GENEVA SCIENCE-POLICY INTERFACE

Governance in the age of complexity: building resilience to **COVID-19** and future pandemics

Policy Brief – March 2021

This policy brief aims to promote a holistic mindset about the COVID-19 pandemic by 1) applying a complexity lens to understand its drivers, nature, and impact, 2) proposing actions to build resilient societies to pandemics, and 3) deriving principles to govern complex systemic crises. Building resilience to prevent, react to, and recover from systemic shocks need to become a core element of how societies are governed. This requires an integrated approach between health, social, economic, environmental, and institutional systems. The brief has been developed by a team of researchers coming from both the natural and social sciences.[1] Reviewed by a group of policy actors,[2] the brief aims to foster a dialogue between academic institutions and policymakers.

For further information about resilience in decision-making, you can contact the Geneva Science-Policy Interface at contact@gspi.ch. You can contact the lead author of the brief at didier.wernli@unige.ch

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1 The **COVID-19** pandemic: a global systemic crisis

As of mid-March 2021, the COVID-19 pandemic has caused more than 2.6 million deaths worldwide. Beyond the dramatic loss of human life, the pandemic has triggered widespread disturbances in health, social, economic, environmental and institutional systems. Ultimately, the pandemic reveals how deeply interconnected societies are unprepared to face a global systemic crisis.

This policy brief aims to address how societies can prevent, react to, and recover from a global health crisis that has wide ranging systemic effects. The core message is that leaders and policy-shapers who take a whole-of-society approach to navigate the complexity of this systemic crisis will be better placed to build resilient societies.

The policy brief derives from an extensive synthesis of the literature and knowledge exchanges,[3] and aims to develop a new mindset about the governance of the COVID-19 pandemic. It defines societal resilience to the pandemic as the capacity to reduce the spread and impact of the disease while mitigating other undesirable societal effects. In this vein, this policy brief:

1. Applies a complexity lens to understand the COVID-19 pandemic,
2. Proposes actions to build societies that are resilient to pandemics,
3. Derives principles to govern systemic crises.

Fundamentally, building resilience to prevent, react to, and recover from systemic crises will need to become a core element of how societies are governed. This should be based on an integrated approach between health, social, economic, environmental, and institutional systems. Governing for resilience is fraught with many obstacles, but failure to do so may trigger a destabilising cascade of events with far more destructive power than the impact of the pandemic on population health.

[3] A preprint version of the academic report is available here: https://www.researchgate.net/publication/348333495_Building_societal_resilience_to_COVID-19_and_future_pandemics_a_synthesis_of_the_literature_and_a_governance_framework_for_action

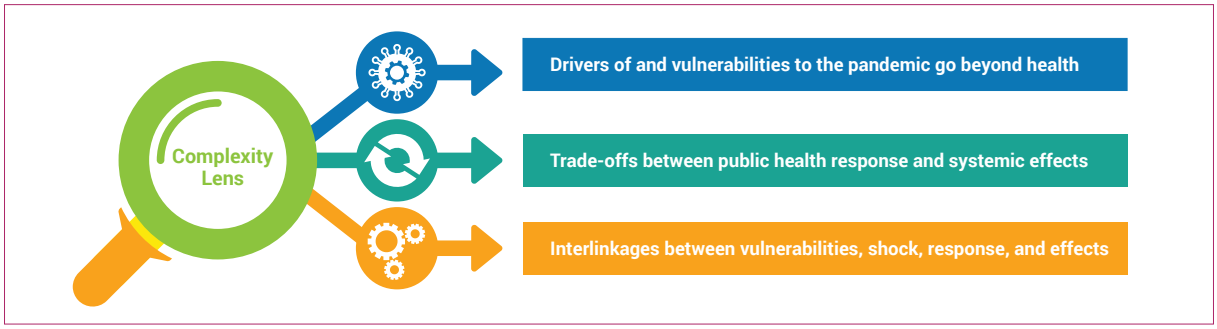
2 Complexity characterises the **COVID-19** pandemic

The linchpin of the COVID-19 pandemic is the social and ecological complexity that has come to define the early 21st century. Complex systems, which encompass individuals, organisations, and societies, consist of a large number of parts whose many interactions result in a collective behaviour that is more than the sum of those parts.[4] Complex systems exhibit several features such as high level of connectivity and abrupt change, that make them hard to understand let alone to govern. The dominant model of policymaking which reduces complex challenges into separate and ever smaller problems is ill-equipped to address systemic disruptions.

Actions taken by governments in many countries have flattened the curve of infections and limited the impact of the crisis on health systems. The growing evidence on the effectiveness of public health and social measures have led to the adoption of multipronged strategies. Yet, the scientific response to the COVID-19 pandemic has been mainly guided by disciplinary-based approaches with a limited range of experts. This falls short of the need for the integration of perspectives, experiences, and knowledge from different fields. Monosectoral policy approaches have both overestimated the levels of control and prediction that can be achieved and underestimated unintended consequences of public health and social measures on other sectors.

The COVID-19 pandemic exhibits several characteristics of a complex problem (Figure 1). Systems thinking and complexity science provide a powerful approach to bridge disciplinary and sectoral perspectives. Applying a complexity lens, which views the crisis as the disruption of an interconnected whole, is vital to understand the bigger picture of the COVID-19 pandemic and examine the resilience of societies, to cope, adapt, and transform in the face of systemic crises.[5]

Figure 1. *Applying a complexity lens to understand the COVID-19 pandemic.*



[4] Mitchell, 2009.
[5] Wernli et al., Under review.

