

# Resilience in the Context of Systemic Risks: Perspectives from IRGC's Guidelines for the Governance of Systemic Risks

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## Introduction

This piece discusses resilience in the context of systemic risks and complex adaptive systems. Systemic risks are an increasingly common threat to many interconnected systems worldwide, from cybersecurity, critical infrastructure to environmental sustainability. Building from IRGC's recommendation regarding the governance of systemic risks, we describe how resilience strategies can support efforts towards helping systems navigate transitions, including cases of adaptation or transformation (IRGC, 2018). We also briefly use the case of insurance to illustrate the articulation of risk- and resilience-based perspectives and the drawback of resilience.

Both theoretically and mathematically, resilience is a function of *systems* and their interaction. More explicitly, resilience is a property, a capacity, and a dynamic process by which a system is able to address disruptions to its core functionality, either at the micro or macro-scale. Dynamic systems are constantly incorporating new information and new practices into their core function and identity at various levels. These ideas define the backbone of *complex adaptive systems*, whereby systems influence and are influenced by other systems, sub-systems, and broader environmental conditions.

Major shocks and disruptions materialise as the result of systemic risks cascading within and between complex adaptive systems and are often unexpected prior to their arrival. This cascading effect is perhaps one of the more complex and unpredictable components of systemic risk and is particularly dangerous in an environment of increasing system interdependency and connectivity (e.g., the global financial system, industrial agriculture and fishing, digital information systems, etc.). A resilience-based approach helps key stakeholders combat the negative consequences of systemic risk by preparing a system for an uncertain future of direct or cascading threats, and by enabling that system to recover from even those disturbances that threaten system collapse.

A critical component which defines complex adaptive systems is the interconnectivity within and between systems. Such interconnectivity is often driven by convenience or for the sake of efficiency – i.e., it is easier to rely upon a public utility for water and power of a building rather than acquiring and managing that resource oneself. For most modern businesses, interconnectivity is often framed

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as normatively positive, whereby an interconnected organization can develop more advanced services or goods to larger customer bases in faster, cheaper, and more effective ways. Such interconnectivity is made possible through digitalisation and the reliance on the Internet for data transactions, as well as globalized economic and supply chain practices, among others.

But what are the potential costs of such interconnectivity? While interconnectivity can increase the efficiency of a system to deliver critical services, it can also increase exposure to risks from external sources. If connections between important nodes are too tight, interconnectivity may expose the various layered systems to risks of sudden external shocks and unsustainable stresses. This may take the form of slow-moving and imperceptible changes that go largely unnoticed with the lay public but can ultimately drive the system beyond a tipping point, resulting in cascading changes in the system itself and other interconnected systems.

Striving for organizational efficiency usually comes at the cost of reduced redundancy. Many business practices, such as *lean manufacturing*, often frame redundancy as a negative organizational trait that bloats costs. However, organizations with limited redundancy or buffer capacity to quickly recover and reorganize are at the greatest risk of collapse from systemic threat. Thinking in terms of resilience in contrast to efficiency implies fostering policies and management that reduce the duration and depth of shocks, enhance the capacity to recover quickly and reduce the severity of the impact on welfare (Connelly, et al., 2017).

Complex adaptive systems can alternate between different stable states or regimes, provided that their base resource and operating requirements are relatively stable. From a socio-ecological perspective, rich grasslands can become increasingly arid and encounter desertification under certain environmental conditions, if a threshold (tipping point) was crossed. Systems are constantly in flux and incorporate new information in a deliberate or unintentional manner. Such transitions between regimes are natural processes and foster adaptation from one steady state into another. Resilient and sustainable systems are better placed than rigid, non-evolutive and non-sustainable systems, when they are confronted with cascading consequences of systemic risks.

