological (individual)
	Business/Economic
	Ecological
	Community

Together, these discipline-oriented dimensions capture the independencies, interactions, and interrelationships found within a society and are therefore relevant to this discussion on bouncing back. In the following sub-section we briefly discuss the key points in each discipline: identifying how resilience, and with that 'bouncing back', is conceptualised. *Engineering/Physical* refers to physical infrastructure and systems while the *psychological* dimension refers to the social domain that focuses on the individual. We then turn to perceptions of 'bouncing back' within the *business/economic* world – drawing from debates on business continuity management and business leadership/management. For this discussion, we take a more organizational approach as opposed to a technical one. This relates to the overall operations of businesses and the role of management. The final two sub-sections on ecological and community resilience wrap up this literature review, the former looks at how research on *ecological* systems has found that bouncing back from shocks can be both static (strict ecological process) or dynamic (in socio-ecological systems) and the expression of resilience is dependent largely on the scale of enquiry (predator-prey interaction *versus* human interaction in natural ecosystems). Similarly, in the latter, research on *community* resilience reveals the importance of adaptive learning and transformation. For this discussion we use the literature on disasters and natural hazards, which demonstrate insights on complexity in community behavior, reactions, and traits of communities when confronted by events that disturb the *status quo*. Overall, this discussion highlights a typology of resilience that is elaborated in section 3.

3.1 Returning to equilibrium: Engineering resilience

Within the world of physics and mathematics, resilience has a long history and is commonly used to "describe the capacity of a material or system to return to equilibrium after displacement."[7] Of particular concern here is the issue of time – or, how quickly does the entity return to its pre-designated operating state? Here the concept of bounce back refers to the

6 Bruneau, et al., (2003), p. 738.

7 Norris et al, (2008), p. 127.; also see Gunderson & Holling , (2002) discussion on engineering resilience pp. 27–8.

time an entity takes to resume functions and achieve homeostasis.

For technical systems – particularly in the discussion on critical infrastructure protection where railway networks, communication lines, electricity, *etc*. are concerned – much attention is placed on building up the robustness (defined as the ability of an entity to resist or delay damaging or catastrophic events) and investing in options to create more redundancy (defined as an entity's ability to provide alternative processes for inline or critical systems) with the goal of ensuring a service returns to normal function as soon as possible following disturbance.[8] In this respect, resilience can be measured or assessed by performing tests that examine the ability of the system to withstand shocks (robustness) and if a disruption occurs how quickly can services be restored (redundancy). In this technical or physical context the entity is not transformed as a result of disturbance (unless it is destroyed or irrevocably altered).

3.2 Psychological (individual) resilience

The disciplines of psychology and psychiatry were arguably the first to apply resilience in an academic context. Research conducted from the 1950s onwards in these fields aimed to understand how oppressive social environments could influence the development of children and adolescents.[9] Continued work since that time has demonstrated that negative psychopathologies (the appearance of mental disorders, where disorder is any deviation away from normal mental functioning and/or behaviour) were not necessarily a foregone outcome, but that some children in these situations emerged stronger, with new capacities to adapt to adverse conditions.[10] In short, such individuals were considered to be resilient.

In psychology, resilience is defined as the collection of personal traits and characteristics that allow an individual to operate normally in the face of trauma or adversity.[11] This definition is conceptually very close to the 'bounce back', in that psychological resilience is about returning to a homeostatic state through the application of stress coping abilities. Many personal abilities and characteristics are implicated in individual resilience, including tolerance, patience, self-efficacy (belief in one's ability to respond), positive emotions and optimism among others.[12] Research concerning, and particularly the measurement of, psychological or individual resilience has tended to focus on these intrinsic or 'within-person' factors as facilitators of resilience, which determine whether a person can 'bounce back' in the face of adversity.[13] By contrast, more recent work is showing that while personal traits might predict individual resilience in stressful circumstances, it is the individual's social and physical surroundings that make resilience more likely.[14]

3.3 'Bouncing Back' in the Business World

In the business world, resilience is couched within discussions about 'Business Continuity Management' (BCM) – defined as a "process that identifies an organisation's exposure to internal and external threats and synthesises hard and soft assets to provide effec-

8 Bruneau, et al., (2003), p. 740.

9 Waller (2001)

10 See Werner (2001), Waller (2001), Johnson & Wiechelt (2004) and Manyena (2006) for some background on this work and its evolution.

