The UN Global Assessment Report on Disaster Risk Reduction 2022 (GAR 2022)[1]

Pre-Zero Draft Annotated Chapter Outline

Background

As presented in the *UN Global Assessment Report on Disaster Risk Reduction 2019* (GAR 2019)[2], extreme changes in ecological and social systems are happening now, across multiple dimensions and scales more quickly and surprisingly than we ever thought possible. Non-linear, systemic change is a reality, and new risks and correlations are emerging in ways that we have not anticipated. Cost estimates of unmitigated climate change for instance, are now considered "potentially infinite"[3]. Four out of the nine planetary boundaries (climate change, loss of biosphere integrity, land-system change, altered biogeochemical cycles) have now been crossed,[4] and the rate of change of the Earth's system is accelerating[5]. Systemic risks threaten to undermine, and potentially reverse efforts to achieve the *2030 Agenda for Sustainable Development* (2030 Agenda). The *Sendai Framework for Disaster Risk Reduction 2015 – 2030* (Sendai Framework) reflects the certainty that in an ever more populous, networked and globalizing society, the very nature and scale of risk has changed to such a degree that it surpasses established risk management institutions and approaches. GAR 2019 described how 'present systems of governance and organization of human knowledge are limited' and currently not adequate for understanding and managing systemic risks – as has been made so very clear by the COVID-19 pandemic emergency. Furthermore, many descriptions of globally connected systemic risk fail to adequately capture the role of human-environment interactions, creating biases towards solutions that ignore new realities[6].

The *Global Sustainable Development Report 2019* (GSDR)[7] states that unless there is a fundamental—and urgent—change in the relationship between people and nature, and a significant reduction in inequalities between and inside countries, any progress of the last two decades risks being undone. "The present model of development has delivered prosperity to hundreds of millions. But it also has led to continuing poverty and other deprivations; unprecedented levels of inequality that undermine innovation, social cohesion and sustainable economic growth; and it has brought the world close to tipping points with the global climate system and biodiversity loss". Improving our understanding of the nature of social-ecological systems across the globe (that can be connected through global trade, international institutions, financialization and/or communication flows) incorporating aspects of environmental justice and inequality[8], is imperative.

Precursor signals of such tipping points abound. The *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate*[9] cites "rapid changes to the ocean and the frozen parts of our planet which are forcing

[1] The UN Global Assessment Report on Disaster Risk Reduction (GAR) – published periodically by the UN Office for Disaster Risk Reduction (UNDRR) – is the authoritative, flagship report of the United Nations on worldwide efforts to reduce disaster risk.
[2] GAR 2019 (gar.unisdr.org)
[3] "There is growing agreement between economists and scientists that the tail risks are material and the risk of catastrophic and irreversible disaster is rising, implying potentially infinite costs of unmitigated climate change, including, in the extreme, human extinction". IMF Working Paper WP/19/185, September 2019
[4] Rockström et al. 2009
[5] Nyström et al. 2019
[6] Keys et al. 2019
[7] https://www.un.org/development/desa/publications/global-sustainable-development-report-2019.html
[8] Keys et al. 2019
[9] https://www.ipcc.ch/srocc/home/

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people from coastal cities to remote Arctic communities to fundamentally alter their ways of life" as warning signs of impending systemic failures. The ocean provides critical regulating and provisioning services that synergistically support most of the Sustainable Development Goals (SDGs). Stabilising the ocean can feed and provide livelihoods for people[10] and, at the same time, maintain habitats, protect biodiversity and coastal areas, and regulate climate change through its role as a carbon sink.

The *IPCC Special Report on Climate Change and Land*, tells a similar story, "Land already in use could feed the world in a changing climate and provide biomass for renewable energy, but early, far-reaching action across several areas is required also for the conservation and restoration of ecosystems and biodiversity"[11]. Such transformations will depend upon an overall commitment to sustainability and the development of locally appropriate policies and governance systems for sustainable and regenerative land management.

The gravity of biodiversity loss as described in the *IPBES Global Assessment Report on Biodiversity and Ecosystem Services* is striking. Many pollinating species have seen critical decline in numbers, putting the production of 75% of global food crops at risk[12]. With 91% of the world's population breathing air in which pollutants exceed the World Health Organization (WHO) pollution guidelines[13], air pollution presents one of the highest health risks globally, especially in fast-growing cities in developing countries.