### **Articulating risk and resilience**

The IRGC is institutionally focused upon addressing *risk*, which may be understood as the negative consequences stemming from uncertainty within a given activity or objective and their associated values. In most contexts, risks may be best addressed through processes of *risk assessment* and *risk management* – both fundamental components of risk governance, and tested tools for regulators across the globe. However, traditional risk assessment methodologies, especially those based on linear or well-established cause-and-effect-relationships, cannot be successfully applied to risks that develop in complex adaptive systems and may even have counter-intuitive and unintended consequences. A better understanding of systemic risks and an appropriate approach for developing management options is thus essential for decision-makers to prepare their organisation for future challenges. For example, the OECD recommends that governments should seek to address critical risks, strengthen resilience to avoid being negatively affected by cascading failures, and create capacity for improved agility in case unexpected shocks and disruptions happen (OECD, 2011; 2014a; 2014b; Linkov, et al., 2014).

*Resilience* serves as a more helpful alternative philosophy and methodology to analyse complex adaptive systems and systemic risks, which are difficult to analyse via conventional risk assessment methodologies. Many modern systems would benefit from a resilience-based approach, particularly for systems with inherent nested interdependencies with others, or those which are prone to low-

probability, high-consequence events that are difficult to accurately predict or model. Resilience helps these systems prepare for disruptions, cope with and recover from them if they occur, and adapt to new context conditions (National Academy of Sciences (NAS), 2012; Linkov & Trump, 2019).

Insurance provides a useful illustration of this. From an insurance point of view, the limitations of standard risk-based approaches are visible and increasingly problematic. The insurance sector is increasingly facing challenges such as accumulation, which go beyond traditional risk analysis and require resilience analysis. Risk management and risk transfer have always been the basic instrument of the insurance industry; but in the light of changes in the global risk landscape and the increased importance of systemic risks, conventional risk management approaches reach their limits. Resilience as an approach to deal with shocks and uncertainty appears a promising way forward and should become more important in the future of insurance, provided it can be measurable.

However, investments in resilience are difficult to valorise, because it is difficult to align high present-day expenses and potential future advantages. On-going work to develop or refine indicators, tools, and quantitative/qualitative approaches to inform system resilience should help characterise and quantify the benefits of investments in resilience (Cutter, Burton, & Emrich, 2010; Hosseini, Barker, & Ramirez-Marquez, 2016). At a high-level, this is what insurance is meant to do with risk-based insurance premiums that can turn such potential future advantages into immediate premium discounts.

Insurance can encourage investments in risk mitigation through financial incentives (e.g., premium discounts) and risk information (e.g., communicated risk assessments (Kousky & Shabman, 2016)). A relevant question for those who develop insurance products and resilience managers is the extent to which insurance can incentivize investments in resilience and make the cost of resilience competitive with the costs of risk-based measures. Answering this question will elaborate on the two properties of insurance: to mutualise costs and benefits across policyholders (space dimension), and to distribute over time the cost of risks (time dimension) (IRGC, 2019).

### **Drawbacks of resilience - How a resilience-based focus might lead to unintended challenges**

Resilience-based approaches, while helpful in promoting expeditious recovery for normatively beneficial systems, can engender infrastructural or cognitive drawbacks that must be carefully guarded against. When system appetite or acceptance of risk is unacceptably high, or when individuals, communities or businesses believe that, if a catastrophe happens, someone else (often the government) will jump in to help recover and rebuild any lost assets or system functions, such resilience-based approaches foster an environment amenable to *moral hazard*. More simply, resilience may perversely lead to more risky behaviour in a belief that any and all disruptions can be quickly addressed and overcome with minimal losses. For example, when the government provides insurance to buildings destroyed by natural hazards such as flood or earthquake, even in areas that are known as exposed, homeowners and businesses may have less incentive to relocate to less hazard-prone areas. In that sense, the promotion of a resilience-based strategy can generate quick recovery from certain types of disruption but generate cognitive and social responses that are highly undesirable and likely to have recurring financial, infrastructural, and human losses. Such arrangements are particularly problematic when short-term gains are given significantly higher value than longer-term losses, fostering an environment that is less capable of preparing for future systemic challenges (Grossi, Kunreuther, & Windeler, 2005).