11 Bonanno (2005); Connor & Davidson (2003); Paton & Johnston (2006)

12 Connor & Davidson (2003); Tugade & Fredrickson (2004)

13 Windle, Bennett, & Noyes (2011)

14 Ungar, 2012

tive prevention and recovery."[15] Rather than looking at the cause of a disruption, BCM is focused on the continuation of operations during a crisis or, if disruptions occur, how to quickly bounce back.[16] To do this, Suter notes that "BCM complements the traditional methods of risk management" by bringing "together the probabilistic methods of traditional risk management with a systematic analysis of the ability of an organisation (or a system) to keep functioning under adverse conditions."[17] Interestingly, however, in this conceptualisation bouncing back can refer to returning to a previous state, but it can also mean adaptation and adjustment to a new business state or environment. In this respect, it is a more of a dynamic process and one that is affected by the broader physical and social interactions within a specific context.

While the BCM discussion looks at the resilience of the 'whole' business system, there is another way in which resilience is discussed within the business world: through the prism of psychology, by analyzing how business leaders – from the management to executive level – deal with stressful situations and crisis. This aspect of the debate concerns the human component of business operations, where the goal is to determine how managers can build individual and team resilience. But what does this body of work say about bouncing back in the face of adversity? This question is answered by engaging research that looks at cognitive (and behavioural) therapy,[18] more broadly, and leadership and coping strategies specifically. Insights are also drawn from studies that examine the differences between how people cope under intense stress[19] and ways in which resilience can be strengthened.[20] While this literature is rather divergent, Margolis and Stoltz have attempted to combine these strands to determine the qualities that (resilient) managers should possess and the lenses through which to view adverse events. One of their key findings is summarised as follows:

> *"Managers need to shift from […] reflexive thinking to 'active' thinking about how best to respond, asking themselves what aspects they can control, what impact they can have, and how the breadth and duration of the crisis might be contained."*[21]

In other words, they argue, that in order to 'bounce back' from adverse circumstances managers need to adopt active, response-oriented thinking (as opposed to cause-oriented) that takes into account factors related to their personal reaction to the crisis (aspects related to control and impact) and his/her impressions of the magnitude of the crisis (aspects related to breadth and duration).[22]

3.4 Ecological resilience: from bounce back to adaptation

Studies of resilience in ecology have diverged over time. Traditional ecology views resilience as the ability of ecological populations to absorb disturbance and maintain function. In this case resilience is a 'bounce back' that results in a steady ecological state

15 Herbane, Elliott , & Swartz, (2004), p. 435; also see: British Standard Institute, (2011) for additional information on BCM.

16 Woodman & Hutchings, (2011)

17 Suter, (2012), p. 14.

18 Albert Ellis and Aaron Beck have contributed to this discussion via their respective work on cognitive therapy. For example see: Beck, A.T., *Cognitive Therapy and the Emotional Disorders.* Intl Universities Press, 1975 ; Alford, B.A., Beck, A.T., *The Integrative Power of Cognitive Therapy.* The Guilford Press, 1998; Beck, A. (1970). Cognitive therapy: Nature and relation to behavior therapy. Behavior Therapy, 1(2), 184 – 200; Ellis, A. (1957). Rational psychotherapy and individual psychology. Journal of Individual Psychology, 13, 38 – 44.; Ellis A., Abrams M. & Abrams L. (2008). Theories of Personality. Sage Press.

19 For example see: Antonovsky, A. *Unraveling The Mystery of Health – How People Manage Stress and Stay Well,* San Francisco: Jossey-Bass Publishers, 1987.