The GSDR 2019 stresses the need to transform key areas of human activity, which could otherwise lead to systems failure – including in respect of food, energy, consumption and production, and cities – and increase resilience to economic shocks and disasters caused by natural and man-made hazards, through active implementation of the Sendai Framework. The goal of the transformation is the decoupling of economic activity from environmental degradation, in other words, shifting from an unsustainable development model to a risk-informed one that restores and regenerates natural systems to ensure that 'no ecosystem is left behind'. The resilience and stability of natural ecosystems, their restoration and regeneration are of paramount importance for systemic risks to be managed effectively. Breaching the limits of those systems presents risks that incur severe (even existential) social, economic and political consequences.

The GSDR 2019 identifies food and energy systems as particularly important areas for change since these systems are critical risk and opportunity nexus areas for human and ecosystems health and well-being. The food system must undergo urgent widespread changes to infrastructure, cultural and societal norms, and policies that support the current, unsustainable status quo[14]. The GSDR further states that the energy system must transform by transitioning to net-zero CO_2 emissions by mid-century, whilst simultaneously closing the energy access gap[15]. GAR 2022 will build on the enquiry presented in the GAR Special Report on Drought 2021 – which seeks to deepen our understanding of the complex pathways of drought impacts for instance on food and energy systems – modernising knowledge and through detailed case studies examine solutions.

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[10] The ocean supports the livelihoods of 40 million fishers, that are threatened by overfishing and ocean acidification.
[11] https://www.ipcc.ch/2019/08/08/land-is-a-critical-resource_srccl/
[12] https://www.ipbes.net/global-assessment-report-biodiversity-ecosystem-services
[13] https://www.who.int/health-topics/air-pollution
[14] 2019 – c. 2 billion people suffer from food insecurity & 820 million people are undernourished. The proportion of populations that are overweight is growing in almost all regions of the world = 2 billion adults / 40 million children under-5 are overweight.
[15] Close to 1 billion people are without access to electricity, predominantly in Sub-Saharan Africa, and more than 3 billion people rely on polluting solid fuels for cooking, causing an estimated 3.8 million premature deaths each year.

The Sendai Framework stipulates that the global community must come to terms with a new understanding of the dynamic nature of systemic risks, new structures to govern risk in complex, adaptive systems and develop new tools for risk-informed decision-making that allows human societies to live in and with uncertainty. As a result, we must now choose to learn to live with uncertainty and complexity and start to address risk from a systems perspective. This compels new conceptual and analytical approaches to improve understanding and management of risk dynamics and risk drivers at a range of spatial and temporal scales. It requires emphasis on the interaction among *social, ecological, political, economic and technological systems* resulting from the activities of humans in nature.

GAR 2022 will extrapolate and enrich the narrative presented in GAR 2019 to assess how worsening social inequalities and potentially irreversible damage to ecosystems created by the current unsustainable development model are increasing systemic risks. It will address how to assess systemic risks – with a focus on aspects of vulnerability and exposure within and between systems – as well as the systems-based approaches that are being put in place to prevent their creation, limit their propagation or mitigate consequences when realised. GAR 2022 will explore how risk perception drives decision-making and how to deal or live more comfortably with uncertainty. GAR 2022 will examine emerging systemic risk management solutions. This, to assist governments and non-state actors better understand and manage trade-offs in realising risk-informed sustainable development in a changing climate and enable increasing coherence and integration across the aligned intergovernmental agendas.

GAR 2022 comes after the call by the UN Secretary-General for a 'Decade of Action' to deliver the SDGs, and so it will take stock of the progress made by governments and other stakeholders in achieving the outcome, goals and targets of the Sendai Framework and the 2030 Agenda. **GAR 2022 will explore systems-based approaches to managing risk within efforts pursuing sustainable development, and the health and well-being of humans and ecosystems.**

The GAR 2022 will be composed of the following PARTS:

I. An update on global progress in implementing the outcome, goal, targets and priorities of the Sendai Framework and disaster-related Sustainable Development Goals (SDGs) and targets. Comprehensive and contextualized analysis of Sendai Framework data, national loss accounting data and additional data (e.g. health, water, education, inequality), examining synergies and trade-offs, transitions and interactions with systemic risks and resilience.

II. An investigation and examination of exposure, as well as vulnerabilities – including of social-ecological systems – and its dynamic characteristics. The PART will include exploration of our evolving understanding of their relationship to risk, including systemic risks.

III. PART III will examine behavioural aspects of understanding and managing risk and uncertainty. It will explore how risk perception drives behaviour and decision-making, and how this could be considered in effectively communicating risk and designing disaster risk reduction interventions.