In broad terms, moral hazard occurs when someone increases their exposure to risk, or willingness to take risk, because someone else bears the cost of that risk. Resilience may indirectly increase risk

exposure and/or inhibit learning from a small manifestation of that risk, thus diverting attention from weak signals that may become stronger and thus stifle system solutions.

Here also, insurance provides a useful illustration. Analysing how insurance and resilience work together can provide interesting insights into possible drawbacks of resilience, and into how insurance can contribute to reducing the risk of drawback.

On the one hand, insurance can reduce incentives to risk management and resilience building by creating moral hazard and a false feeling of security. Insurance can reduce incentives to those who manage physical safety and security of insured assets. This has always been a problem in risk transfer solutions. The moral hazard needs to be addressed through the design of the insurance contract, in a way that there should be no incentive for policyholders to create a loss. For example, coverage limits or conditional coverage can provide such incentives. Conversely, resilience can reduce the perceived need for insurance.

On the other hand, insurance can increase incentives for improving resilience, if insurance premiums are revised depending on the depth of disruption and speed of recovery after an insured risk event. Insurance can improve resilience by providing the financial resources to recover, rebuild and adapt (as insurance will require rebuilding in a way that intrinsic susceptibility to risk will be lower than before the risk event). Likewise, resilience can improve insurability or reduce the cost of insurance, for example by defining factors of insurance cost reduction based on tangible resilience indicators (IRGC, 2019).

### **Can resilience be designed for transition, adaptation or transformation?**

In the context of systemic risks, considering resilience to cope with, navigate or steer possible transitions that come with change is worth some attention. Organisations must develop capabilities to adjust and adapt to uncertainty, rather than to inherently resist change. A traditional response to a specific threat is to *harden* a system to better withstand and absorb said threat – this works well when such threats are well characterized and understood. However, when threats are more uncertain, or the affected systems more complex and difficult to model, greater emphasis upon modularity and redundancy can afford greater system capacity to transition towards a more normatively positive resilient state.

Resilience-based approaches for complex adaptive systems enhance the system's capacity to absorb disturbances and re-organise system functions and characteristics in order to essentially retain the same system mission and purpose to deliver a specific set of services. For example, when a city with large and important assets is prone to flooding through sea level rise and storm surge, re-organising land-use and creating floodplains around that city can 'absorb' the risk of flooding and subsequent disturbances. This would be in contrast to building dykes to prevent the flood from entering the city. The city and its surroundings would be adapted or even transformed through resilience building.

IRGC's Guidelines for the Governance of Systemic Risks place resilience as a tool to better understand and prepare complex adaptive systems to systemic risks. These systems adapt dynamically to internal and external changes, and resilience is well-placed to help a system adapt. Resilient social-ecological systems try to absorb shocks so that the crossing of a dangerous threshold is avoided. However, an organisation or system can deliberately engage in the process of change (transition) to adapt to change and, if needed, transform itself. In that case, the question is (a) whether resilience can be designed to steer, or drive a fully transformative process, which may be required in the face of transitions to fundamentally different regimes or systems, or (b) if a resilient system cannot do more than small adaptation. The capacity to fundamentally transform a system

may be beyond what conventional strategies for resilience can achieve. But in either case, resilience can help deal with the specific disruptions that result from the transformation process, especially when transformation creates losers that must be compensated.

#### **Key terms and definitions related to systemic risks (IRGC, 2018)**

**Persistence** involves absorbing on-going change or risk. It may also correspond to a non-vital degradation of the system as it absorbs such risk. Persistence can be thought of as the capacity of a system to exhibit low vulnerability to risk or provide a good level of resistance to risk. For example, persistent ecosystems can provide a steady supply of valued ecosystem services, but over the long term, this may require adaptation and possibly transformation at other scales.

