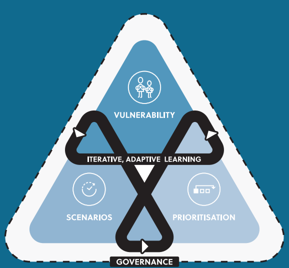
06

Climate and disaster risks:

What they are, why they matter, and how to consider them in decision making

Terms and Concepts



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Foreword

The risk landscape is changing quickly, and the stability of natural, social and economic systems can no longer be taken for granted. The scale and seriousness of the momentum of change, requires genuine national collaboration, a broad range of knowledge and strategic guidance on navigating growing uncertainty.

Choices made at multiple levels by a wide range of decision makers in both government and industry interact to affect our vulnerability and resilience. Better decision making, guided by new forms of systemic risk governance, assessment and management are key to preventing and reducing climate and disaster risk.

Led by the National Resilience Taskforce and released in April 2019, the co-developed *National Disaster Risk Reduction Framework* (Framework) sets a common agenda for collective action. This new Framework is in part informed by the report *Profiling Australia's Vulnerability* that reflects a fuller understanding of systemic disaster risk and values, choices and trade-offs.

Profiling Australia's Vulnerability brings into sharp focus the reality that hazards lead to disaster where there is exposure of a vulnerable society and where the consequences exceed people's capacity to cope. The report also finds that what we value, and the choices that we make between these values, are different during periods of stability compared with disruption. Understanding this can help reframe how we approach climate and disaster risk reduction efforts into a whole-of-society approach.

The Framework sets a foundation for action for decision makers across all sectors of the Australian economy. It seeks to raise awareness of the causes and effects of climate and disaster risks and to enable decision makers to proactively take steps within their spheres of influence and control to reduce these.

To support its implementation and encourage new conversations about climate and disaster risk, a set of interconnected guidance documents has been developed.

This Guidance is foundational and is a first iteration. It is designed to help decision makers in the non-trivial task of contextualising the systemic physical impacts of a changing climate. In particular, it provides direction on how to call upon knowledge, capabilities and processes to apply climate and disaster risk to governance, strategic planning and investment decisions.

As you *Turn the Page*, you will be contributing to the journey from where we are now, to where we need to be.

Mark Crosweller AFSM
Head of National Resilience Taskforce
Department of Home Affairs

Turning the Page

Reducing Systemic Climate and Disaster Risk for a Resilient and Prosperous Australia

Momentum is Building

The risk landscape is changing quickly and we need to break from business as usual.

- Natural hazards are more frequent and intense
- Demand is growing to address financial impacts of a changing climate
- People, livelihoods and assets are more exposed and vulnerable
- Essential services are increasingly hyper-connected
- Disaster impacts are long-term and complex
- Costs of disasters are growing
- Stability of natural, social and economic systems can no longer be taken for granted

We are Aspiring Towards

A systems and values-based mindset reduces climate and disaster risks.

- Risk-informed sustainable development
- Substantial reduction in loss and harm
- Successfully living with natural hazards and a changing climate
- Reduced intergenerational vulnerability
- Wellbeing, trust and confidence

1. Introduction

This document supports a set of interconnected Guidance documents on *governance, vulnerability, scenarios* and *prioritisation* related to climate and disaster risk reduction. It defines and explains terms and concepts used throughout the Guidance documents.

This document is designed to complement existing resources or authoritative glossaries that provide definitions of terms and concepts relating to climate and disaster risk reduction such as:

Systemic risk and risk governance

The 2019 Global Assessment Report on Disaster Risk Reduction describes the pluralistic nature of risk: in multiple dimensions, at multiple scales and with multiple impacts. It is a useful resource for learning more about the terms and concepts described throughout the Guidance.

https://gar.unisdr.org/

The International Risk Governance Council (IRGC) report on *'Guidelines for the Governance of Systemic Risks'* provides a useful resource for explaining terms and concepts relating to systemic risk governance.

https://irgc.org/risk-governance/systemic-risks/guidelines-governance-systemic-risks-context-transitions/

Climate risk

The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change and the mitigation and adaptation to the potential impacts of climate change. It provides numerous glossaries of specialised terms.

https://archive.ipcc.ch/publications_and_data/publications_and_data_glossary.shtml

The Glossary of the Fifth Assessment Report is also available in an Annex.

https://www.ipcc.ch/site/assets/uploads/2018/02/AR5_SYR_FINAL_Annexes.pdf

The Department of the Environment and Energy provides Climate Compass: A climate risk management framework for Commonwealth agencies that has a technical supplement explaining technical climate risk issues and terms.

