OECD Reviews of Risk Management Policies

Future Global Shocks

IMPROVING RISK GOVERNANCE

BETTER POLICIES FOR BETTER LIVES

OLIVER WYMAN

Foreword

It has become trite to note that the world's societies, economies and businesses are increasingly buffeted by unexpected events. Global disruptions in the past decade alone include events as diverse as the 2003 SARS outbreak, the 2004 tsunami in the Indian Ocean, tainted food imports, the 2008 financial crisis, volcanic eruptions in Iceland, wildfires in Russia and Australia and most recently, the earthquake and tsunami in Japan. These events have had significant and lasting impacts on businesses and their global supply chains.

The increasing number and severity of events, and their far-reaching effects, is widely perceived, but to date there has been relatively little robust research into their causes, pathways and implications. This report by the Organisation for Economic Co-operation and Development (OECD), "Future Global Shocks: Improving Risk Governance", examines the sources of heightened global vulnerability and presents recommendations for action at the national and international level.

The OECD's report focuses on global shocks, defined as rapid onset events affecting two or more continents. It uses case studies (including a pandemic, a cyber attack disrupting critical infrastructure, a financial crisis, socio-economic unrest and the impacts of a geomagnetic storm) to illustrate how natural and man-made shocks affect the complex web of interconnections linking economies and societies.

Ultimately, the report notes, the forces and impacts of business globalization have outpaced global governance at a policy level. Economies are linked more tightly together, but nations have not yet developed the mechanisms required to govern those connections or to stem the spread of negative shocks throughout the systems.

While not a call for greater regulation, this report is a call for greater national and international coordination by governments and policy makers. Specifically, the OECD recommends that governments make efforts to share data and to model events in order to better understand and assess the vulnerabilities and risks of large-scale interdependent systems. Governments are already moving in this direction. For example, the first meeting of the G20 agriculture ministers in June, 2011 was convened in recognition of the impact of increasing volatility in food prices. A key outcome was the agreement on the need for major players, including those in the private sector, to "share data, to enhance existing information systems, and promote greater shared understanding of food price developments".

To better understand and govern the impacts of global shocks, many steps must be taken at the national and international policy level. However, businesses must also be attuned to the potential effects of future global shocks and the underlying trends that are supporting their development and transmission. Reports such as this help drive analysis and promote dialogue regarding critical questions, such as:

- Where are the organization's vulnerabilities to systemic shocks?
- What are the key vulnerabilities in supply chains?
- How are globalization trends and evolving global economies and societies changing the organization's risk profile?

Oliver Wyman's Global Risk Center is pleased to sponsor this report by the OECD as part of our overall commitment to support critical research into the causes of global risks and the key elements of risk management.

Alex Wittenberg, Partner, Oliver Wyman Global Risk Center

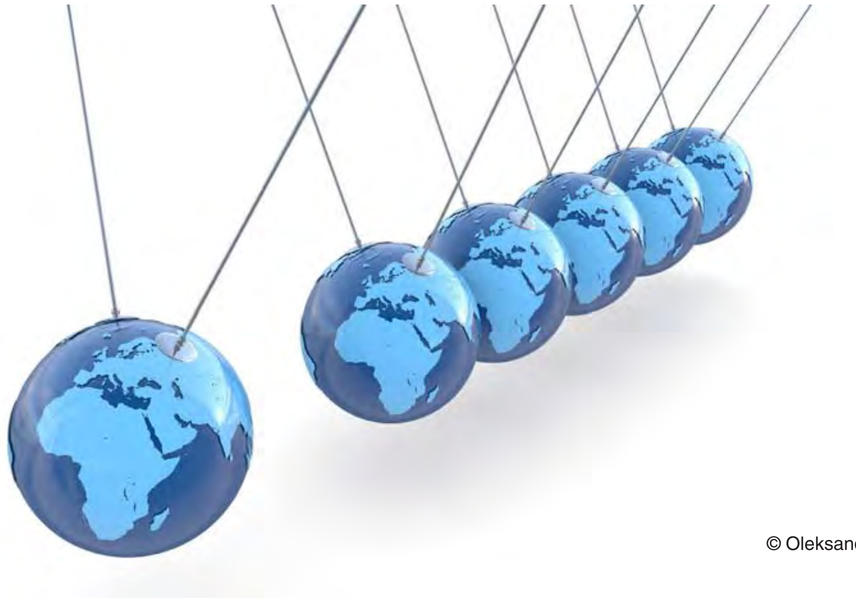
Introduction

Recent global shocks, such as the 2008 financial crisis, have driven policy makers and industry strategists to re-examine how to prepare for and respond to such events in the future, whether they arise in financial, natural, public health or even political systems. This OECD report is part of the organisation's pioneering work on the policy implications of emerging and systemic risks and supports the development of foresight capacity in its Member countries. The report's findings draw primarily from analysis contained in five case studies on different types of events: financial crises, cyber risks, pandemics, geomagnetic storms and social unrest – some of which have proven capacity to produce global shocks. All five background papers are available separately on the OECD website: *www.oecd.org/futures*.

Global leaders are acutely aware that another systemic shock could severely challenge economic recovery, social cohesion and even political stability. Visible indicators of vulnerability persist in the forms of economic imbalances, volatile commodity prices and currencies, colossal public debts and severe budget deficits. Less visible than these metrics are the drivers of vulnerability that tightly weave interconnections between commercial supply chains, technological systems and investment vehicles underlying the global economy. Unanticipated events such as natural disasters, failures in key technical systems or malicious attacks could disrupt these complex systems and produce shocks that propagate around the world.

There is a palpable sense of urgency to identify and assess risks arising from vulnerabilities in these crucial systems, and to develop policies that will bolster efforts for prevention, early warning and response to ensure sustained economic prosperity. This urgency explains the demand for OECD to deliver strategic advice on preparing for and responding to potential global shocks mired in uncertainties.

Since the beginning of this project in 2009, the world has witnessed the effects of a global financial meltdown, the first declared pandemic in over 40 years, political upheaval in the MENA region, the BP oil spill, closure of European air space due to a volcanic ash cloud, and most recently the Tohuku earthquakes, tsunami and ensuing nuclear reactor accidents at the Fukushima power plant. Never before have global risks seemed so complex, the stakes so high, and the need for international co-operation to deal with them so apparent.



What are future global shocks?