**Transition** is the process or period of changing from one state or condition to another (Oxford Dictionary, n.d.). It is seen as a fluent change towards a new future, which is an improved version of what exists; it is a “gradual, continuous process of societal change, changing the character of society (or a complex part) structurally” (Rotmans, van Asselt, Geels, Verbong, & Molendijk, 2000). A dynamic phase between two stable phases enables the system to shift from a first context to a new, stronger one. Crises are often needed to make such changes happen. In a condensed form, the EEA defines transitions as “long-term, multi-dimensional and fundamental processes of change, based on profound changes in dominant practices, policies, and thinking” (EEA, 2016).

**Adaptation** is the action or process of adapting or being adapted to something. It involves adjusting responses to changing external drivers and internal processes to remain in a necessary or a desired regime and on the current pathway. Adaptation is achieved through incremental change. It is seen as a slow process, which modifies the landscape only slightly.

**Transformation** is a thorough or dramatic change in form or appearance. It involves fundamentally changing the system dynamics, so there are new feedbacks to maintain the system in a new regime or along a new pathway (Renn, 2017). It is a change towards a future that is fundamentally different from the existing paradigm (Roggema, 2012). In the case of the resilience of the global social-ecological system, transformability for sustainability is about shifting into new pathways of development (Folke, Biggs, Norström, Reyers, & Rockström, 2016).

**Resilience** includes sustaining what we want to keep the same (i.e., persist). Adaptability can also be part of resilience because it represents the capacity to learn and adjust responses to changing drivers. “The very dynamics between periods of abrupt and gradual change and the capacity to adapt and transform for persistence are at the core of the resilience of social-ecological systems” (Folke, et al., 2010).

IRGC's Guidelines for the Governance of Systemic Risks suggest that strategies should create supporting conditions to:

- Reduce the exposure of the system and its vulnerability to various shocks and stresses
- Collaborate with others at the periphery of the system. Multi-stakeholder partnerships and value-chain analysis can provide incentives to those actors who contribute to reducing systemic risks by adding diversity, modularity or other components of resilience, in such a way that the value chain can be more adaptive and able to re-organise if needed
- Prepare proactive measures to adapt or transform the system, should a fundamental change occur
- Consider planned adaptive governance

- Prepare for when a window of opportunity opens, which will make possible the implementation of a strategy to adapt or transform the system or organisation.

These supporting conditions can participate in the effective deployment of various types of approaches to the management of systemic risks. In the face of many unknowns, increasing the overall resilience of an organisation can be a way to prepare for and better deal with the shocks and stresses arising from those systemic risk. In line with mainstream recommendations for resilience-building (Hollnagel, Woods, & Leveson, 2006), IRGC therefore proposes three main strategic approaches:

- Supporting and strengthening the ability of a system to self-organise and self-control, which is a property of resilient or sustainable systems. When biological systems engage in 'self-healing' in order to overcome disruptions to biological processes, they use a critical component of system resilience, whereby such systems can better recover from and adapt to threats and disruptions from various sources.
- Engaging in proactive intervention strategies: prevention, adaptation, mitigation or transformation. The most radical intervention, transformation, is based on the logic that there is a window of opportunity to catalyse a positive regime shift and let the system evolve on new or improved trajectories. It typically involves initiating changes at lower scales while maintaining the resilience of the system at higher scales as the transformation proceeds, until the feedbacks in the new stability domain are sufficiently established. An example is the energy transition in Germany or the transformation to a circular economy (Centre for European Policy Studies (CEPS), 2017).
- Preparing for disruptions, accidents and crises, which requires thinking in terms of resilience.