2 Complexity characterises the COVID-19 pandemic

2.1 Drivers of and vulnerabilities to the pandemic go beyond health

Preventing, reacting to, and recovering from systemic crises require an understanding of complex causality. The COVID-19 pandemic is in fact a 'syndemic', where the virus interacts with pre-existing vulnerabilities that are ultimately driven by larger political, economic, social, and environmental processes, many of which transcend sectoral and national boundaries (Figure 2).[6]

The precise animal origin of the SARS-CoV-2 pathogen remains so far unknown. Relevant drivers known to facilitate the transmission of pathogens from animals (especially wild animals) to humans include agricultural disruption of animal habitats, widespread environmental degradation, and trade in wildlife.[7] From a planetary health perspective, emerging and re-emerging infectious diseases are one manifestation of the degradation of the biosphere.[8]

Vulnerabilities include factors that facilitate the transmission of COVID-19 within and between populations. Obvious factors are globalisation and the intrinsic social nature of human behaviour. However, the degree to which people are affected differ. Populations unable to adapt their behaviours have been especially vulnerable. Particularly salient are socio-economic inequalities, such as the lack of a safety net or insurance, that make people more likely to go to work while sick. Transmission is also amplified by mis/disinformation and a low trust in government.

Other vulnerabilities encompass factors that increase the mortality of COVID-19 within and across populations. These factors primarily concern population health and the capacity of health systems. Ageing of populations and the high prevalence of chronic conditions including asthma, obesity, diabetes, and hypertension have increased the risk of developing severe disease or dying from COVID-19. Health systems vulnerabilities include the lack of a trained workforce, limited resources or access to technologies, and a lack of reserve capacity.[9] The austerity policies that followed the financial crisis of 2008 have also led to the under-investment in health systems.[10] Inequalities both within and among countries are exacerbating the impact on the population.[11]

Finally, vulnerabilities are related to governance systems. Political systems that favour mutual gain can promote self-organisation, innovation, and creativity.[12] Over the long term, these qualities are essential for the adaptation of diverse societal agents in a dynamic environment.Over the short term, however, governance systems such as liberal democracies may be disadvantaged in addressing issues that require quick actions and high levels of public adherence to them.[13]

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[6] Singer, Bulled, Ostrach, & Mendenhall, 2017.
[7] Dobson et al., 2020.
[8] Watts et al., 2017; Whitmee et al., 2015.
[9] Blumenthal, Fowler, Abrams, & Collins, 2020.
[10] McKee & Stuckler, 2020; Stuckler, Reeves, Loopstra, Karanikolos, & McKee, 2017.
[11] Bambra, Riordan, Ford, & Matthews, 2020; Perry, Aronson, & Pescosolido, 2021.
[12] Acemoglu & Robinson, 2012.
[13] Gelfand et al., 2021.

2 Complexity characterises the COVID-19 pandemic

Figure 2. The complex syndemic of COVID-19: from individual drivers to broader societal processes.[14]

2.2 Trade-offs between public health response and systemic effects

For disruptions that have a high potential of propagation, the initial failure to contain the event at its onset suffices to trigger a massive disruption of interconnected systems.[15] High levels of connectivity across systems create pathways for the initial manifestations of the crisis to propagate and amplify. The COVID-19 pandemic has accordingly generated wide-ranging effects across health, social, economic, environmental, and institutional systems (Table 1). Both the course of the pandemic, and the responses to it, have had effects that are often surprising, non-linear, and difficult to predict.

A striking challenge of the COVID-19 pandemic is managing trade-offs between health, social, economic, environmental and institutional systems that have different objectives (Figure 3). The pandemic is essentially a multi-objective problem under deep uncertainty that requires careful and critical reflection. It remains to be established over the long term which trade-offs are the most pervasive or under which conditions positive spillovers exist between systems. In most countries, trade-offs and their underlying values have neither been debated nor addressed transparently.

[14] This figure is adapted from Bambra et al., 2020; Dahlgren & Whitehead, 1991; Merrill Singer, 2009.
[15] Helbing, 2013.

2 Complexity characterises the COVID-19 pandemic

Table 1. Examples of COVID-19 generated systemic effects in different systems.