A global shock is a major rapid-onset event with severely disruptive consequences covering at least two continents. Slow-onset shocks, such as the environmental risks emanating from climate change and risks to public finances due to human longevity do not represent global shocks, since they provide more time for society to adjust, react and mitigate impacts. Likewise, severely disruptive events at national or regional level do not qualify as global shocks either. While the management of such events might require international assistance, they would not meet the threshold test unless they produce highly significant secondary or knock-on effects across other continents.

While a large asteroid collision with the earth could certainly cause a global shock, the public policy options to address this threat are somewhat restricted. The focus of this OECD report is on events – such as pandemics, financial crises, etc. – that begin locally and rapidly spread their impacts through contamination or contagion to societies and economies.

This enables more attention to be paid to identifying propagation pathways, possible tipping points, control points and circuit-breakers, and to strengthening the resilience of complex systems more generally. Not only are these topics poorly mapped and modelled, remedial actions often require a higher level of co-ordinated, international response than national level disasters.

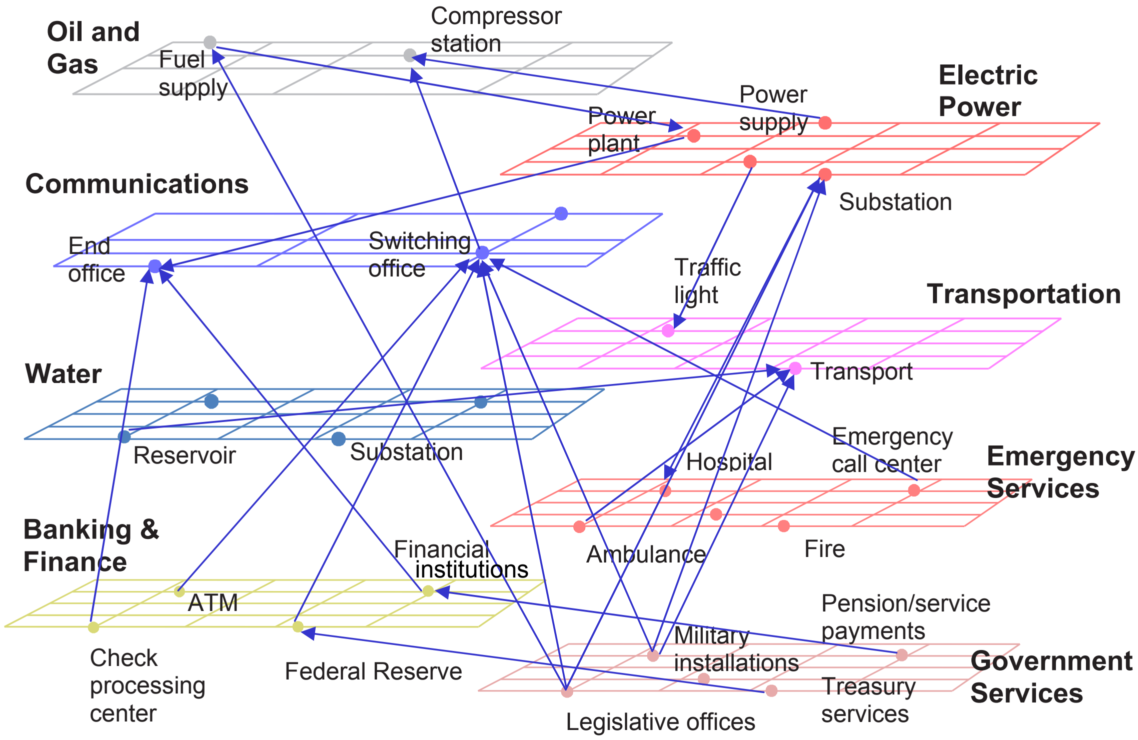
The model for aggregate supply and demand can help visualise rudimentary economic impacts of negative shocks. For example, in July 2010 wildfires in Russia occurred in conjunction with a record drought that had already threatened the country's crop harvests. The fires eventually destroyed a fifth of the country's wheat crops, and these massive losses in domestic production prompted it to place an embargo on wheat exports. Although Russia is the world's third largest grain producer, reserve capacity was initially thought to be sufficient to avoid the volatility that shook commodities markets in 2008. Massive floods in Australia and Canada, however, further reduced global supplies while at the same time significant structural changes to global demand had been underway with booming economic growth in China and India. The unlikely combination of these events and trends resulted in sharp fluctuations in grain prices in agriculture commodities markets.

The temporary influence of the Russian export ban was further exacerbated by hoarding in some countries for fear that another food crisis may be looming. In Tunisia the effects of rapid and multiple price hikes combined with chronic conditions to trigger social unrest, which in turn spurred contagion effects in Egypt, Libya and throughout several countries in the Middle East and North Africa region.

The aggregate supply and demand model is a view through the rear-view mirror that describes, but does not explain, the underlying dynamics driving the sudden and forceful shifts it indicates. Nor does this static model allow policy makers and risk managers to anticipate and prepare for such shocks before they happen.

For this purpose, risk managers need to collect data, develop metrics and fashion tools such as maps that depict functional interconnections (see Figure 1) and models that produce a probability of the transmission of risks through complex and interdependent systems. Such tools are the foundation for early warning systems that could be used to activate policy interventions to contain risks before they spread to different sectors and multiply losses. They also enable policy makers to visualise the relative importance of various vulnerabilities, and plan accordingly the use of limited resources to mitigate them. A caveat here is that there is no valid "one-size-fits-all" approach to modelling, and some models do fail to provide actionable information. Models should be used to complement a policy maker's broader understanding of a situation to help come to a decision.

Figure 1. Critical infrastructure interdependencies



Source: The National Association of Regulatory Utility Commissioners (2005), "Utility and network interdependencies: What state regulators need to know",*Technical Assistance Brief on Critical Infrastructure Protection*.