IV. An exploration of effective, emergent systems-based approaches to systemic risk assessment, management and governance for sustainable and resilient societies and ecosystems. Through known and vetted practices and case studies, this PART will examine the solution space. It will highlight successes in fomenting societal transitions and explore overarching principles that can guide such systems-level transformations, navigate trade-offs, and provide examples of effective approaches to bring forward portfolios of solutions.

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STRUCTURE

PART I – Reaching the Target - *Realising the outcome, goal and targets of the Sendai Framework, the 2030 Agenda and risk-informed sustainable development*

PART I will assess the current state of progress by countries towards achieving the goals and targets of the Sendai Framework and the 2030 Agenda, seven years after their adoption. It will examine synergies and trade-offs that may ensue in pursuing resilient and risk-informed development pathways.

PART I will showcase practices that have been successful in preventing, reducing and managing risk and losses and will undertake a comprehensive and contextualized analysis of the progress made by countries towards realising the outcome of the Sendai Framework:

The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.

Chapter 1 – Aiming for the Targets - *What does national reporting data and good practices tell us about national progress towards achieving Sendai targets*

CLA: UNDRR Bonn Team

Chapter 1 of PART I will present the current state of progress regarding the implementation of the Sendai Framework and its global targets, putting forward global, regional and national disaster loss and impact trends. Assessment of disaster losses will, to the degree possible, go beyond direct losses to include indirect losses also.

1.1 Global, regional and national disaster loss and impact trends

CA: UNDRR Bonn Team

To assess if countries and communities are on track in reaching the outcome, goal and global targets of the Sendai Framework and the 2030 Agenda, GAR 2022 represents a more comprehensive picture of losses and impact. This will be consistent with the expanded scope of the Sendai Framework, to include impact and losses from environmental, biological and technological hazards where reported.

Progress in achieving the global targets of the Sendai Framework and disaster-related SDGs will be undertaken using data and information submitted through the Sendai Framework Monitor and the SDG reporting mechanism, and where relevant, metrics and data pertaining to the Paris Agreement.

This PART will explore efforts undertaken by countries to fulfil monitoring and reporting commitments to the global targets, as well as developing and retrofitting national loss accounting systems and developing disaster-related statistics. Preliminary analysis of the evolution of disaster losses as compared with baseline data from the HFA decade 2005-2015 will be presented.

This will also provide, and outline data gaps and country needs across the reporting mechanisms of the main frameworks – demonstrating the importance of integration and the interlinkages between the Sendai

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Framework, the 2030 Agenda, as well as data, geography, big data, leveraging digital transformation. This would be a common theme of this Chapter and the next one following.

1.2 Quantifying indirect losses and impacts of disasters – building the picture of systemic consequences

CA: UNDRR Bonn Team – need further CA Risk Analysis and Academic Institutions

To assess if countries and communities are on the right track in reaching the outcome, goal and global targets of the Sendai Framework and the 2030 Agenda, GAR 2022 showcases efforts in quantifying long-term, indirect impacts of disasters. Although not mandatory reporting by countries, appropriate prioritisation of risk reducing actions is impossible without a more complete understanding of indirect losses and impacts of a disaster.

Measurement of indirect losses is not undertaken by all countries, and where this is undertaken, methodologies and approaches vary significantly between States. In the absence of a globally comparable methodology, case studies and analysis of common denominators between countries will provide insights into the impacts of given disasters.

This subchapter starts with a wider and broader angle to examine what is being done and then narrows down, building the basis for the next subchapter as to how indirect losses are currently being measured and considered, and thus contributing to a better understanding of systemic risks and cascading losses.

1.3 Case studies and best practices in reducing risk and loss trends

CA: UNDRR Bonn Team; UN DESA; GEO; IRD

This subchapter proposes to examine cases and practices that have been successful in preventing, reducing and managing risk and losses. Qualitative analysis of progress in achieving targets included in national disaster risk reduction (DRR) strategies – as reported using nationally-determined custom indicators – will also be presented, and where available, analysis of sub-national reporting on progress will provide a local perspective on global efforts to achieve the outcomes, goals and targets set in 2015.

It is proposed that case studies presented here provide the recurring themes that will build the common conclusions that will resurface continuously throughout the GAR22. This could include ecosystem of data, digital transformation, nature-based solutions, optimal decision-making processes, etc.