https://environment.gov.au/climate-change/adaptation/publications/climate-compass-climate-risk-management-framework

Explanations of the fundamentals of climate change science are provided by CSIRO on the Climate Change in Australia website.

https://www.climatechangeinaustralia.gov.au/en/climate-campus/

Emergency and disaster management

UNDRR provides a comprehensive source for explaining terms and concepts.

https://www.unisdr.org/we/inform/terminology

The Australian Disaster Resilience Institute provides a consensus glossary on terms and definitions or information to account for jurisdictional and contextual variation.

https://knowledge.aidr.org.au/glossary/

2. Terms and concepts

adaptation

Adaptation involves the proactive or reactive adjusting of actions, behaviours and responses of an individual, community or system to changing external drivers and internal processes. The purpose of adaptive actions can be to maintain an existing identity, state or regime or to transition and transform to a new climate-change compatible identity, state or regime. Adaptation can be achieved through incremental or large-scale rapid changes.

ambiguity

Ambiguity describes situations where the characterisation of potential threats or outcomes is problematic[1]. This may be the case even for events that are certain or have occurred already. It covers divergent or contested perspectives on the justification, severity or wider meanings associated with a given threat, its potential impacts and possible management interventions[2]. For instance, asking which of a series of possible measures would be 'safest', 'safe', 'safe enough', 'acceptable', 'cost effective', 'proportionate', or 'best' may each yield radically different answers for risk-based rank orderings of intervention options.

Key challenges also arise in comparing different notions of benefit and cost including whether and how we value and account for impacts of hazards and climate change (or risk reduction measures) on the general public, adults or children, affluent or impoverished communities, domestic citizens or foreigners. These kinds of dilemmas raise the 'apples and oranges' challenge in the appraisal of climate and disaster risk management interventions, often with no explicit recognition of the basis for choice expressed.

1 Stirling, A. & Scoones, I. 2009. *From risk assessment to knowledge mapping: science, precaution and participation in disease ecology. Ecology and Society* 14 (2):14. Available at: ***http://www.ecologyandsociety.org/vol14/iss2/art14/***

2 IRGC. 2018. *Guidelines for the Governance of Systemic Risks.* Lausanne: International Risk Governance Center (IRGC). Available at: ***https://infoscience.epfl.ch/record/257279?ln=en***

benefits

Benefits are enhancements to amenity, connectivity or community outcomes and services. A benefit is a measure of the beneficial outcomes arising from an infrastructure/development project. Benefits from changes to the quantity or quality of the state of an asset or service due to an intervention can be experienced in different ways by diverse stakeholders through direct or indirect uses and non-uses (such as bequest and existence values)[3]. Some benefits are amenable to quantification, and even monetisation, and others are not[4]. Examples of benefits from investments in transport infrastructure include:

- Improved access to transport networks and other amenities
- Improved labour force accessibility
- Improved access to services, such as retail, health and educational services
- Reduced travel times, chance of accidents and other transport user benefits
- Reduced physical discomfort, stress and anxiety

beneficiaries

A beneficiary is a segment of the community that would be directly or indirectly impacted in a beneficial way by an investment or development to reduce climate and disaster risk. A beneficiary must have a physical or spatial relationship to the intervention, whether the derived benefits are experienced directly or indirectly. In the context of investments in infrastructure that provides critical services such as flood protection, transportation, communication, water or energy, beneficiaries can include:

- Homeowners
- Landowners
- Employers
- Existing businesses
- Potential businesses
- Investors and developers
- Local and central government
- Road and public transport users