There are three ways to frame resilience as a mechanism to facilitate system adaptation and transformation, and whether it can assist key stakeholders to steer a system transition towards a more favorable direction:

- Say that adaptive systems will by definition adapt and resilience will *help them recover from shocks while transitioning* to a new state that is better adapted when context conditions change. Resilience is conceived over the long term and fits well as a concept with dealing with changes in system performance and their capacity to absorb shocks (Hollnagel, Woods, & Leveson, 2006). Resilience strategies have the potential to deeply change how an organisation prepares for the possible disruptions of key services on which it relies. When organisations prepare for recovery from external shocks of a significant magnitude, resilience strategies *must* be considered (Linkov, et al., 2014). Example: resilience of Walmart supermarkets after Hurricane Katrina (Zimmerman & Bauerlein, 2005), (Horwitz, 2009).
- Say that resilience can or must *promote adaptation* of the system. This can be a discourse and an attitude of managers who are convinced that such a statement will force dynamic resilience to pursue a normative goal, such as adaptation to a new, preferable order. Example: change in agricultural practices to adapt to climate change.
- Say that resilience must *promote transformation* towards sustainability or fundamentally changed conditions. This discourse must be accompanied with adequate leadership and authority to steer the transition to transformation. Examples: transformation of the energy system to avoid future shocks and disruptions; transformation to circular economies.

Bresch, Berghuijs and Kupers (2014) summarise scholarly literature and describe nine lenses of resilience, among which "transformative resilience" requires systems to review changes over

extended time horizons. This type of resilience enables an organisation to transform itself if the fundamental conditions of its survival have changed. Such change can take many shapes, such as the need to reduce exposure to systemic risk via reduced interconnectivity and feedback loops with other systems, or the creation of redundancies and reserve capacities to quickly address such shocks as they arise.

Transformative resilience is based on various factors that can help address systemic risks in a responsible and thorough manner. These include (a) distributed governance, (b) foresight and anticipatory measures, and (c) innovation and experimentation. Collectively, these factors support strategies to anticipate and respond proactively to changes in the systems in which a company or an organisation is embedded with dynamic reorganisation, restructuring, and reinvention.

*Distributed governance* is management undertaken from multiple centres of authority, with trust and effective communication between stakeholders and the capacity to develop and use measures of anticipating systemic risks.

*Foresight* refers to the capacity of individuals and organisations to engage with uncertainty and anticipate the potential outcomes and the future state of the system in which they operate. Foresight is an effort undertaken by various stakeholders to both understand emerging trends regarding systemic behaviour and potential for disruption, as well as futuristic threats that may arise to disrupt a system in the years to come.

*Innovation and experimentation* involve efforts to identify new strategies of system formation and operation, and to review the efficacy of such innovative proposals through modelling or small-scale implementation. Innovation often starts at the frontiers of a system, sometimes as alternative solutions to existing problems. While innovation frequently represents a threat to incumbents and existing practices, and is therefore often purposely ignored, it nevertheless represents opportunities to steer change, adaptation and transformation. Small-scale experimentation and modelling exercises provide the ability to simulate how a system behaves under stress, and how transitions to a system can allow it to perform more optimally in response to such systemic risks in the future.

## **Conclusion**

Resilience is a key feature of complex adaptive systems when those are affected by transitions, which require adaptation and transformation. It can provide confidence to managers of such transitions that negative consequences from systemic risks, particularly those cascading within and between systems, will be addressed by the intrinsic and dynamic ability of that system to recover and adapt. What is less easy to figure out is how those managers can leverage transformative resilience to produce actual transformations of the system, when such transformation is deemed necessary.

Systemic risks will become a regular threat to modern life. Increasing layers of interdependence between important yet fragile infrastructural, environmental, cyber, and social systems will generate situations where disruption may threaten severe limitations in how many basic services and modern conveniences are able to operate. Further, as interconnectivity becomes increasingly widespread across the globe, the number and scale of systemic threats will likewise only grow in number, complexity, and frequency.

Though we cannot fully prevent systemic threats and risks from arising, resilience-based approaches might help policymakers and key stakeholders in system management better navigate the process of disruptions. By adopting a scientifically grounded systems approach, and accounting for potential

unintended drawbacks of a resilience-based approach, an emphasis upon system recovery and adaptation may help many segments of our complex adaptive society better prepare for the threats to come.

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