Complex systems: The vectors of future global shocks

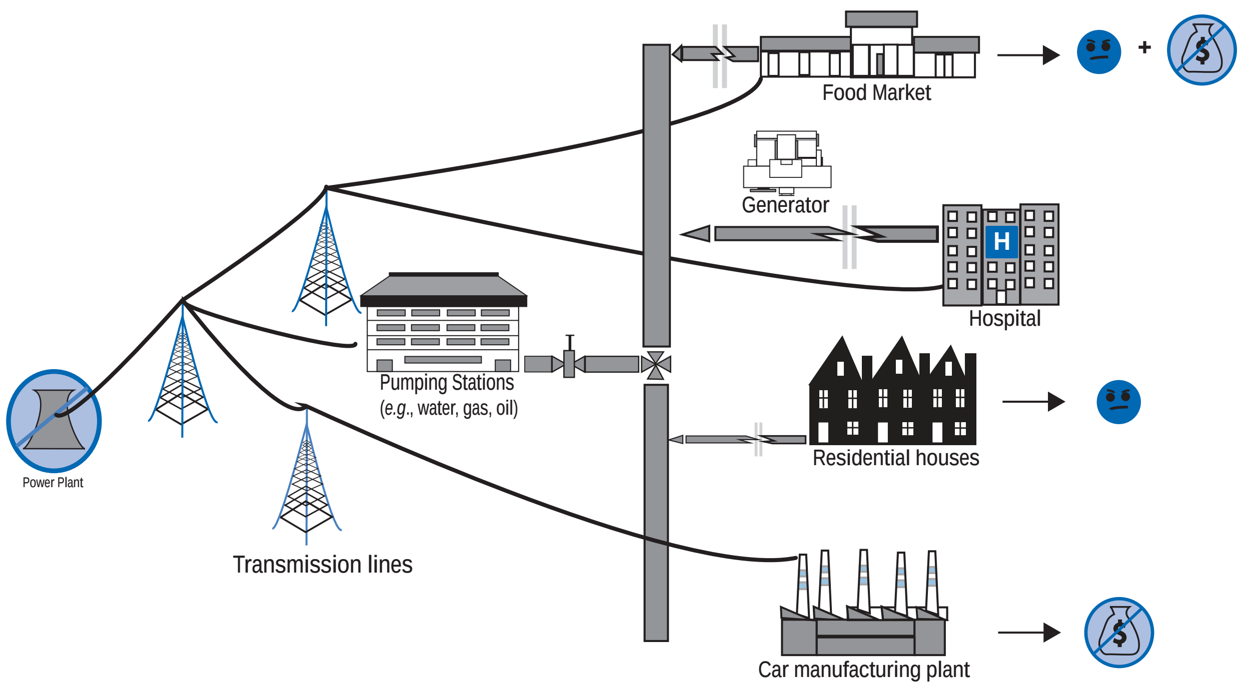
The principle differences between global shocks and local or even national level shocks are the interconnected pathways through which risks can accumulate, propagate and culminate in a much greater scale of effects. These key differences imply the need for risk managers to take a systemic perspective to risk assessment that looks at the causal relations of contagion and the total impacts of direct and indirect costs.

Figure 2 provides a very simplified diagram of an electricity and water distribution system. The power plant at the left of the figure normally provides electricity to a network of transmission lines. The electricity is then distributed to various customers including businesses, residences and public utilities – such as the water-pumping station that then supplies water to the same customers as the power plant. All of these components together make up a system, as they are all linked to each other in some way – spatially or otherwise. The effects of the loss of power propagate through the system with some components being affected while others are not. In many cases the severity of the impact depends on the longevity of the event (the power outage) and the criticality of the specific components adversely affected.

Figure 2 is a relatively simple system – where there are only a few elements and their relationships and interconnections are well understood – it is relatively easy to determine how an event will propagate. This is not the case in complex systems. It can be very difficult to understand propagation in complex systems because they are composed of many parts that interact with and adapt to each other and, in so doing, affect their own individual environments. The combined system-level behaviour arises from the interactions of parts that are, in turn, influenced by the overall state of the system. Global patterns emerge from the autonomous but interdependent mutual adjustments of the components.

Understanding key characteristics of complex systems is important for anticipating events that may require policy interventions and identifying where those interventions should or could occur for maximum efficiency. For example, if the water pipes connecting end-users to the pumping station in Figure 2 are vulnerable to seismic tremors, one policy option would be to reinforce their robustness. Investments in such an undertaking need to be weighed against, or even added to, the costs of maintaining sufficient surplus in reservoirs and diversified means of distribution should water mains break due to an earthquake.

Figure 2. A simplified electricity and water distribution system



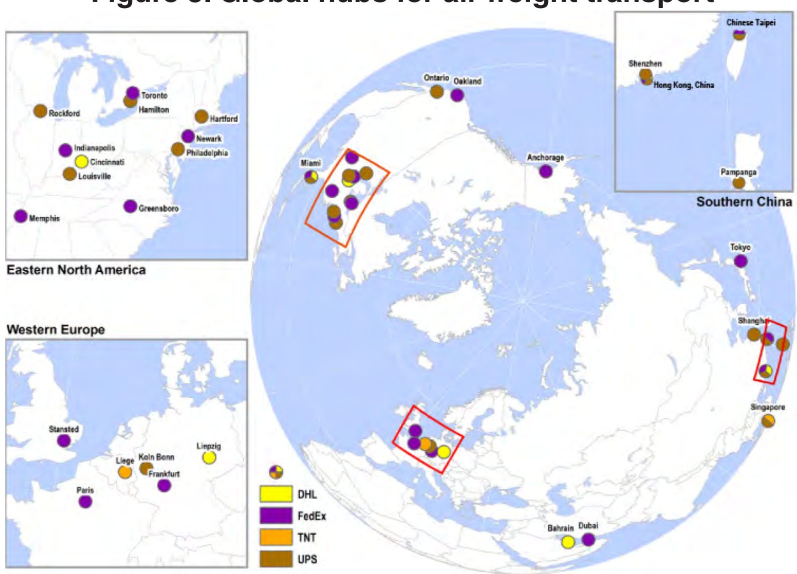
Interconnectedness could make global shocks more likely to happen

Events that qualify as global shocks have been relatively infrequent, since they require an unusual set of circumstances to occur simultaneously. This means that modelling such extreme events to produce a probability of occurrence relies on experimental data. Looking forward, it would seem that the 21st century is likely to experience severe global shocks more often, some familiar, others new. This is due to a number of rapidly changing drivers that may combine to create perfect storm conditions, including: heightened mobility of goods, capital, people and information; growing interdependence of production and delivery systems and their infrastructures; the centralisation and concentration of critical systems; and urbanisation and concentration of economic activity and assets.