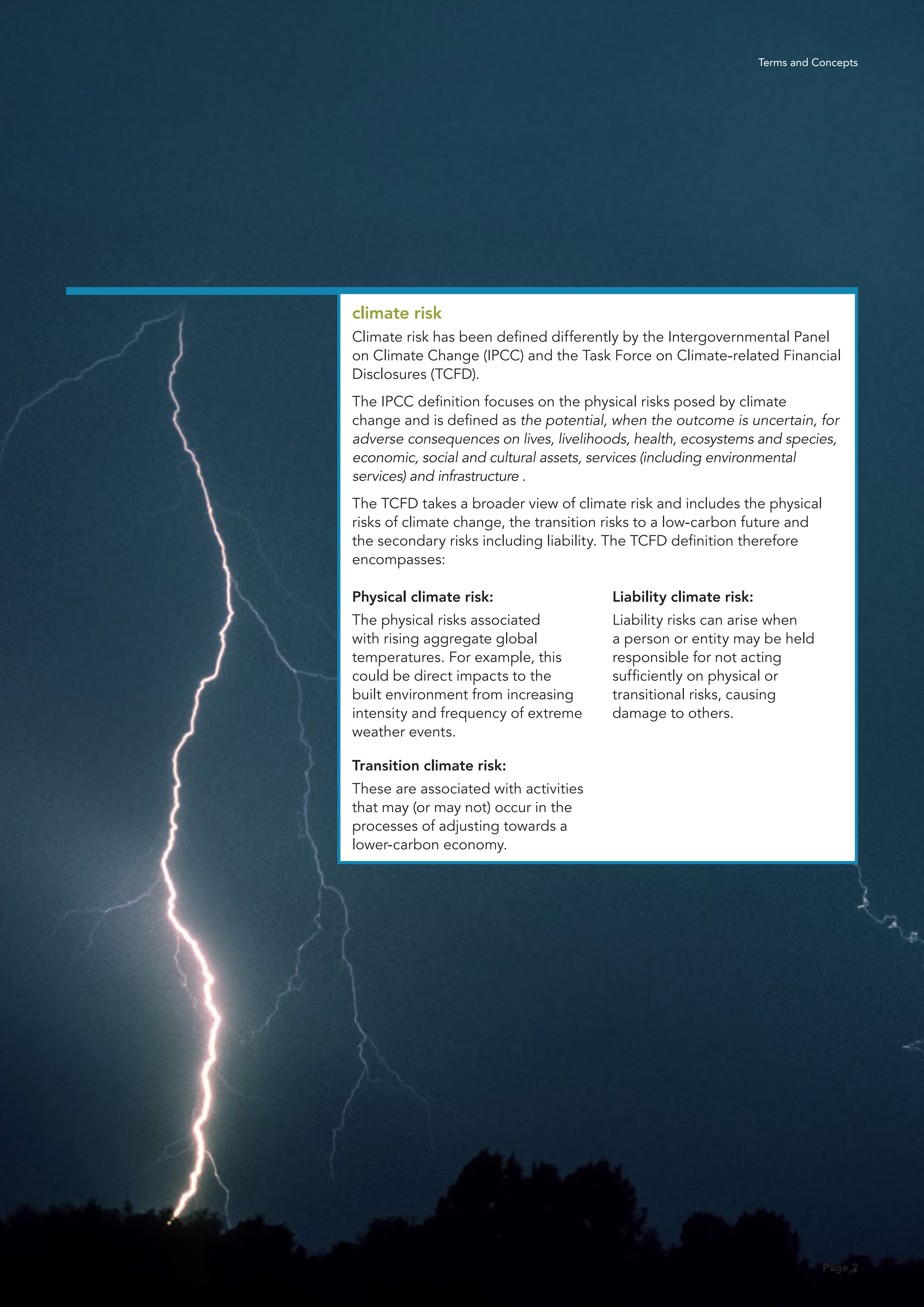
cascading effects

Multiple self-reinforcing feedback mechanisms whereby a shock to one system triggers consequences in various connected subsystems[5].

3 Benefits are determined by the nature of the relationships between people and things of value. For an explanation and examples of this see: *https://www.pnas.org/content/pnas/113/6/1462.full.pdf* and *https://www.nespmarine.edu.au/document/rethinking-approaches-valuation-marine-systems*

4 See *https://coastadapt.com.au/sites/default/files/information-manual/IM04_Costs_and_benefits.pdf*

5 IRGC. 2018. *Guidelines for the Governance of Systemic Risks.* Lausanne: International Risk Governance Center (IRGC).



climate risk

Climate risk has been defined differently by the Intergovernmental Panel on Climate Change (IPCC) and the Task Force on Climate-related Financial Disclosures (TCFD).

The IPCC definition focuses on the physical risks posed by climate change and is defined as *the potential, when the outcome is uncertain, for adverse consequences on lives, livelihoods, health, ecosystems and species, economic, social and cultural assets, services (including environmental services) and infrastructure* .

The TCFD takes a broader view of climate risk and includes the physical risks of climate change, the transition risks to a low-carbon future and the secondary risks including liability. The TCFD definition therefore encompasses:

Physical climate risk:

The physical risks associated with rising aggregate global temperatures. For example, this could be direct impacts to the built environment from increasing intensity and frequency of extreme weather events.

Transition climate risk:

These are associated with activities that may (or may not) occur in the processes of adjusting towards a lower-carbon economy.