Societal system	COVID-19 shock or response	Short-term systemic effects	Potential long-term systemic effects
		GOVERNANCE SYSTEM	
INSTITUTIONAL	Adoption of a state of exception/ emergency at the national level.	• New balance of power in favour of the executive. • Acceleration of decision-making process. • Restrictions of fundamental rights such as the freedom of movement, the right to demonstrate, the right to assembly, and the right to privacy. • Difficulties with electoral processes such as postponing elections and low voter turnout due to restrictions on movement.	• Durable loss of trust in institutions due to civil rights infringements and reduced civic space. • 'Normalisation' of emergency measures through legislative process. • Wielding executive power outside of democratic (Parliament) or judicial (Courts) control. • Institutionalisation of emergency institutions to the detriment of constitutionally based institutions.
		SECTORAL SYSTEMS	
HEALTH	Unprepared health systems including a lack of infrastructure and personal protective equipment, workforce shortages, and weak service delivery.	• Cascading effect of infections from patients to healthcare workers. • Reduced surge capacity to absorb the increased number of patients requiring intensive care. • Overloaded health systems leading to triage in terms of who is admitted to intensive care or not, resulting in problematic life-death decisions. • Prioritisation of COVID-19 over other health issues, reducing treatment and health-seeking behaviours for other diseases. • Exposure of healthcare professionals to high levels of psychological distress and physical exhaustion, hindering quality of care.	• Increased focus on infectious diseases to the expense of non-communicable and chronic diseases. • Worn out hospital infrastructure. • 'Backlog' of healthcare procedures due to disruptions in essential health services during the acute phase of the pandemic. • Increased health system pressure with health conditions associated with containment measures and the economic recession which include mental disorders (anxiety, depression) and physical ailments (weight gain, unbalanced nutrition). • Increased morbidity and mortality due to delayed preventive care and chronic disease monitoring and management.

2 Complexity characterises the COVID-19 pandemic

Table 1. continued

Societal system	COVID-19 shock or response	Short-term systemic effects	Potential long-term systemic effects
		SECTORAL SYSTEMS	
SOCIAL	Prolonged quarantines, blanket lock-downs, school closures.	• Increased mental ailments, thereby increasing substance abuse, domestic violence, child abuse and neglect, and suicide. • Exacerbation of gender inequalities with women bearing the brunt of the work related to children being out of school. • Jeopardization of education and its social by-products (free school meals, peer socialisation, right to play).	• Hampered efforts to alleviate poverty and foster human development. • Educational crisis resulting in a waste of human capital and a global generational catastrophe. • Increase in inequalities both within and among countries. • Abuses and long-term regression of human rights. • Risk of developing authoritarian societies based on the widespread surveillance of citizens.
ECONOMIC 	Disruptions in supply and demand in an inter-connected economy.	• Increased financial hardship and debt, particularly for vulnerable households. • Unequal industry impacts with the tertiary sector more vulnerable to lockdown associated disruptions than primary and secondary sectors. • Disrupting the informal economy, which represents the bulk of employment in low- and middle-income countries. • Small and medium-sized firms hit harder than globally connected firms with the most market power.	• Long-run global recession concerns following increased fiscal and monetary support. • Long-term unemployment which leads to a reduction in productivity and quality of life. • Deepening income and wealth inequalities within and between countries. • Shift to online working with increased worker flexibility but a blurring of the distinction between working and personal life.
ENVIRONMENTAL 	Disruption in food production/ consumption and economic production systems.	• Increase in certain waste-related emissions, for example those associated with the production and disposal of personal protective equipment. • Disruptions in food production and supply chains, increasing food-waste and food insecurity. • Temporary improvements in air quality, lower greenhouse gas emissions and lower levels of noise pollution.	• Uncertain long-run environmental effects which depend on how our unsustainable consumption and production systems are reshaped. • Increase in global hunger resulting from the combined effects of the disruption of food production and economic crisis.

2 Complexity characterises the COVID-19 pandemic

Figure 3. Systems and their goals relevant to assess trade-offs before, during, and after the pandemic.

2.3 Interlinkages between vulnerabilities, shock, response, and effects

Navigating the complexity of the COVID-19 pandemic requires an understanding of the relationship between ❶ pre-existing *vulnerabilities*, ❷ the nature of the *shock*, ❸ the cascading *effects* in interconnected networks, and ❹ the *response* to the shock. The response aims not only to address the issue responsible for the shock but also to preserve the integrity and functions of the governance system. Given the variations in vulnerabilities, shock, and effects across and within countries, there is no 'one size fits all' response.

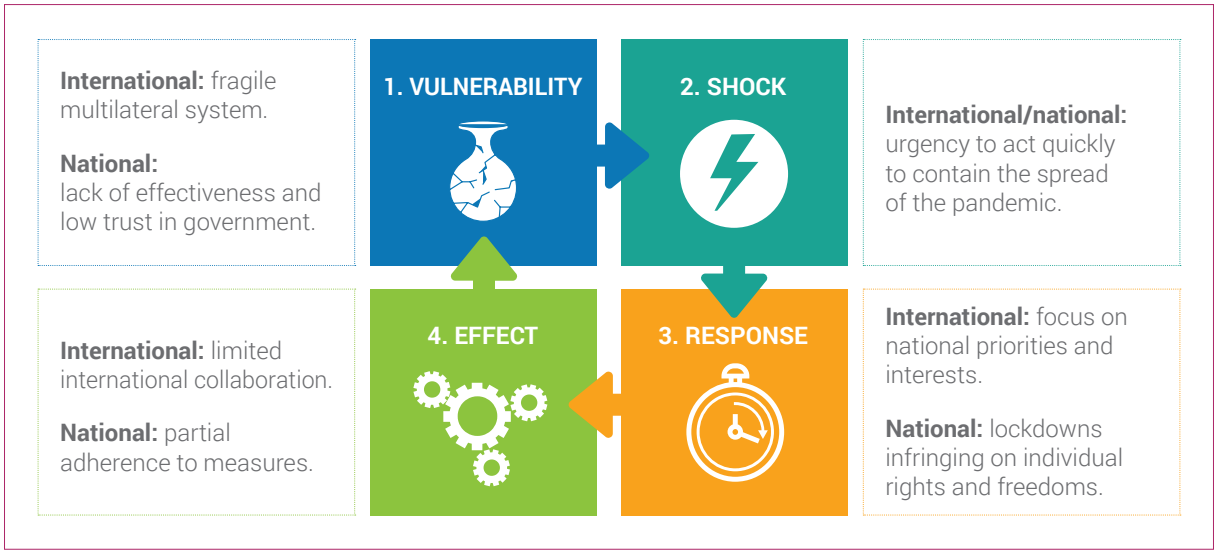
2 Complexity characterises the COVID-19 pandemic