Concentration, if not centralisation, has become an important facet of efficiency for transportation hubs and financial payments. As a network structure, a hub allows greater flexibility within the transport system and transaction speed within the financial payment system. If a major hub is disrupted, however, delays may ripple through interconnected supply chains. This not only upsets the functioning of the tightly knit transportation and financial payment sectors, it induces volatility that may lead to losses in productivity, foreign investment and access to exports, whether they be food, water, electricity, productive capital or some other scarce resource. Part of the challenge in preparing for and managing the risk of future global shocks is to diversify these hubs or to build-in greater system robustness and redundancy.

For example, there are four major air freight carriers that account for the bulk of global air cargo (see Figure 3). Each has a hub-and-spoke organisation of their network with hubs clustered around the world's three major zones of economic activity: North America, Europe and Pacific Asia. The choice of the main consolidation hub is based upon an airport that is well located, has good infrastructure, but that does not service a very large local passenger market to ensure it is the airport's main customer and receives privileged access to the runways. There is a high level of concentration of hubs in the Eastern part of the United States, which roughly corresponds to its demographic concentration. Disruptions to this hub result in bottlenecks and delivery delays to the rest of the continent.

Figure 3. Global hubs for air freight transport



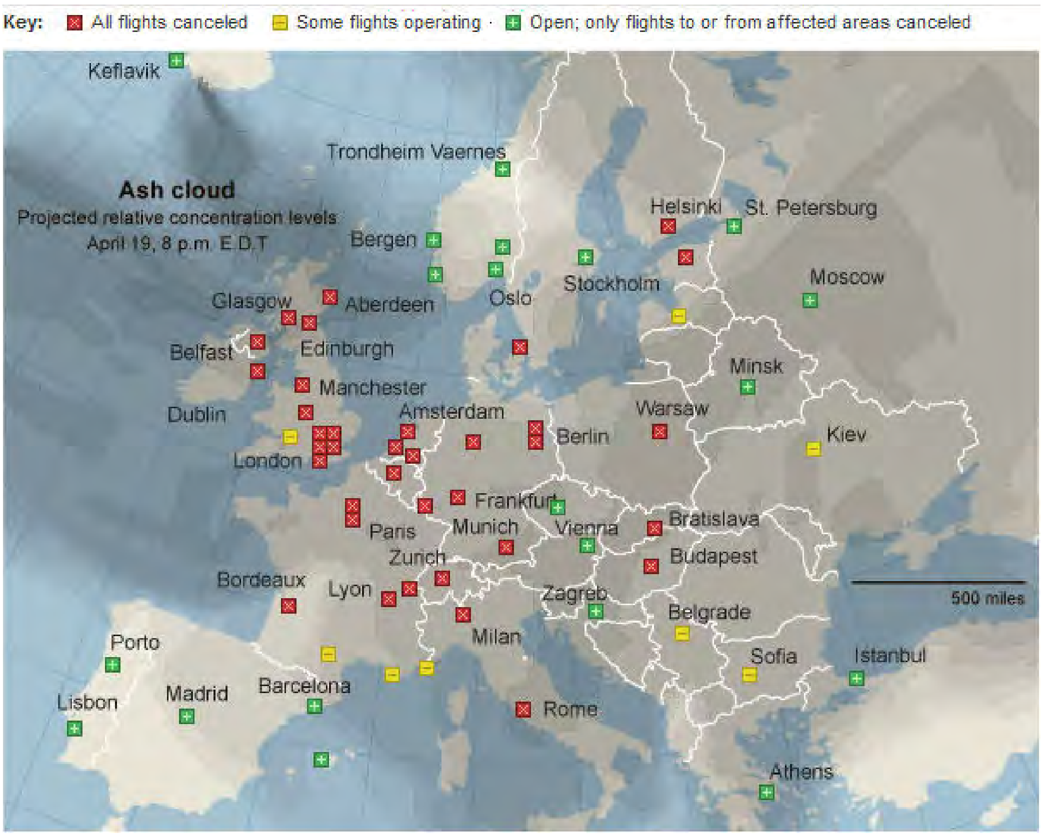
Source: Rodrigue, J-P *et al.* (2009), *The Geography of Transport Systems*, Hofstra University, Department of Global Studies & Geography, *http://people.hofstra.edu/geotrans.*

When a volcanic eruption in Iceland produced an ash cloud over the air space of Europe's major air hubs in 2010, many companies were unable to deliver products or key components to markets and production systems throughout Europe (see Figure 4). The event was an opportunity to consider many questions relevant to policy makers and businesses alike, for example: What level of diversification would be required to maintain current supply capacity if the eruption had continued and air space had been closed for a month, a year or even longer?

What technologies could be implemented to better inform risk analysis, and avoid blanket closures of air space in the future? In the short term, the major effects of closing air space were mostly limited to losses for airlines, stranded passengers, delayed orders for manufacturing and lost orders for sellers trying to export perishable goods to European markets. In a longer lasting scenario, global trade and especially Europe might suffer massive losses.