Liability climate risk:

Liability risks can arise when a person or entity may be held responsible for not acting sufficiently on physical or transitional risks, causing damage to others.

chronic stresses

Chronic stresses, also known as 'slow-developing catastrophic risks', are threats, perils, or risks that develop slowly but which can ultimately lead to sudden, catastrophic and often irreversible changes in complex social, economic and ecological systems[6].

complexity

Complexity describes situations where difficulties exist in identifying and quantifying causal links between a multitude of potential causal agents and specific observed effects[7]. Systems that are complex are not merely complicated; by their nature they involve deep uncertainties and a number of legitimate perspectives. A lesson of complexity, therefore, is that no single indicator can be the unique correct one. Hence the indicators must be used in a dialogue among stakeholders, rather than in a demonstration by experts. In this way, the decision-making process becomes central to the tasks of making policy[8].

Complex contexts are increasingly emerging. Complex contexts can be distinguished from simple or complicated ones, by emphasising that at least one right answer exists in simple or complicated contexts but in a complex contexts right answers can't be identified. Most situations and decisions faced by organisations today are complex because some major change – a bad quarter, a shift in management, a merger or acquisition – introduces unpredictability and flux. In this domain, we can understand why things happen only in retrospect. Instructive patterns, however, can emerge if the leader conducts experiments that are safe to fail. That is why, instead of attempting to impose a course of action, leaders must patiently allow the path forward to reveal itself. They need to probe first, then sense and then respond[9].

complex risks or complex system

(see system, complicated system)

A complex system exhibits emergent properties that arise from interactions among its constituent parts. Examples of a complex system include a traffic jam, regime change or social unrest triggered by natural hazards[10].

6 IRGC. 2018. *Guidelines for the Governance of Systemic Risks.* Lausanne: International Risk Governance Center (IRGC). ***https://infoscience.epfl.ch/record/257279?ln=en***

7 IRGC. 2018. *Guidelines for the Governance of Systemic Risks.* Lausanne: International Risk Governance Center (IRGC). ***https://infoscience.epfl.ch/record/257279?ln=en***

8 Report from the European Environment Agency: ***https://www.eea.europa.eu/publications/ISSUE09***

9 Based on the Cynefin framework developed for business leaders by David Snowden and Mary Boone in 2001. This is available at: ***https://hbr.org/2007/11/a-leaders-framework-for-decision-making***

10 UNDRR. 2019. Global Assessment Report for Disaster Risk Reduction: ***https://gar.unisdr.org/***

Complex systems have cause-effect relationships that can often only be understood in hindsight (i.e. after a disaster occurs). Complex systems involve interactions and interdependencies, which cannot be separated. It can be difficult to clearly identify where a risk could emerge. Complex systems are more amenable to building general forms of resilience[11].

complicated risks or complicated system

(see system, complex system)

A complicated system can be dis-assembled and understood as the sum of its parts. They can be broken down into their components. Just as a car is assembled from thousands of well-understood parts, which combined allow for simpler and safer driving, multi-hazard risk models allow for the aggregation of risks into well-behaved, manageable or insurable risk products[12].

Complicated systems are characterised by cause-effect relationships that can be understood in advance, before the risk event occurs. Complicated systems are more amenable to building specified forms of resilience[13].

decision lifetime

A decision lifetime is the period over which the implications of a decision play out. A full decision lifetime is made up of a lead time (till the decision becomes operational), operating time, and consequence time (this may include the time to decommission an asset)[14].

The full decision lifetime of an activity may extend well beyond the original activity. For example, a policy decision to build a flood protection levee may take five years to gain design approvals and build. The levee itself may only be operational for 30 years, but during that time people may have been encouraged to build behind it (a common effect called 'asset anchoring'). As such decision makers in the future are essentially locked into re-furbishing the levee – the consequence time is much longer than 35 years. The decision lifetime helps determine how far into the future you need to look[15]. Further detail can be found in the technical supplement of Climate Compass: A climate risk management framework for Commonwealth agencies.

11 Cavello, A. and Ireland, V. 2015. Preparing for Complex Interdependent Risks: A system of systems approach to building disaster resilience. *Input Paper Prepared for the Global Assessment Report on Disaster Risk Reduction 2015*. University of Adelaide. ***https://www.unisdr.org/we/inform/publications/49732***

12 UNDRR. 2019. Global Assessment Report for Disaster Risk Reduction: ***https://gar.unisdr.org/***

13 Cavello, A. & Ireland, V. 2015. Preparing for Complex Interdependent Risks: A system of systems approach to building disaster resilience. *Input Paper Prepared for the Global Assessment Report on Disaster Risk Reduction 2015*. University of Adelaide. ***https://www.unisdr.org/we/inform/publications/49732***

14 Definition taken from the climate risk management framework 'Climate Compass' available at: ***https://environment.gov.au/climate-change/adaptation/publications/climate-compass-climate-risk-management-framework***