Differences in the stringency and timing of the responses across countries have not only reflected different epidemiological, demographic, and geographical contexts, but also political regimes and levels of socio-economic development. This is also testament to the variety of cultural values, ethical and legal norms, and political priorities.

During the first wave of the pandemic in the first half of 2020, some national governments (e.g., United States, Sweden) chose not to shut down their economies entirely. Other governments (e.g., United Kingdom) went into lockdown but only after delaying their response. In contrast, the governments of Taiwan or New Zealand took decisive actions early on (e.g., strict travel and screening measures and effective contact tracing), avoiding or reducing the length of lockdown. While the 'go early-go hard' has worked best in some contexts (especially islands), the flow of people across nations can undermine the effectiveness of these strategies in other contexts, notably with limited international collaboration.

The success or failure of the emergency response during the initial shock can also generate feedback loops and create a path-dependent response (Figure 4). For example, some traditionally liberal countries that adopted stringent but late policies experienced a vicious circle between command-and-control approaches and responses to contain the spread of the virus that were partly successful. Mediated by a low adherence to public health measures and a low trust in government, this vicious circle led to the amplification of command-and-control measures such as the adoption of curfews in several countries. Another vicious circle took place at the international level where the prioritisation of national interests limited international coordination and further weakened an already fragile multilateral system.

Figure 4. *Examples of a feedback loop ('vicious circle') between vulnerability, shock, response, and effect, amplified by a command-and-control approach.*



3 Governing complexity to build resilience to systemic crises

The COVID-19 pandemic and its wide-ranging societal impacts serve as a clarion call for a deeper understanding on how to govern systemic crises. Resilience thinking, which has been developed in several areas of science and policy,[16] encompasses the capacities of societies to ❶ prepare, prevent, and protect before disruption, ❷ absorb, mitigate, and adapt during disruptions, and ❸ restore, recover, and transform after disruption.[17]

Fostering resilience to pandemics requires actions before, during, and after the crisis (Figure 5). Preventive resilience refers to actions to prevent a shock from occurring by addressing its drivers and vulnerabilities. It also stresses the need for an adequate governance system to quickly detect and alert of a localised problem, so that immediate multisectoral actions can be implemented before becoming a full-blown crisis. Reactive resilience corresponds to actions that can be used to mitigate the impact of a shock. Finally, recovery resilience includes actions that allow a system to recover from a shock. Reactive or recovery actions can be taken before a potential shock by increasing response capacities.

3.1 Recommended actions to build resilience across systems

Resilience thinking provides a holistic framework to ❶ identify critical dependencies that may lead to vulnerabilities, ❷ reduce vulnerabilities that increase transmission and impact of a shock, ❸ increase key system capacities to prepare for shocks and ❹ take decisive action when necessary to reduce shock diffusion and strengthen shock absorption.[18] To foster the capacity for preventive, reactive, and recovery resilience, several actions should be taken in sectoral systems and the governance system (Table 2). The latter covers both formal and informal institutions. In addition to formal governmental action, informal social norms can either support or undermine the adoption of public health measures such as physical distancing.

[16] Quinlan, Berbés-Blázquez, Haider, & Peterson, 2015.
[17] Linkov and Trump 2019.
[18] Guillén 2015.

3 Governing complexity to build resilience to systemic crises

Beyond individual actions, it is vital to recognise the interconnectedness of health, social, economic, environmental, and institutional systems. For example, actions that foster social resilience such as providing a safety net can also support an effective public health response (reactive health resilience). Moreover, resilience is a co-production process. This means that actions to build resilience to pandemics rest upon the engagement of a large range of agents including individuals, families, communities, organisations, businesses, and governments.

Figure 5. *Three different types of resilience are needed before, during, and after the pandemic at the health, social, economic, environmental, and institutional interface.*