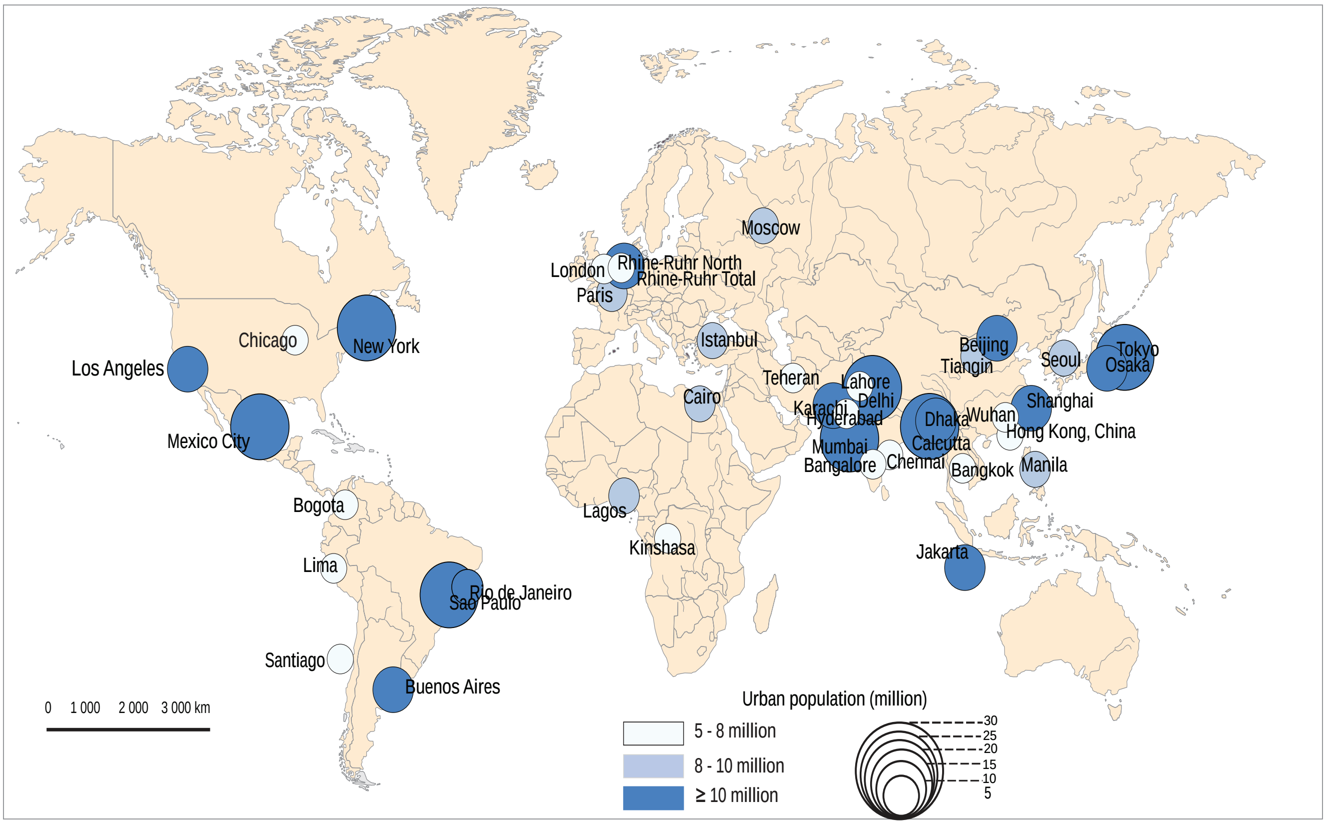
The increasing urbanisation of the world population has resulted in a rising number of megacities with high concentrations both of people and assets in relatively small, compact areas (see Figure 5). With such dense convergence of populations and collective wealth into geographic centres, the risk of a catastrophic event producing irreparable damage and loss is significantly increased. Similar to the logic of the increased interconnectivity of infrastructure, high concentrations of population and resources in urban centres both present potential sites of greater calamity due to natural hazards and attractive targets to nefarious attacks. Although more can be done to increase society's resilience and communicate more effectively with these populations about the risks they face, expected population growth will only exacerbate the trend toward urbanisation in the future.

Figure 4. 2010 European volcanic ash cloud disrupts air travel



Source: Joergen Brandt (2010), *Tracking cancellations from the ash cloud*.

Figure 5. Concentration of populations in megacities



Source: Frauke Krass (2002), *Megacities*. © United Nations, 2002.

Policy options to address growing systems interdependencies, globalisation and concentrations

Recommended steps for risk managers to undertake before any future events actually occur include:

- Building and maintaining restricted access databases and models that identify exposed and vulnerable hubs, which if disrupted could lead to a "Global Shock", as well as amplifiers in the system;

- Assessment of the criticality of systems and conditional likelihood of events that would disrupt the function of hubs; and

- Estimation in monetary terms of the overall, direct and indirect economic consequences of potential shocks. Decision makers also need to take into account how their mitigation and prevention activities might create risks, liabilities or unintended consequences for different parties.

These tasks should be carried out, whenever possible, before weighing options how to prevent and respond to threats, which involves an analysis of costs and benefits in light of an acceptable level of risk.

The particular challenges posed by global shocks

Risk managers confront far more difficulty to prepare for and cope with global shocks than to deal with national large-scale disasters, even where these have an international dimension. The challenges are considerable and are present in all stages of the risk management cycle – risk assessment, prevention, mitigation, emergency response and recovery.

Risk assessment

Gaps in information and data on the nature and scale of hazards, vulnerability and potential for propagation are larger and more serious for global shocks than for national or regional large scale disasters. The quality and reliability of information sources vary considerably among countries across the globe. Gathering information to assess risks is more difficult since the root causes of an event are geographically remote to many concerned parties. This may pose significant linguistic, legal, financial or cultural barriers to the access, comprehension and/or use of information when it has been compiled.

Consequently, assessment of potential global shocks demands a more sophisticated mix of expertise and cooperation than is often currently available. It requires a multidisciplinary approach comprising scientific and technical expertise to navigate the interdependencies of complex systems, but also an understanding of the interconnections between economies, markets, populations groups and cultures. A major challenge in analysing future global shocks is the need to understand not only the way a complex system's various components are interrelated, but also the relative strength of interdependencies (see Table 1).

Table 1. Sample dependency matrix

Sector		Energy and utilities					Services		
Element		Electrical power	Water purification	Sewage treatment	Natural gas	Oil industry	Customs and immigration	Hospitals and health care	Food industry
Energy and Utilities	Electrical power	-	L	N/A	N/A	M	N/A	N/A	N/A
	Water purification	H	-	N/A	N/A	M	N/A	N/A	N/A
	Sewage treatment	L	H	-		H	N/A	N/A	N/A
	Natural gas	M	N/A	N/A	-	L	N/A	N/A	N/A
	Oil industry	H	L	N/A	N/A	-	N/A	N/A	N/A
Oil industry	Customs and immigration	H	L	L	L	L	-	L	N/A
	Hospitals and health care	H	H	L	H	H	M	-	H
	Food industry	H	H	H	L	M	M	L	-

Key: H = High; M = Medium; L = Low.

Source: Pederson *et al.* (2006), *Critical Infrastructure Interdependency modelling: A Survey of U.S. and international research*.