15 Definition taken from the climate risk management framework 'Climate Compass' available at: ***https://environment.gov.au/climate-change/adaptation/publications/climate-compass-climate-risk-management-framework***

decision makers

Decisions require knowledge generation and exchange, and people and organisations making and implementing them. In this context decision makers include policymakers, managers, planners and practitioners, and range from individuals to organisations and institutions. Relevant issues to decision making include consideration of values, purpose, goals, available resources, the time over which actions are expected to remain effective, and the extent to which the objectives, roles and responsibilities being pursued are regarded as appropriate. These are particularly important and challenging in the context of systemic risks as not all decision makers have the official mandate, positions or the influence to inspire and enact appropriate changes to tackle the systemic causes and effects of climate and disaster risk.

deep uncertainty

The concept of deep uncertainty describes situations experiencing large and uncertain change that could lead to multiple, often equally plausible, futures. Deep uncertainty occurs due to the presence of: multiple possible future worlds without known relative probabilities; multiple divergent but equally-valid world-views, including values used to define criteria of success; and decisions which adapt over time and cannot be considered independently[16].

disaster risk

(see systemic risk, systemic disaster risk)

Disaster risk is a function of the decisions we take about how we develop and use resources in production and consumption activities to support lifestyle choices and socio-economic or cultural practices, which then shape the world around us[17].

Disaster risk is defined as *the potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined as a function of hazard, exposure, vulnerability and capacity*[18]. The vulnerability and capacity of people, communities and nature are influenced by the interactions between societal rules, values and knowledge and their interactions with the biophysical world. These elements of disaster risk have the characteristics of being: complex, dynamic, systemic and cross-scale (temporal, spatial and sectoral).

16 Hallegatte, S., Shah, A., Brown, C., Lempert, R. and Gill, S. 2012. Investment decision making under deep uncertainty - application to climate change. World Bank, Policy Research Working Paper (6193). ***https://openknowledge.worldbank.org/handle/10986/12028***

17 UNDRR. 2019. Global Assessment Report for Disaster Risk Reduction: ***https://gar.unisdr.org/***

18 UNDRR. 2019. Glossary: ***https://www.unisdr.org/we/inform/terminology***

disaster risk reduction
(see resilience, specified resilience, general resilience)

Disaster risk reduction is the prevention of new and the reduction of existing disaster risk, including the management of residual risk. Disaster risk reduction contributes to strengthening resilience to disasters and therefore to the achievement of sustainable development. Disaster risk reduction is the policy objective of disaster risk management, and its goals and objectives are defined in disaster risk reduction strategies and plans[19].

Disaster risk reduction requires systematic efforts to analyse and reduce drivers of disaster risk. This includes reducing exposure to hazards, lessening and addressing vulnerability of people and property, sustainably managing land and environment and improving preparedness and early warning for natural hazard events[20].

While disaster risk reduction is most familiar to practitioners in fields like disaster management, disaster mitigation and disaster preparedness, it is also a central concept of sustainable development; for development activities to be sustainable they must reduce disaster risk. It is also a central component of climate change adaptation. Climate adaptation and disaster risk reduction both aspire to building the resilience, adaptability and transformability of systems' integral components and capabilities for sustainability[21].

Disaster risk reduction strategies ought to include measures to build specified and general resilience.

emerging risks

New risks or historically known/experienced risks with behaviours and dynamics that are changing in unprecedented or unpredictable ways or which are occurring in new locations.

19 UNDRR. 2019. Glossary: ***https://www.unisdr.org/we/inform/terminology***

20 UNDRR. Accessed 2019. ***https://www.unisdr.org/who-we-are/what-is-drr***

21 Australian Government, Department of Home Affairs, 2018. Deconstructing Disaster: The strategic case for developing an Australian Vulnerability Profile to enhance national preparedness – March 2017. National Resilience Taskforce.

exposure

The degree to which a system is exposed to significant climatic variations.

The situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas. Exposure changes in response to the decisions and policies of individuals, communities, agencies and governments about where to locate growing populations, industries and resource-use activities. Exposure will change as the intensity, frequency and distribution of hazards change and as new hazards emerge.

feedback loop

When outputs of a system are routed back as inputs into the system as part of a chain of cause-and-effect that forms a circuit or loop. This feedback loop can be positive (vicious, enhancing) or negative (dampening).

general resilience

(see resilience, specified resilience, complex systems)

General resilience applies to the system as a whole, or a system of systems, and refers to unknown risks, whose consequences may be unforeseen or not previously experienced, and where risks are generally hyper-connected, complex and have high levels of uncertainty.

General resilience involves diversity (natural and social), openness (flows in and out of the system – social and biological), reserves, responsive to feedback loops, modularity and 'redundancy' e.g. overlapping governance. Note, the quotations are used to distinguish between genuine redundancies that serve no purpose and apparent redundancies which actually reflect response diversity.