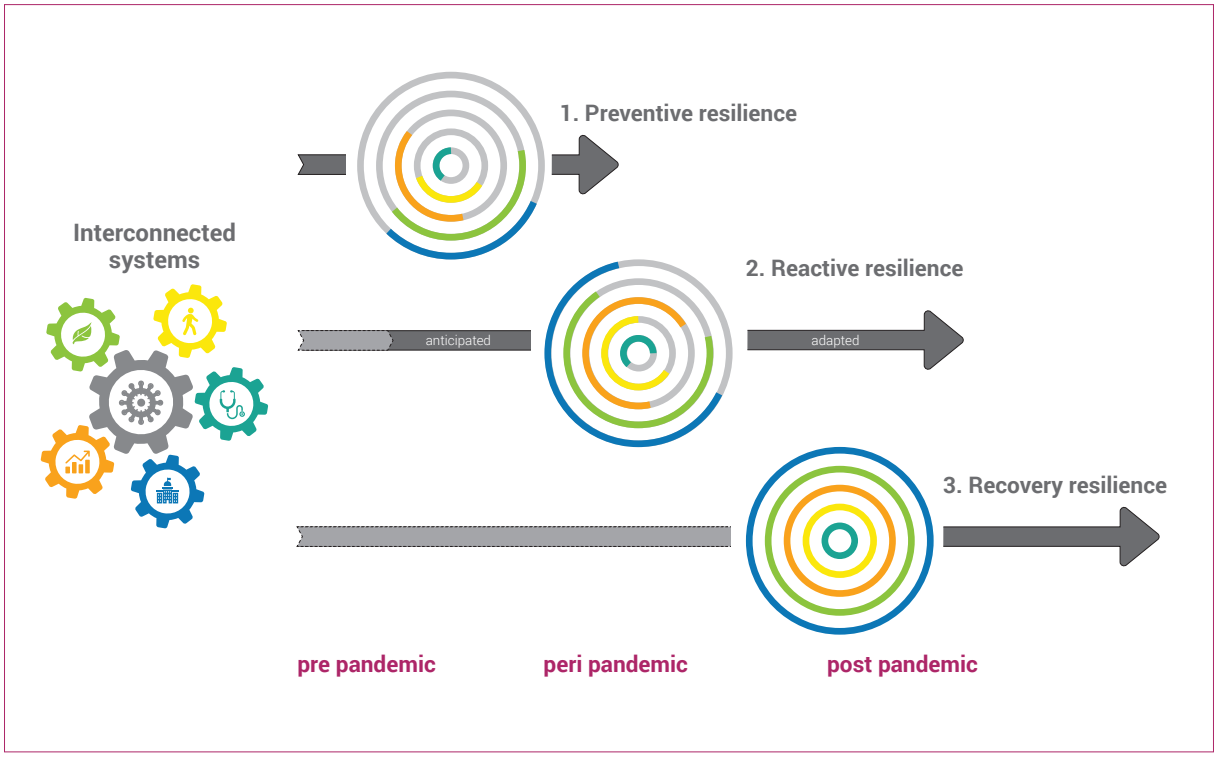


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Table 2. Framework to build preventive, reactive, and recovery resilience to pandemics in governance and sectoral systems.

System	Type	Foundation	Actions
		GOVERNANCE SYSTEM	
INSTITUTIONAL RESILIENCE 	Preventive	Build an inclusive and adaptive institutional system to favour a concerted approach to systemic risks.	1. Favour a multipartite political system with proportional representation, as opposed to majoritarian representation, to avoid large parts of the population non-represented. 2. Engage in formal or informal consultative processes or bodies that regularly report on and assess different societal threats. 3. Organise trust-building communication channels that effectively communicate the emergency measures that may need to be taken. 4. Integrate risk-awareness and risk-mitigation schemes such as mandatory insurance policies. 5. Identify incentives that may lead to undesirable windfall gains, moral hazards, or dual uses, and take measures against them. 6. Promote binding and non-binding international instruments to support the stability of the global governance system.
	Reactive	Recourse to informal bodies rather than altering the institutional structure of the polity to maximise the effectiveness of the response.	7. Uphold principles for good governance such as transparency and deliberation in the decision-making process. 8. Maintain the essential functions of public authorities under their control to maximise legitimacy of the response. 9. Ensure that formal and informal emergency bodies set-up during the crisis are diversely composed to balance the complex dimensions of the response to the crisis. 10. Reinforce education and other tools to tackle conspiracies and dis/misinformation which undermine trust in institutions. 11. Provide support to other countries when needed to improve bilateral and multilateral relationships and foster a collective response.
	Recovery	Envisage long-term adaptation of the institutional system to integrate the lessons learned.	12. Dissolve as soon as possible the 'emergency bodies' set-up during the crisis. 13. Adopt guidelines on the composition and functioning of 'emergency bodies' to improve the governance capacity of the next crisis. 14. Develop legislative procedures for reviewing the relevance of emergency measures and their termination to guarantee that the emergency regime cannot be turned into permanent institutional arrangements without a proper constitutional reform conducted outside of emergency procedures.