Mapping and modelling future global shocks

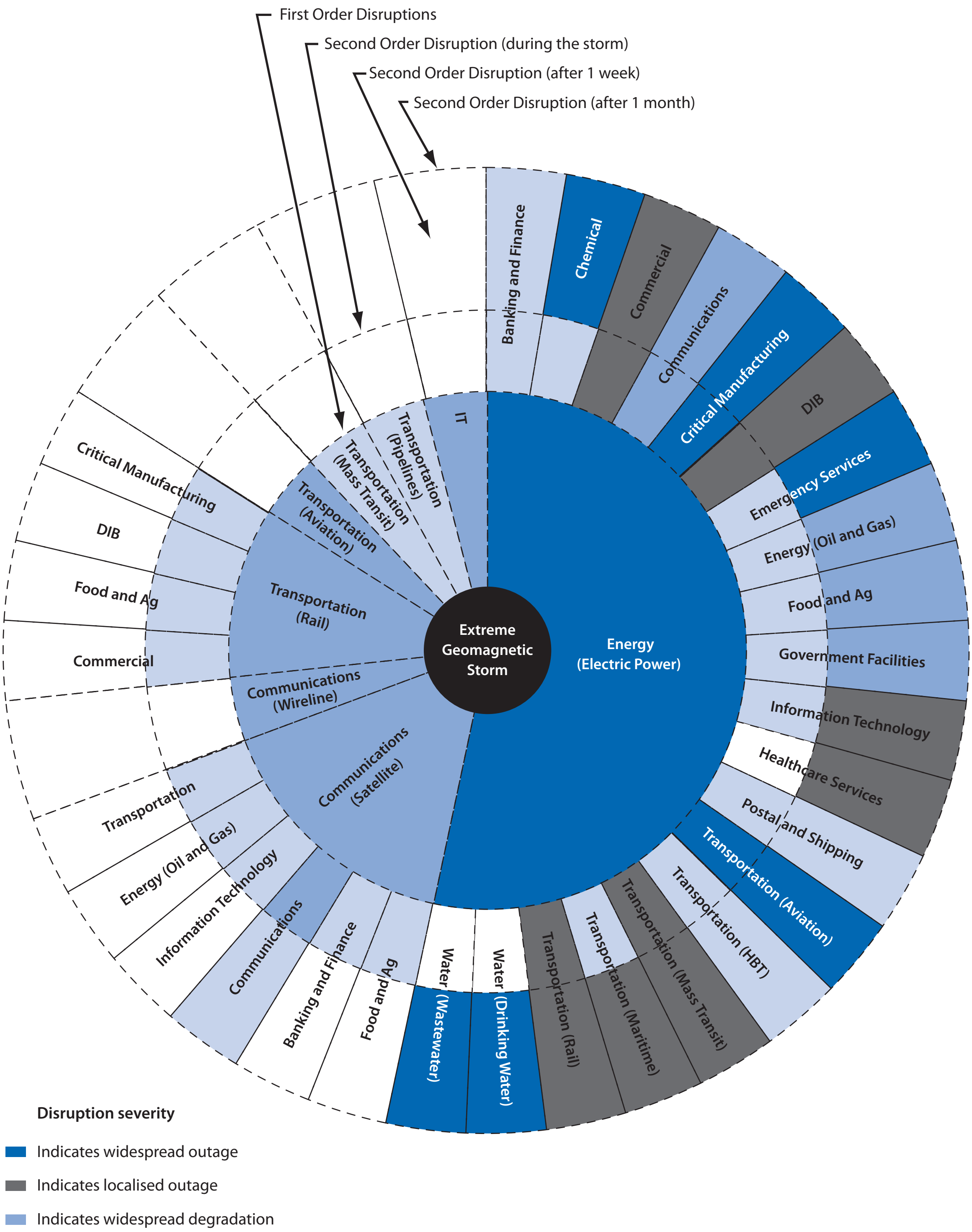
Not all threats lend themselves to such conceptual diagrams as Table 1. Efforts to map and model pandemics, for example, are associated with particularly high uncertainties, and validations have proven to be scarce. In many parts of the world, the infrastructure for real time data gathering and surveillance is weak for certain important hazards, and the sophistication of maps and models has surpassed the limits of willingness to share some types of information. Complex systems also develop over time, through institutional mergers, the acquisition of one time competitors or via joint ventures to capitalize on a new technology. In some cases their vulnerabilities may change over time, which means their capacity to withstand shocks should be re-evaluated periodically with stress tests.

Destructive forces in a primary system often produce disruptive impacts in adjacent or interdependent systems. Managing such secondary effects requires cataloguing all sectors that the primary system supplies as well as assessing the feasibility of mounting resources to combat such a diverse range of impacts. Uncertainties about causal relations pervade such analysis. Collaboration across jurisdictions and between competitors is therefore often necessary to develop strategies to stem or slow the progression of a global shock or limit its damage at the outset. This requires not only a more expansive mapping approach to fully understand the points of intersection between different sectors of a system, but also greater collaboration to anticipate spillover effects and to co-ordinate a response that maximises available resources.

Not only might the magnitude of secondary impacts be potentially greater than the initial event, they can be extremely wide-ranging if a highly connected hub within a complex system is disrupted. As described above, electricity production and distribution is one such hub in critical infrastructure networks. If this capacity is taken offline, it will have wide-ranging impacts. Figure 6 displays the direct and secondary critical infrastructure disruptions, as well as their severity, resulting from an extreme geomagnetic storm. The impacts range in severity from localised degradation (*i.e*. services are available but of reduced quality) to widespread outage (*i.e.* services unavailable), and could affect a diverse range of sectors.

Figure 6 also distinguishes impacts to different economic sectors according to the duration of disruption. While some secondary effects occur very quickly and remain stable over time, such as the disruption of telecommunications, others develop slowly and increase over time. The power outage depicted would hold broad consequences for the distribution and provision of drinking water, which requires energy for supply, purification, distribution and treatment both of water and waste water. The severity of disruptions resulting from secondary impacts is seen to increase in intensity as the longevity of the original event increases, which underlines the importance of developing rapid recovery capacity.

Figure 6. Direct and secondary critical infrastructure disruptions



Policy options to address complexity of risk and impact

- As a measure of redundancy, a variety of modelling approaches should be pursued to help inform risk management policy decisions.
- Mapping and modelling of future global shocks needs proper government support to ensure continuity, validation and refinement over time. In particular, models for extreme events that use experimental data in particular need to be revised as data becomes available. Information systems should be established to regularly update map dynamics and model variables. The basic assumptions in models should undergo periodic "wild-card" stress tests.
- Due to the high number of complex systems from which future global shocks could arise, there is a need to develop diverse modelling capabilities with global coverage that make use of variables derived from various disciplines, including the social sciences.