20 Reivich & Shatté, (2002)

21 Margolis & Paul, (2010), p. 4.

22 Ibid, p. 3.

with little dynamism. This view of resilience has been (and continues to be) informed by short-term research experiments conducted at small geographical scales, and resulted in the view that 'nature finds a balance' in response to disturbance.[23]

An expansion into examining systemic processes and interactions led to the complex systems view of resilience in ecology. This avenue of resilience research, most notably illustrated by the work of C.S. Holling[24] and the Resilience Alliance,[25] highlights the interconnectedness of organisms, populations and communities in an ecosystem. From this perspective, resilience is an adaptive process characterised by systemic re-organisation, renewal and development – where equilibrium or a steady-state response is neither anticipated nor desired.[26]

This adaptive view of resilience has most recently been employed in discussions relating to the sustainability of socio-ecological systems – the existence and implications of people in nature. Here encouraging resilience has become a central focus because of its assumed role in enhancing sustainable pathways in development, and because it helps to partially account for the way changing systems deal with surprise where future disturbance is unpredictable.[27]

3.5 Community resilience to disasters and natural hazards

The literatures on emergency response and preparedness to disasters and natural hazards has produced some interesting insights on community behaviour during a disaster, defined as a disturbance (generally significant) that results in social disruption and loss. A focus on resilience in the context of disasters is relatively recent, having been brought into the mainstream by the adoption of the 'Hyogo Framework for Action' by the United Nations International Strategy for Disaster Risk Reduction.[28] This process saw a shift from a previous concentration on addressing vulnerability, to a focus on the way communities, in particular, could help themselves by responding to disaster in a more independent manner.[29]

Although disasters impact on the lives and lifestyles of individuals, resilience to disasters is influenced by community-level processes that reflect the way individuals exist as part of a community. This systemic view acknowledges the importance of community attributes like social capital, shared learning, leadership, trust, sense of community and attachment to place.[30] Such community attributes are important in resilience to disasters because of the inherent abilities of people to communicate and share knowledge, experiences and technologies that help them to adapt to the consequences of disaster. In this respect, disaster resilience is a very dynamic process (rather than an outcome), influenced by community structures, geographies, demographics, institutions and infrastructures. Relatively simplistic conceptualisations like resilience as a 'bounce back' are unable to adequately capture the complexity of resilience in a disaster context (although the term has often been used to describe the way people respond to disaster, though this usage is widely debated in the literature[31]).

23 Folke (2006)

24 Holling (1973); (2001)

25 *www.resalliance.org*

26 Gunderson & Holling, (2002) refer to this dynamic process as "nature evolving", p. 14.

27 Folke, (2006); Walker, Holling, Carpenter, & Kinzig, (2004); (Adger, Hughes, Folke, Carpenter, & Rockström, (2005)

28 *http://www.unisdr.org/we/coordinate/hfa*

29 Manyena (2006)

30 Paton and Johnson (2006)

31 Manyena, O'Brian, O'Keefe, & Rose, (2011)

4 TYPOLOGY AND CASE STUDY

4.1 Proposing a Typology

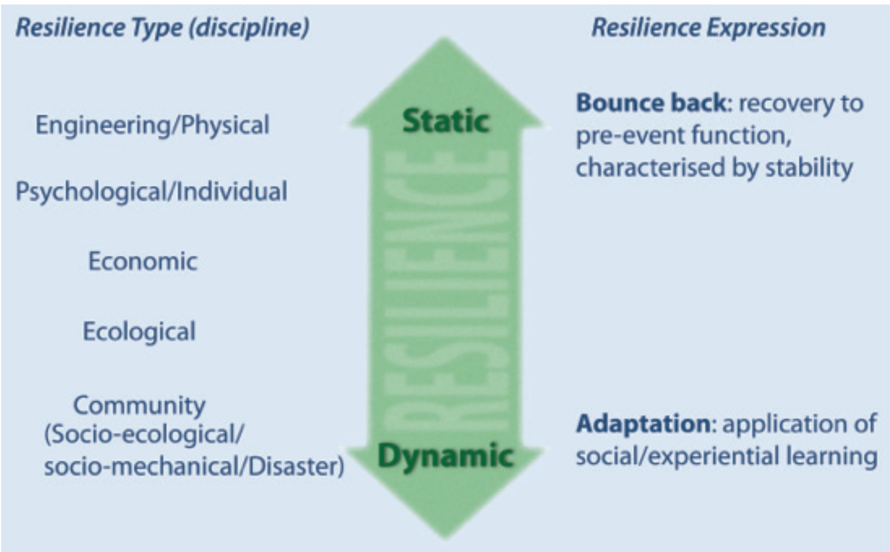
The disciplinary descriptions of resilience in the previous section loosely illustrate and reflect a typology of resilience expression or conceptualisation. This typology stretches from the outwardly simple 'bounce back', which revolves around stability of function and quick recovery in response to disturbance, to resilience through adaptation and learning that reflects the inherent complexity in the systems of focus in a security or disaster context.