Table 2. continued

System	Type	Foundation	Actions
		SECTORAL SYSTEMS	
HEALTH RESILIENCE 	Preventive	Build national public health capacities supported by international collaboration to reduce the risk that a localised event becomes a pandemic.	15. Improve capacities for monitoring disease outbreaks to support early detection and immediate and effective localised response. 16. Deploy an early warning system to monitor vulnerabilities that are conducive to the emergence of infectious diseases. 17. Revise the International Health Regulations with enhanced information sharing and notification requirements to improve the international response which includes early and transparent communication and consultation with experts. 18. Educate the population on basic preventive measures to maintain hygiene and control disease transmission. 19. Invest in the research and development of vaccines for diseases with pandemic potential.
	Reactive	Develop health systems that are prepared to absorb shocks and respond to a pandemic flexibly and equitably.	20. Invest in community-based, inclusive, and equitable health systems so that the health needs of different communities are met. 21. Elaborate strategies for the re-organisation of health systems including health workforce training to quickly move into emergency mode. 22. Strengthen health promotion, preventive medicine, and primary health care to address risk factors such as non-communicable diseases to make the population less vulnerable to a pandemic. 23. Create mechanisms that accelerate the development of drugs, vaccines, and diagnostics in case of emergency. 24. Strengthen public health capacities so that effective yet proportionate measures can be taken including mass testing and contact tracing. 25. Ensure transparent and accountable communication about the public health response so that the public understands the relevance and importance of governmental decisions. 26. Develop ethical guidelines that provide clear criteria and rules for fair processes to avoid arbitrary and discriminatory allocation of scarce resources such as intensive care unit beds or vaccines.
	Recovery	Support physical and mental health recovery based on proactive actions that target the most affected populations.	27. Develop integrated programs for patients affected by the pandemic within health systems to limit and adapt to long-term health issues. 28. Reactivate essential health services and repair patient-provider relationships to reduce unintended consequences for other health issues. 29. Ensure the equitable, safe, and rapid deployment of vaccines through redesigned intellectual property frameworks and new regulatory and access pathways. 30. Address the root cause of vaccine hesitancy so that technologies are endorsed more rapidly when they become available. 31. Invest in the development of mental health programs to help people recover from the trauma of the pandemic and its associated response.

Table 2. continued

System	Type	Foundation	Actions
		SECTORAL SYSTEMS	
SOCIAL RESILIENCE	Preventive	Reduce vulnerabilities associated with the spillover of infectious diseases with pandemic potential.	32. Build awareness about the risks of disease spillover associated with the consumption of wildlife animals while respecting cultural sensitivities and people who are dependent on wild animals for their food security. 33. Tackle poverty and lack of education as the root drivers that increase the risk of spillover of infectious diseases.
	Reactive	Foster the capacity of individuals and communities to absorb a shock while reducing the transmission of a pandemic.	34. Strengthen the safety net for all citizens through innovative incentive schemes or other context-appropriate mechanisms to reduce the risks of hardships. 35. Develop access to information and communication technologies to facilitate the continuation of essential work, education, and social activities. 36. Invest in better equipped mental health services so that psychological distress is not left unaddressed. 37. Encourage safe access to activities such as arts and sports that help people cope with psychological distress. 38. Maintain or facilitate access to green-and-blue spaces so that people can benefit from exposure to the natural environment while respecting public health measures.
	Recovery	Restore societal connectedness by reaffirming and protecting rights of all people and fostering their capacities to choose their own life in a safe society.	39. Support victims of psychological distress to mitigate the risk of a global mental health crisis. 40. Step up social support to children and adolescents to mitigate the long-term generational effects of the pandemic. 41. Strengthen social policies which target poverty, gender and racial inequalities to protect all members of any community and reinforce intergenerational solidarity. 42. Ramp up actions to mitigate the effective violations of human rights to avoid a degraded state of democracy. 43. Support and promote cultural activities and sporting events to restore social interactions.

Table 2. continued

System	Type	Foundation	Actions
		SECTORAL SYSTEMS	
ECONOMIC RESILIENCE 	Preventive	Implement strategies which prevent the emergence and spread of pathogens to avoid a massive shock to the economy.	44. Identify effective interventions and strengthen regulatory frameworks to reduce the risk of pathogen transfer from animals to people and the subsequent transmission of emerging infectious diseases across borders. 45. Foster an understanding of the economy as a complex system that promotes a long-term vision based on human well-being and the respect for the natural world. 46. Ramp up efforts to transition to more sustainable forms of food production along with the respect for biosecurity measures to reduce the risk of spillover from animals to humans.
	Reactive	Foster the capacity of the economic system and its components to cope with shocks affecting supply and demand while maintaining the adherence to public health measures.	47. Conduct stress tests in different industries to identify sources of vulnerabilities to a pandemic and guide the development of prudential regulations. 48. Provide income support and defer taxes to avoid catastrophic loss of income in the most affected industries. 49. Ease solvency and liquidity for banks to avoid the paralysis of the financial system. 50. Deploy public sector subsidies and cheap loans to support the most affected industries. 51. Strengthen financial and logistical support to micro-enterprises and small and medium-sized enterprises to deal with supply chain disruptions effectively. 52. Avoid unnecessary barriers to international trade of strategic goods such as essential medical technologies to avoid a domino effect that can exacerbate both the economic and health impacts of the pandemic. 53. Streamline the process of the release and clearance of essential goods such as expediting import procedures, applying risk management procedures and facilitating transit procedures. 54. Adopt policies to help reduce the decline in tourism revenue such as one-year visas to incentivise travel and remote working. 55. Strengthen coordination mechanisms such as trade facilitation committees to facilitate international trade flows and value chains, international aid, and technical support.
	Recovery	Create the conditions for economic reconstruction, rehabilitation, and restoration.	56. Implement stimulus packages coupled with measures that improve business and consumer confidence. 57. Adopt an expansionary plan which emphasizes new multilateral solutions such as a global tax on systemic risks or a debt restructuring framework. 58. Reshape unsustainable production and consumption practices to reduce the drivers of emerging infectious diseases. 59. Strengthen efforts to diversify economies, particularly those dependent on tourism. 60. Implement international frameworks for sovereign debt restructuring that place sustainable development at their core.