General resilience often refers to interdependent risks that are complex to assess (i.e. complex risks). It refers to the ability of a community to face unknown shocks. The underlying philosophy is that it is not possible to clearly specify the threat. Risk-reducing factors often come from programs and institutions that do not appear in disaster management plans[22].

22 Cavello, A. & Ireland, V. 2015. Preparing for Complex Interdependent Risks: A system of systems approach to building disaster resilience. *Input Paper Prepared for the Global Assessment Report on Disaster Risk Reduction 2015*. University of Adelaide. ***https://www.unisdr.org/we/inform/publications/49732***

horizon scanning

An organised formal process of gathering, analysing and disseminating value-added information to support decision making[23].

intervention

An intervention is the act of intentionally seeking to shift the status quo of a situation or system. Interventions include policies, legislation, investments or projects. They can be made to steer or guide the systems, at a range of scales, onto different trajectories and toward different futures.

locked-in

An arrangement where a system is increasingly obliged to operate under a certain series of principles, resources or realities that makes it less nimble to transition in the face of adversity[24].

low-regret

Low-regret strategies or options are those that yield benefits irrespective of the future scenario (i.e. even in absence of climate change)[25]. They maximise positive and minimise negative outcomes for communities and societies in climate sensitive areas.

23 IRGC. 2018. *Guidelines for the Governance of Systemic Risks*. Lausanne: International Risk Governance Center (IRGC). Available at: ***https://infoscience.epfl.ch/record/257279?ln=en***

24 IRGC. 2018. *Guidelines for the Governance of Systemic Risks*. Lausanne: International Risk Governance Center (IRGC). Available at: ***https://infoscience.epfl.ch/record/257279?ln=en***

25 Hallegatte, S., Shah, A., Brown, C., Lempert, R. & Gill, S. 2012. Investment decision making under deep uncertainty – application to climate change. World Bank, Policy Research Working Paper (6193). ***https://openknowledge.worldbank.org/handle/10986/12028***

rate of return

The Rate of Return (RR) criterion measures the extra benefit compared to the extra cost of an investment and thus justifies expenditure only in cases where extra benefits exceed extra costs (i.e. economic returns to scale). This rate of return rule is the most appropriate criterion to use for allocating monies both within and across projects because the estimated net benefits to investments in projects generally depend on the scale of the project.

In practical terms, considering projects in terms of their rate of return (to scale) may require a project planner to re-frame the way they have previously approached budget estimation. Instead of asking "What is the budget required to achieve outcome Y?" decision makers must have information on "What is the outcome given a budget $X?". To answer this, a project planner needs to be able to identify upfront the potential benefit generated by discrete portions of the proposed budget and pick the best possible scale of expenditures.

Using a RR rule for decision-making allows for a consistent ranking of different projects, unlike with the use of Benefit-Cost Ratio, regardless of whether their scales differ. The idea is simply to compare rates of return and allocate budgets accordingly. This is important not only in climate and disaster risk management, but also in the valuation of environmental assets[26] and biosecurity measures[27].

resilience

(see specified resilience, general resilience, disaster risk reduction)

Resilience refers to the ability of a system to plan, prepare for, absorb, recover from and adapt in the aftermath of systemic threats[28]. A resilience approach calls for building both specified and general resilience.

These two forms of resilience do not represent a dichotomy. Both need to be built, there are trade-offs between them.

risk governance

The totality of actors, rules, conventions, processes and mechanisms concerned with how relevant risk information is collected, analysed and communicated and management decisions are made.

26 Akter, S., Kompas, T. and Ward, M. B. 2015. Application of portfolio theory to asset-based biosecurity decision analysis', *Ecological Economics*, 117, 73–85.

27 Kompas, T. Vhu, L. Van Ha, P. and Spring, D. 2019. Budgeting and portfolio allocation for biosecurity measures', Australian Journal of Agricultural and Resource Economics, in press.

28 IRGC. 2018. *Guidelines for the Governance of Systemic Risks*. Lausanne: International Risk Governance Center (IRGC). Available at: *https://infoscience.epfl.ch/record/257279?ln=en*

robustness

Robustness is often cited as the most desirable criterion for managing large decision uncertainties. It ensures that a particular decision is likely to perform well, or satisfactorily, over a wide range of plausible climate futures, socioeconomic trends and other factors. Robust decisions often perform better (or are associated with lower regret) than decisions informed by optimisation methods if the future turns out differently than expected[29].

scenarios

Plausible storylines about how the future might unfold and how this might affect an issue that confronts a region, jurisdiction, organisation or community or challenge their status. Scenarios can be developed qualitatively, quantitatively, or both[30].

specified resilience

(see resilience, general resilience, complicated systems)

Specified resilience involves understanding and identifying the controlling (often slowly changing) variables that are likely to have threshold effects, leading to unwanted and perhaps irreversible regime shifts. In considering specified resilience a question raised is: How will these variables respond to particular kinds of shocks and disturbances, and what attributes of the system can be enhanced to avoid exceeding particular thresholds?