The typology is graphically depicted in Figure 1, arranging disciplines of resilience (or types of resilience) based on how resilience is expressed or dealt with in the referent entity or system. The typology basically describes a continuum of resilience from static (engineering or physical resilience) to dynamic (socio-ecological and disaster resilience) responses/actions to build resilience – though it is important to note that in every discipline there are exceptions, and that this typology cannot be universally applied. For example, socio-ecological resilience is described in section 4 as the academic derivative of traditional ecological resilience, yet we have placed it with community and disaster resilience toward dynamic end of the continuum because of its complex, systemic nature. We place the 'bounce back' conceptualisation of resilience at the static end of the continuum, and the adaptation conceptualisation at the dynamic end.

It is important to note that this typology is not a reflection of 'good' or 'bad' resilience, merely that there are different ways of characterising resilience. In fact, addressing resilience in a systemic context (as is most likely in a security risk situation) will require, and draw on, a variety of resilience approaches (drawn from different disciplines) that correspond to the individual actors or components in the system.

The typology presented here is disciplinary in content, but conforms to the generic typology of resilience proposed by Handmer and Dovers, which progresses from resilience as system stability (type 1) to

Figure 1: *Loose typology based on resilience disciplines*



resilience though mechanisms that foster flexibility and adaptability (type 3):[32]

1. Resistance and maintenance;
2. Change at the margins; and,
3. Openness and adaptability.

4.2 Applying the typology: Case analysis on the 2005 power outage in Switzerland

In June 2005, Switzerland suffered a power outage that caused disruptions to the country's railway system. This was a technical hazard, caused by maintenance work on two of the three power lines in the southern region, including one of the two high-tension lines. Switching off these power lines resulted in a deficit in power that had cascading effects across the country – specifically overloading power circuits between Ticino and the German-speaking part of Switzerland. Subsequently, the rail network of SBB was completely shut down during the evening rush hour period, with services completely restored the following day. Roughly 100,000 passengers were stranded at stations and many more affected by the disruptions. While authorities were taken by surprise, they did manage the disturbance reasonably well – putting additional buses and diesel locomotives into service and handling the travel and compensation needs of those affected.[33]

From a resilience perspective, this system is composed of a range of different actors and factors that operate on a range of scales, and where decisions, activities and responses are likely to occur with some temporal variability. Importantly, these system components are all connected, whether directly (rail lines and SBB maintenance) or indirectly (commuters and energy providers), and the characteristics or activities of one component are likely to influence others (to a greater or lesser extent). In Figure 2, we illustrate the various components of the system that were likely affected by the disruption and their approximate position on the resilience spectrum (from static to dynamic; recover to pre-event stability to adaptation). While this figure is merely conceptual, its intention is to show that there are many actors or entities (as listed) within a social system (represented by the orange sphere) whose resilience can be expressed along a resilience continuum (illustrated by the green bi-directional arrow). For example, SBB maintenance is positioned roughly midway along the green continuum arrow because resilience is likely to be expressed in this component both in the static 'bounce back' form (making sure the power lines were back in service quickly), but also in the form of adaptation (learning to build greater redundancy into the energy supply system, and ensuring better management of maintenance processes in the future). On the other hand, because of its overarching policy function, the Federal Office of Transport is located at the adaptation or dynamic end of the continuum. The four resilience dimensions and the corresponding system components (reflecting only the hypothesised expressions of resilience for these components in lieu of empirical evidence) are listed below:

- **Engineering/Physical:** Energy infrastructure; rail lines; Energy provider; SBB maintenance
- **Psychological (individual):** Commuters
- **Business/Economic:** Industry; SBB management; private rail companies; Federal Office for Transportation
- **Community:** Cities (i.e. combined commuters); SBB management and maintenance; private rail companies; Federal Office for Transport

32 Handmer & Dovers, (1996)

33 The total cost of the disaster at about SFr 3 million. SOURCE?

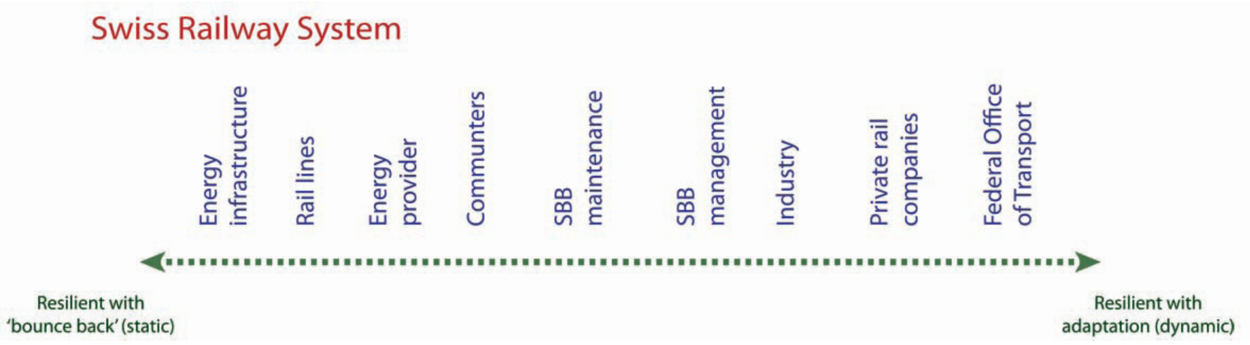


Figure 2: *A conceptual (and simplified) model of the Swiss rail system, illustrating components of the system that might respond to disturbance or threat events in either a 'bounce back' or adaptation expression of resilience. (note: this image is not representative, merely conceptual)*

As illustrated in the figure, the elements positioned at the 'bounce back' end of the continuum include: rail lines, energy infrastructure, energy provider(s), and even commuters. Commuters are included as they are part of the social system that relies on the technical system (e.g. rail and electrical network) to carry out daily functions. It is important that the services provided by the components of the system are back up and running as quickly as possible so that trains could resume services and commuters could reach their destinations. For other components, like the SBB management, the crisis provided an opportunity to test response (or crisis) plans and learn from the experience. What worked particularly well and what not? Do plans need to be adapted to ensure faster recovery time in the event of future crises or was the crisis handled as efficiently and effectively as possible? These are just a sample of the type of reflective questions that can inspire an organization to further refine plans. As such, they are located toward the dynamic, adaptation end of the continuum. Notably, SBB's management did respond to this incident with operational protocol changes. For example, Mr Benedikt Weibel, SBB's CEO at the time, admitted that authorities did not consider this worst-case scenario and were not aware that the system did not have sufficient redundancy. Management consequently implemented measures it felt would address these issues, such as reducing the sale of power to third parties, increasing and improving staff training, and updating emergency scenarios designed to minimise future risks. They also learned that future maintenance activities should be taken with more consideration of the power needs and dynamics in the country. Such adaptive learning was experienced across industry and government.

This case demonstrates that systemic resilience requires the simultaneous development or fostering of resilience though bounce back and adaptation. The development of 'bounce back' capacities is necessary in the rail power supply infrastructure, and the need for resilience through adaptation (in relation to maintenance of and the establishment of appropriate redundancy in the energy delivery infrastructure) is important at the SBB management and operations levels.