Table 2. continued

System	Type	Foundation	Actions
		SECTORAL SYSTEMS	
ENVIRONMENTAL RESILIENCE 	Preventive	Reduce the disruptions of nature by humans' actions that favour the emergence of zoonotic diseases.	61. Strengthen One Health approaches including monitoring hotspots for emergent infectious diseases to reduce spillovers from animals to humans. 62. Foster more sustainable forms of food production and consumption to reduce natural habitat encroachment.
	Reactive	Curb unintended environmental degradation and reduce environmental factors that exacerbate the risk of disease transmission and mortality.	63. Reduce indoor air pollution to limit disease transmission and mortality. 64. Encourage safe and sustainable mobility such as walking or cycling to reduce outdoor air pollution. 65. Enhance the built-in environment including the design of indoor spaces and city planning to make them more useful in pandemic scenarios. 66. Improve waste management associated with personal protective equipment production and disposal of single-use products. 67. Provide bailout and rescue packages conditional on reducing carbon footprints to incentivise sustainable business models.
	Recovery	Address the negative and exploit the positive environmental side-effects to reduce the risk of future pandemics.	68. Move towards an 'environmentally friendly' circular economy mindset to reduce, reuse, and recycle. 69. Incentivise innovations for new methods of transportation, production and consumption that are environmentally friendly. 70. Encourage outdoor activities with the respect of the natural environment to promote a broader understanding of the place of humans in nature.

3.2 Five principles to govern systemic crises

An agile governance system is needed to support both the effectiveness and adaptation of these bold actions in different systems. Five key principles should guide the governance of systemic crises (Table 3). Application of these principles can help avoid traps such as the aforementioned vicious circle between command-and-control approaches and low adherence and trust of the population. More broadly, these governance principles are critical to support the constant co-evolution between the governance system and the system to be governed.[19] The discovery of new variants of the virus and the need for subsequent adaptation of policies to tackle the COVID-19 pandemic illustrate the value of a co-evolutionary approach to governance.

In addition to guiding the response to the pandemic, the proposed governance principles can also foster the resilience of the governance system which rests upon the capacity of existing institutions to maintain their core functions and adapt to internal or external disruptions. In the case of the COVID-19 pandemic, the temporal dynamic of the pandemic with several epidemiological waves has required the governance system to shift gear quickly from normal to emergency modus operandi and vice versa several times within a one-year period.[20] This has proved challenging for many governments.

[19] Søgaard Jørgensen et al., 2020.
[20] Young, 2017a.

3 Governing complexity to build resilience to systemic crises

Table 3. Principles, rationales, and tools to govern systemic crises.

Principle	Rationale	Tools
1 Encourage a whole-of-society response through participation and deliberation.	Addressing systemic crises requires a whole-of-society response to improve legitimacy, accountability, and adherence. The capacity for adaptation ultimately depends on civil society. Synergistic and symbiotic effects are part of the solution and should be promoted.	• Consultation, debate, deliberation, and other participatory mechanisms to foster collective decision-making. • Suitable digital communication and organisation platforms to enable people to support themselves and each other.[21] • Community-based initiatives to empower people and organisations to be part of the solution.
2 Improve communication and complexity literacy to build awareness and understanding.	Fear-based communication is ill-suited to engage the public. A narrative that recognises the interdependent nature of the crisis is critical to develop a shared understanding of the drivers and impacts of systemic crises. This will in turn foster adherence to the public health response.	• Transparent communication strategy to foster trust in response and institutions. • Multimodal information campaigns using traditional and social media to encourage understanding of policies and measures and reduce dis/misinformation. • Development of systems thinking skills in education and policymaking to develop a new mindset about the crisis.
3 Promote coordination and interplay management to foster policy coherence.	Multi-objective problems under deep uncertainty require coordination. Overcoming silos across different sectors that operate with distinct norms, values, and priorities is needed to assess societal trade-offs, minimise unintended consequences, and maximise synergies across systems and goals.	• Proportionality, coherence, and fairness assessments to evaluate trade-offs regarding any measure taken. • Mechanisms for shared information, resources, and responsibility across sectors to reduce systemic effects. • Multi-stakeholder partnerships and multilateral initiatives to improve coordination across borders.

[21] Spitale et al., 2020.

Table 3. continued

Principle	Rationale	Tools
4 Design inter-disciplinary learning systems at the science-policy interface.	Close collaboration between policy and science ensures that the issue is fittingly governed by the governance system. Collective intelligence, diversity, and improved learning mechanisms enable the adaptative management of the crisis.	• Mechanisms for the protection of research from political interference. • Interdisciplinary research for the integration of knowledge from all relevant disciplines. • Harness the power of information and communication technologies to combine different sources of evidence and guide evolutionary policies.
5 Foster polycen-tricity to protect the distribution and balance of power.	Concentration of power allows for rapid decision-making in times of emergency. However, multilevel governance, the preservation of the balance of power, and respect for human rights and dignity are essential for a longer-term approach to address complex challenges.	• Devolution of power from national to local governments to empower local communities. • Balance of power between the executive, judicial and legislative branches to avoid the abuses associated with emergency powers. • Applying the rule of law and respecting human rights to protect human dignity in all circumstances.