Emergency preparedness and management

Effective emergency management of global shocks requires the mobilisation of significant reserves and surge capacity (*e.g.* energy, food, water and first responders). For maximum effect, countermeasures and strategic reserves must be rapidly delivered and broadly deployed across multiple jurisdictions. Currently, such capabilities face significant risk governance deficiencies – stockpiles, reserve capacity and other back-up solutions are generally costly to maintain, and there is clearly a lack of incentive or competitive pressure behind the chronic lack of investment in them.

Timely delivery of response measures is sometimes beyond the ability of current science and technology, or beyond the current capacities of human resources, production and sourcing of goods. International co-operation becomes much more multi-layered with the participation of international organisations, intergovernmental agencies, multiple globally active NGOs and corporations. Since a global shock by definition impacts many countries more or less simultaneously, access to resources (*e.g.* vaccines, spare parts, transformers, food, specialised first responders, etc.) from other affected countries may not be easily forthcoming.

Communications management becomes especially complex as governments may tailor their messages to national audiences without considering how foreign sources might provide divergent messages and contradictory signals. Hastily issued or uncoordinated messages might have knock-on effects in foreign populations and markets.

In the recovery and post crisis management phases of risk management, countries will be preoccupied with their own crisis management and may be less able or willing to provide assistance to neighbours in need. Claims resulting from a global-scale disaster may stretch the insurance and reinsurance community's funds to the limit, possibly triggering payout defaults and bankruptcies.

Economic recovery from a major global shock may take longer to materialise than is the case for national level disasters. Many countries may find themselves hampered by a weak economic situation that does not allow their markets to provide either the consumers or the capital to re-ignite growth.

Table 2. Comparative characteristics of routine emergencies/ disasters/ global shocks

Routine emergencies	Disasters	Global Shocks
Scale is modest and well-defined in space and time	Scale may be large, but defined	Scale is large and perhaps ill-defined in space and time. High impact possibly irreversible
Event recognised, but low visibility	High visibility	Very high profile, intense and long-lasting political and media interest
Interaction with familiar faces	Interaction with unfamiliar faces	Counterparts unknown
Familiar tasks and procedures	Tasks and procedures sometimes unfamiliar	Tasks and procedures outside previous experience
Intra-organisational co-ordination needed	Intra- and inter-organisational co-ordination needed	Multi-layered international co-ordination needed
Roads, telephones and facilities intact	Roads may be blocked or jammed telephones jammed or non-functional, facilities may be damaged	Transport and communication hubs blocked , ports may be damaged (airports, Internet ports, maritime ports), disrupting global supply chains
Communications frequencies adequate for radio traffic	Radio frequencies and mobile services often overloaded	International telecommunications overloaded or disrupted
Communications primarily intra-organisational	Need for inter-organisational information-sharing	Need for international information-sharing
Use of familiar terminology in communicating	Communication with persons who use different terminology	Communication between persons with different language, culture, norms and geo-political perspective
Need to deal mainly with local press	Hordes of national and international reporters	Media sources incapacitated, social media unmanageable
Management structure adequate to co-ordinate the number of resources involved	Resources often exceed management capacity	Resources sometimes cannot be accessed for long periods

Source: Left and centre columns are adapted from Auf Der Heide (2000), *Disaster response: Principals of preparation and coordination*; top 2 rows are adapted from Handmer and Dower (2007), *Handbook of disaster and emergency policies and institutions*.

Policy options to address heightened need for preparedness

1. Surveillance and early warning should be emphasised as a cost-effective measure of damage reduction and enabler of containment activities.

2. A holistic review of prevailing incentive structures is needed to identify where and how production of protective countermeasures to systemic threats has been undermined, and policy makers should consider what fiscal and regulatory options are available to address such market failures.

3. An inventory of strategic reserves and stockpiles of critical resources should be conducted as part of an assessment of resilience to global shocks.

4. The design and implementation of complex systems should provide for early monitoring of future developments that could pose potential risks, and forward assessment for loss of control points on an ongoing basis.

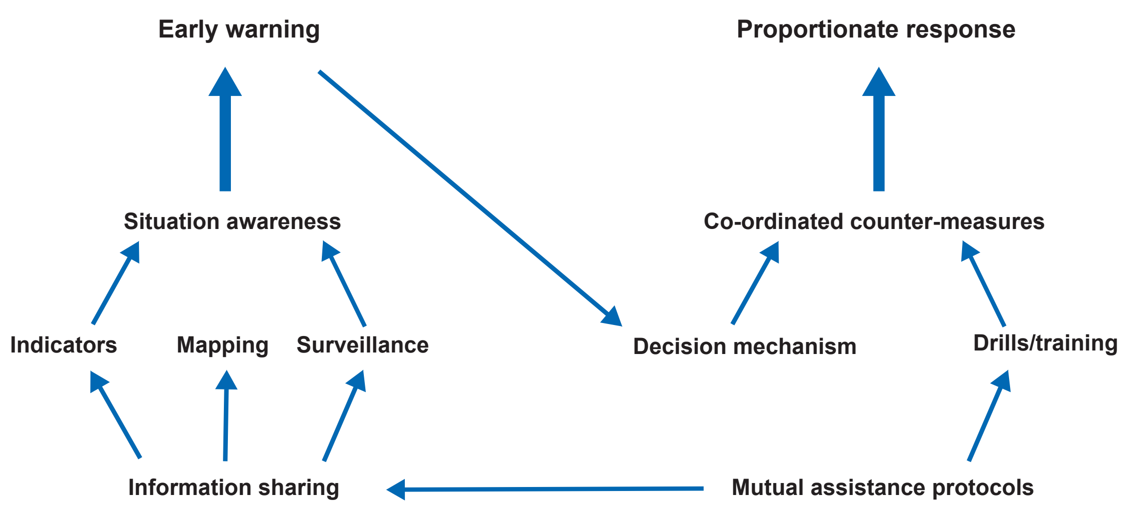
Building resilience for future global shocks

Future global shocks are pervaded by uncertainties about their frequency and severity, which may tempt some policy makers to ignore them as too complex to deal with. Uncertainty does not have to lead to inaction. It can be qualified, evaluated in light of similar past experiences, and measured against the costs of doing nothing. Strategies to identify and deal with uncertain extreme events begin with an elaboration of a reasonable worst case scenario. Governments must be prepared to accept some level of risk and prepare for the undesirable eventuality that they may occur.