5 CONCLUSIONS AND IMPLICATIONS FOR SWITZERLAND

Operationalizing resilience in a systemic context is very complicated.[34] By unpacking the concept of the 'bounce back', and exploring its varying, but connected meanings in the range of disciplines it has been used, we have demonstrated that the bounce back is only one expression of resilience, and that resilience is differently expressed between different dimensions of any referent system. Importantly, no expression of resilience can be classified as either 'good' or 'bad', unless its application to a system component is inappropriate (for example, trying to build 'bounce back' resilience in a community exposed to flood where homeostasis following disaster is not the preferred response). Building systemic resilience cannot be a one-size-fits-all exercise, but must be context and actor- or entity-specific. In particular, one must take into account the differences between the behaviour and expectations of technical systems and individuals/communities during and following a hazard event.

Resilience in security risk is likely to fall toward the complex adaptive end of the resilience typology presented in section 4. It likely calls for a multi-layered approach to resilience development (or maintenance) since it is concerned not only with ensuring infrastructures are resilient, but that these are operated and used by resilient communities, who in turn are buoyed and serviced by resilient businesses and economies. At the next level, maintaining these aspects of society within resilient environments is also necessary, especially if recent research demonstrating connections between conflict and climate change (or other forms of global environmental change) proves to be accurate.[35]

34 See reports by: Prior, T. & Hagmann (2012). Measuring Resilience: Benefits and Limitations of Resilience Indices. CIP Focus Report 8. Center for Security Studies (CSS), ETH Zurich; Prior, T. (2013). Measuring Critical Infrastructure Resilience: Possible indicators. CIP Focus Report 9. Center for Security Studies (CSS), ETH Zurich.

35 Koubi, Spilker, Bernauer, & Kalbhenn, (2012)

For the Swiss case specifically, it is also very important to consider how transferable different conceptualisations of resilience are to government and decision-making at the local, cantonal and federal levels. When a hazard event occurs, regardless of its origins and causes, how does the 'bounce back' differ between the different components of a system (social, management/government, technical, etc.) and, perhaps more importantly, can governments be resilient in the face of extreme stress? If policy-makers and governments use reactive policy, rather than proactive policy, then can this have a snowballing impact through society to individuals that might negatively affect their resilience, or ability to become resilient? For instance, the people at the centre of disasters like the 2001 terrorist attacks in the United States and the Japanese earthquake and tsunami of 2011 were upheld as beacons of resilience (for whatever reasons, and whether subjectively or objectively), but can this resilience be affected if government policy is unable to capture and build on it with proactive and reflexive policy? This discussion also begs the question: is individual, community or infrastructure resilience compromised if governance is not resilient (or resilience-generating)? If governments or organisations do not recognise resilience in their constituents or employees, do they miss an opportunity to corral and develop resilience from the bottom up? Is this form of development even appropriate or effective when building resilience? Such considerations are important to take into account as the current CIP Strategy is under review and being expanded to the national level.[36] Given that one of the key points identified for the future strategy is to improve the resilience of critical infrastructures, it bears considering the different expressions of resilience discussed in this document,

36 See for more information on the Swiss CIP programme: www.infraprotection.ch

and how the ‘bounce back’ varies, or even applies, for each component in a social system. This will be the case both outside of government (*i.e.* with private sector partners and the like), but also within government. In short, this discussion should contribute to current debate on how to understand, conceptualise, and measure resilience for the different CI sectors.

In addition, it is important not to overlook the human component in technical systems, or the tight relationships existing between technical interests and business/economic interests. As fundamental components in socio-technical systems, the resilience of managers, and their response to disturbance or threat situations, is an important component to the overall resilience of a system. In the case of critical infrastructures, the decision-makers who influence the operation and maintenance of these infrastructures must also have the tools and capacities to cope with, and adapt to, adverse circumstances. In this respect, government actors can play an important role in developing and delivering training or workshops that focus on the resilience of managers within both the public and private sector. These should focus on the important roles played by people in socio-technical systems, and focus on bottom-up mechanisms for resilience building that help to generate systemic resilience.

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