4 Societal resilience: a foundation for governance

The current pandemic has prompted calls for 'building back better'. Beyond a global recovery plan, what is needed is a global transformation plan, supported by suitably interlinked top-down and bottom-up approaches.[22] While resilience thinking is needed to facilitate a systemic response to the pandemic, the adoption of a wider complexity lens is essential to transform the way we govern complex systems.[23] The major governance issue is to reconcile this transformative agenda with institutional resilience which often makes systems resistant to change.

To prevent, react to, and recover from pandemics, developing the capacities associated with resilience should become a key priority at the local, national, and international levels. Considering resilience in the health, social, economic, and environmental systems as fundamentally interlinked and interwoven with the governance system will support effective actions (Figure 6). The multiplicity and variety of systemic threats require not only policies that address specific issues, but, more importantly, governance systems that support societal resilience to all sorts of issues.

The inclusive 2030 Agenda for Sustainable Development relates knowledge and policy goals from different perspectives. In combination with the Universal Declaration of Human Rights, the Sustainable Development Goals provide the framework for recovery, adaptation, and transformation that connects the social foundation of human dignity with the ecological ceiling of planetary boundaries.[24] However, the current pandemic is also testing the Sustainable Development Goals and stresses the need for further commitments and a re-assessment of priorities post-COVID-19.[25]

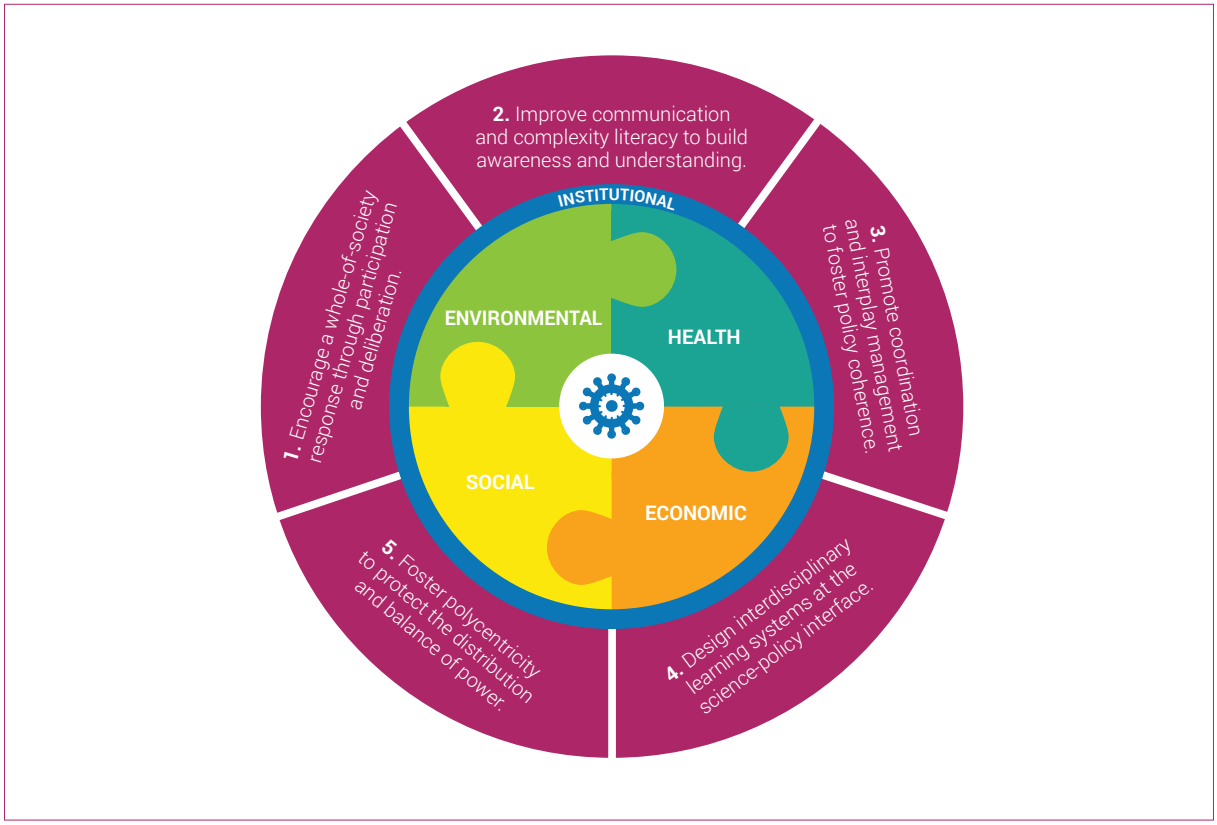
As an immediate next step, national governments should set up transdisciplinary enti-

[22] Lenton, 2020.
[23] Young, 2017b.
[24] Raworth, 2017.
[25] Naidoo & Fisher, 2020; van Zanten & van Tulder, 2020.

4 Societal resilience: a foundation for governance

ties tasked with assessing systemic risks and proposing policies and institutions to strengthen resilience according to their respective context. Investments should be commensurate with the impacts of pandemics on societies. Finally, given global interconnectedness, multilateral initiatives should converge towards the adoption of a global action plan to foster societal resilience to systemic crises. Crucially, transformative governance in the age of complexity rests upon the willingness to implement visionary actions that shape resilient, inclusive, and sustainable societies.

Figure 6. *Transformative Agenda to govern pandemics.*



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