Specified resilience often refers to known risks (i.e. complicated risks), or a system of subsystems, whose consequences have already been observed in the world. This is the case with analysis of many natural hazards occurring in the past. The risks are broken down into more manageable components that are addressed individually. The underlying philosophy is that it is possible to mitigate identified risks. At present, many disaster risk reduction strategies are focusing more on building specified resilience[31].

strategic

Long-term and systemic considerations relevant to achieving one or more goals under conditions of uncertainty, and particularly emphasises the existential dimensions of these systemic considerations that warrant reflecting on the ongoing viability of objectives, structures, or procedures and modifying these accordingly.

29 Lempert, R.J., Popper, S.W., Bankes, S.C. 2003. Shaping the Next One Hundred Years: New Methods for Quantitative, Long-Term Policy Analysis. Report prepared for the RAND Pardee Centre, Santa Monica. ***http://www.rand.org/pubs/monograph_reports/2007/MR1626.pdf***

30 IRGC. 2018. *Guidelines for the Governance of Systemic Risks*. Lausanne: International Risk Governance Center (IRGC). Available at: ***https://infoscience.epfl.ch/record/257279?ln=en***

31 Cavello, A. & Ireland, V. 2015. Preparing for Complex Interdependent Risks: A system of systems approach to building disaster resilience. *Input Paper Prepared for the Global Assessment Report on Disaster Risk Reduction 2015*. University of Adelaide. ***https://www.unisdr.org/we/inform/publications/49732***

strategic risk assessment

The process used to identify, assess and prioritise strategic risks in terms of their potential effects on priority objectives or predetermined standards, target risk levels or other criteria.

strategic risk management

The strategic design and implementation of the actions and remedies required to avoid, reduce, transfer or retain the risks.

system

(see complicated system, complex system)

A system is a collection of elements and subsystems, defined by their relations within some sort of hierarchy or hierarchies. The hierarchy may be one of inclusion and scale, as in an ecosystem with (say) a pond, its stream, the watershed and the region, at ascending levels. Or it may be a hierarchy of function, as in an organism and its separate organs. A species and its individual members form a system with hierarchies of both inclusion and function. Environmental systems may also include human and institutional sub-systems, which are themselves systems. These latter are a special sort of system, which we call reflexive[32].

Importantly, any system is itself an intellectual construct that some humans have imposed on a set of phenomena and their explanations. Sometimes it is convenient to leave the observer out of the system; but in the cases of systems with human and institutional components, this is counterproductive. For interconnected social-environmental systems, the observer and analyst are embedded in their own systems, variously social, geographical and cognitive, with characteristic spatial and temporal scales that frame their perceptions.

32 European Environment Agency: *https://www.eea.europa.eu/publications/ISSUE09*

systemic risk governance

The opportunities and limitations (effectiveness) of different governance systems working together as a whole. Systemic risk governance considers the interconnected elements and interdependencies among individual risks.

Note: Disaster risk reduction requires a form of governance that not only responds to the uncertain and complex nature of natural hazards and a changing climate, but to the interrelated and complex distribution of responsibility for identifying, managing and reducing systemic risk. Currently, stakeholders are not set up to govern systemic risk. Systems thinking for strategic decision making is an emerging practice.

systemic (disaster) risk

Systemic risk refers to the threat that individual failures, accidents, or disruptions present to a system through processes such as contagion. The notion of systemic risk refers to the risk or probability of breakdowns in an entire system, as opposed to the breakdown of individual parts or components[33]. Systemic risks are interconnected with non-linear cause-effect relationships.

The term 'systemic' describes the extent to which a risk is embedded in the larger contexts of societal processes. Systemic risk requires a more holistic approach to hazard identification, risk assessment and risk management, because investigating systemic risk goes beyond the usual agent-consequence analysis. Instead, the analysis must focus on interdependencies and ripple and spill-over effects that initiate impact cascades between otherwise unrelated risk clusters[34].

Systemic risk is hard to quantify and hard to predict. Systemic risk cannot be measured or governed by separately quantifying the contributing parts. As systems and services become more hyper connected and globalised, the propensity for system disruptions and reverberations are intensified, setting up the feedback loops with cascading consequences that are difficult to foresee. It may not be possible to mitigate or repair certain changes once tipping points and thresholds are reached.