In such cases, strategic planning calls for building resilience to ensure critical systems are robust, diversified and/or they possess adequate reserve capacity at reasonable cost. Such measures will dilute adverse impacts of unknown risks and by the same token, strengthen reactive capacities and resilience. Public policies in support of such measures will therefore play a central role in the management of global shocks. Due to the remote source of many risks, however, prevention or regulation cannot be ensured. Hence, states will need to act at national, regional and global level in partnership with other actors, such as the corporate sector, NGOs, the scientific community and ordinary citizens. Such a multifaceted, multilayered approach to stakeholder involvement, if not adequately structured and managed, is unlikely to yield effective outcomes.

Figure 7 sketches the relationship between an internationally integrated mechanism for early warning and rapid response. Building cross-border capacity for early warning entails the expansion of national situation awareness to include risks that emerge abroad, and that hold potential to rapidly propagate across borders to impact upon national interests. It also requires the abilities to share, receive and integrate sources of information from partners abroad into risk assessments. The capacity for early warning should feed into the process of mounting a proportionate response via a co-ordinated decision-making process, which is also built on the ability to rapidly integrate services and equipment from foreign sources into the apparatus of countermeasures. This cannot realistically be achieved without protocols for mutual assistance and training drills.

Figure 7. Key capacities for governance of future global shocks

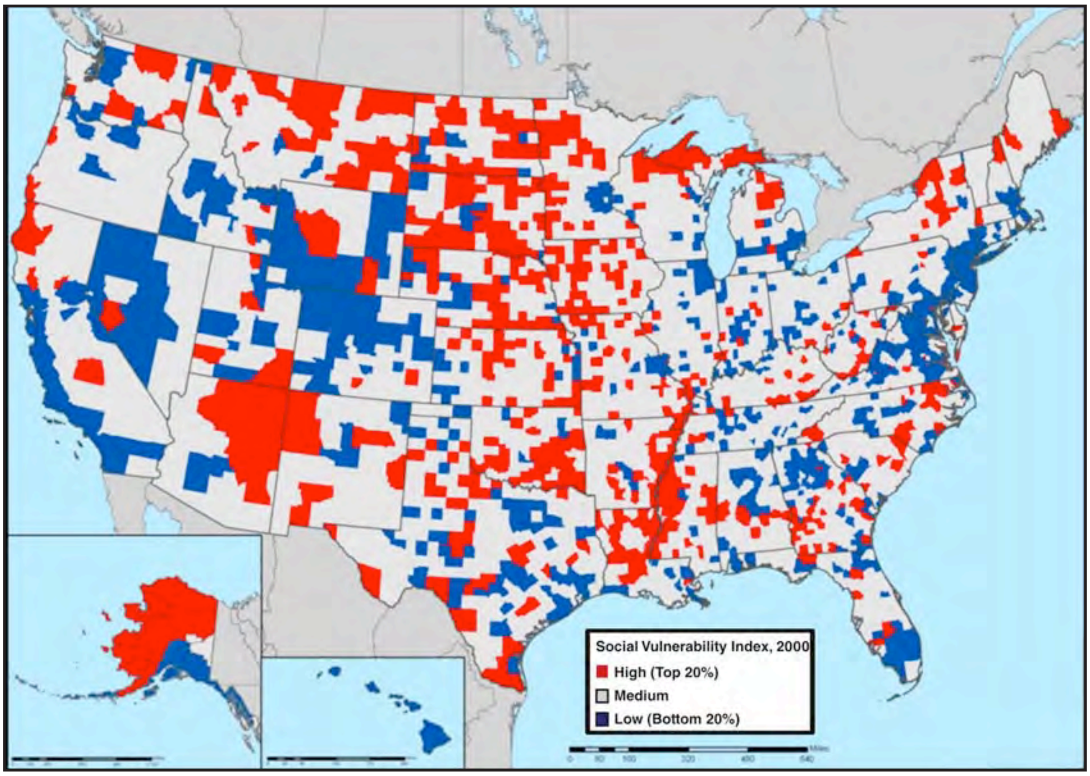


Social resilience refers to the capacity of a community (or organisation) to adapt under adverse conditions and restore a sense of normalcy from an external shock. The longer this takes, the more unlikely the community will ever fully recover its economic vitality and the greater the risk of damage to the social fabric that holds it together. Efforts to foster resilience need to prioritise vulnerable populations (*e.g.* elderly, socio-economically disadvantaged, physically impaired people, people living in highly exposed housing). If a sufficient percentage of the vulnerable population is unable to cope with the effects of a shock event, the stress on social stability can reach a tipping point and lead to social unrest. It is important to identify socially vulnerable populations in advance (see Figure 8), and provide for capabilities that reduce their vulnerability or bring them the aid they need when they need it. Although the focus here has been on people, similar reasoning supports the need to reinforce the weak links in critical systems.

Policy options to address the need for improved resilience

- International co-ordination to address global shocks should be strengthened at all phases of the risk management cycle and in particular through the use of partnerships between public and private actors.
- Self-organisation needs to be promoted across society as a cornerstone of building resilience.
- Efforts to improve resilience should focus on routine processes, *e.g*. information-sharing, broad consultation and participation, training exercises and simulations, citizen level resilience.
- Internationally agreed information procedures could be expanded to co-ordinate announcements of global shocks, without prejudice for each country to convey an appropriate message to its populace.

Figure 8. Social vulnerability to environmental hazards



Source: Susan Cutter (2001), *Social vulnerability index.*

Oliver Wyman is an international management consulting f rm that combines deep industry knowledge with specialized expertise in strategy, operations, risk management, organizational transformation, and leadership development. The **Global Risk Center** is Oliver Wyman's research institute dedicated to analyzing increasingly complex risks that are reshaping industries, governments, and societies. Its mission is to assist decision makers in addressing these risks by developing research that combines Oliver Wyman's rigorous analytical approach to risk management with leading thinking from research organizations.

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The OECD International Futures Programme provides early warnings of emerging issues, pinpoints major developments, and analyses key long-term concerns to help governments map strategy. The Programme uses a variety of tools including multiyear projects, high-level conferences, expert workshops, and consultations; a futures-oriented online information system, and a network of contacts from government, industry, academia and civil society. For more information on the Programme and background papers on the case studies examined in the *Future Global Shocks* report, please visit the OECD website: www.oecd.org/futures.

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