33 Kaufman, G. and Scott, K.E. 2003. What Is Systemic Risk, and Do Bank Regulators Retard or Contribute to It? Independent Review 7(3): 371– 391. *https://www-cdn.law.stanford.edu/wp-content/uploads/2017/09/tir_07_3_scott.pdf*

34 Renn, O., Klinke A., & van Asselt, M. 2011. Coping with Complexity, Uncertainty and Ambiguity in Risk Governance: A Synthesis. Ambio 40: 231–246. *https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3357789/*

systems approach

A systems approach creates an understanding of cross-scale and cross-system dependencies and interactions; root causes and impacts of disasters, vicious cycles and key points of intervention; and the interplay between values, rules and knowledge. A systems approach requires recognition that the definition of the system is itself an intellectual construct and associated explanations of a set of phenomena, imposed by a subset of people. It is important to recognise or acknowledge that the observer and analyst are embedded in their own systems and therefore need to be included in the descriptions of the system.

systems thinking

A mindset where all objects, organisations and activities in daily life operate within a given system and are comprised of smaller subsystems. The ultimate goal of a systems thinking approach is to determine where a system might be vulnerable to disruption based upon shocks within and without one's system[35]. Systems thinking can be used to deal with complex situations.

tipping point or threshold

A critical moment or point in a (generally complex, non-linear) system, situation, entity or variable in which a small influence or development produces a sudden large or irreversible change that alters form, function or identity.

transformation

Transformation involves a thorough or dramatic change in the identity of an individual community or system as defined by its form, function, process or appearance creating a different identity[35].

uncertainty

In a general sense, uncertainty can be thought of as situations where there is a lack of clarity or quality of scientific or technical data[36].

The strict definition of 'uncertainty' describes situations where the available empirical information or analytical models do not present a definitive basis for assigning probabilities. In such situations we can treat these as a basis for systematic analysis using subjective judgements taking a number of different, equally plausible forms[37].

35 IRGC. 2018. *Guidelines for the Governance of Systemic Risks*. Lausanne: International Risk Governance Center (IRGC). Available at: ***https://infoscience.epfl.ch/record/257279?ln=en***

36 IRGC. 2018. *Guidelines for the Governance of Systemic Risks*. Lausanne: International Risk Governance Center (IRGC). Available at: ***https://infoscience.epfl.ch/record/257279?ln=en***

37 Stirling & Scoones (2007) available at: ***http://www.ecologyandsociety.org/vol14/iss2/art14/***

underlying disaster risk drivers

Processes or conditions, often development-related, that influence disaster risk by increasing levels of exposure and vulnerability or reducing capacity. Underlying disaster risk drivers – or factors – include poverty and inequality, climate change and variability, unplanned and rapid urbanisation, lack of disaster risk considerations in resource management, as well as compounding factors such as demographic change, non-disaster risk-informed policies, lack of regulations and incentives for private disaster risk reduction, complex supply chains, limited availability of technology, unsustainable uses of natural resources, declining ecosystems and pandemics and epidemics[38].

values

Values are what we consider to be important in life. They include moral principles, desirable goals and belief constructs and are expressed as preferences. Things of value can include; living things such as nature, animals and people; non-living physical things such as buildings, roads, money; critical services such as communications, health services, transport, energy and information; and processes and rules such as regulations and standards, land-use planning and governance.

38 UNDRR. 2019. Glossary: ***https://www.unisdr.org/we/inform/terminology***

value creation and capture (for funding and financing purposes)

Value creation refers to delivering enhanced value/benefits, in terms of economic, social and environmental outcomes. These benefits need to be beyond what would ordinarily be achieved as a direct result of the investment by government in the infrastructure.

Value capture is when the potential value created for a beneficiary by a project is monetised and applied as funding towards servicing and repaying project financing. Different mechanisms may be targeted to different beneficiaries to capture the value created, such as:

- Differential ratings on property valuation
- Targeted user rates and charges (e.g. developer charges)
- General and specific levies (e.g. ticket levies, fuel levies, parking levies)
- Stamp duty and land tax amendments
- Property rezoning
- Proceeds of sale of government property
- Air rights

vulnerability

The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, community, assets or systems to the impacts of hazards[39].

The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. The IPCC also emphasises distinguishing between contextual vulnerability and outcome vulnerability[40].

39 UNDRR. 2019. Glossary: *https://www.unisdr.org/we/inform/terminology*

40 IPCC, 2014. AR5 Climate Change 2014: Impacts, Adaptation, and Vulnerability *https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-AnnexII_FINAL.pdf*