1.4 What does risk-related data from the SDGs and the Paris Agreement show?

CA: UNDRR Bonn Team; Prof. Bali Swain (Stockholm School of Economics); UN DESA; GEO Community (tbc)

This subchapter reflects on the positive impacts that implementation the Sendai Framework has had on the successes of other frameworks and agreements; including the 2030 Agenda, the Paris Agreement, the SAMOA Pathway and the New Urban Agenda among others. The subchapter will look at not only at disaster-related data from the SDG reporting mechanism, and relevant metrics and data pertaining to the Paris Agreement to complement the global picture of progress in realising the Sendai Framework targets, but also data from other related indicators (e.g., poverty, clean water and sanitation, etc.). This subchapter

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proposes to focus on these additional data sources to provide a more comprehensive analysis of progress and identify gaps or where extra effort is needed to accelerate action.

This subchapter also sets the tone for Chapter 2 by looking at synergies and interlinkages among these frameworks. Promoting a discussion on synergies and difficult trade-offs for risk and focusing on positive interventions - what works, what can be used to provide forward-looking recommendations.

Chapter 2 – Interlinkages and Synergies in pursuing risk-resilient development pathways

CLA: UN DESA, UN-GGIM, UNDRR SAMSFI Branch; UNDRR NY

Chapter 2 will focus on where sustainable development meets disaster risk reduction to create risk-resilient development pathways. In order to achieve the Targets of the Sendai Framework, State and non-state actors at national and local level should prioritize action which both accelerates sustainable development and creates or builds resilience, but at minima does not create additional risk. However, global action to meet the SDGs is not advancing at the speed nor scale required to deliver the goals by 2030. This prompted the UN Secretary-General to mark 2020 as the beginning of the 'Decade of Action' that 'calls for accelerating sustainable solutions to all the world's biggest challenges - ranging from poverty and gender to climate change, inequality and closing the finance gap'[16].

The chapter will assess the interlinkages and synergies in pursuing risk-resilient development pathways, examining challenges as well as success stories. It will provide recommendations for countries to consider in their efforts to simultaneously realise the goals and targets of the 2030 Agenda and the Sendai Framework by 2030, in the context of the climate emergency and imperilled ecological systems. By building on the global picture and the themes developed in Chapter 1, this chapter will provide focus on the synergies and interlinkages based on analysis conducted at sub-national / national levels in selected countries.

The analysis will provide the positive framing to understand interlinkages and synergies in instances where the pursuit of sustainable development outcomes has supported increased resilience and reduction of risk, or vice versa, where approaches to reduce risk and increase resilience to natural and man-made hazards and risks have supported positive sustainable development outcomes, establishing the 'win-win' scenario.

This chapter will seek to leverage existing data sets and tools, including those available in the UN Open SDG Data Hub, and capabilities in modelling and assessing synergies and trade-offs within the SDGs, so that these capabilities can be applied in an expanded analysis of Sendai Framework datasets. This will commission research through 'call for papers' and other innovative mechanisms of challenges and hackathon etc. to provide additional background and case studies.

Moreover, the chapter will enable discussion into the lessons learnt from Covid-19, including from preparation and activities of previous preparedness activities that led to positive outcomes and reduced impact in countries and in terms of progress towards the SDGs.

[16] https://www.un.org/sustainabledevelopment/decade-of-action/

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2.1 Interlinkages and Synergies – possibilities and trade-offs in pursuing the global goals and building resilience

CAs: UN DESA Statistics Division; SDSN; GEO Community represented by IRD France; UNGGIM; Prof. Ranjula Bali Swain; Future Earth (TBC); UNDRR NY

The UN Global Sustainable Development Report (GSDR) 2019 stressed the need to transform key areas of human activity, which could otherwise lead to systems failure – including in respect of food, energy, consumption and production, and cities – and increase resilience to economic shocks and disasters caused by natural and man-made hazards, through active implementation of the Sendai Framework.

As GAR 2019 highlighted, the nature of risk is systemic, joined-up, cascading. One type of risk can transform into another or expose and exacerbate existing vulnerabilities. COVID-19 has revealed the precarious nature of the systems upon which trade, food, energy, transportation, and social safety nets depend. The COVID-19 pandemic is a dramatic demonstration of how a risk in one area impacts other risks and may expose and exacerbate existing vulnerabilities. Moreover, COVID-19 has highlighted the urgent and critical need for data, statistical and geospatial information, traditional and non-traditional to fully implement – as well as monitor progress in realising – the SDGs, decision makers everywhere need data and statistics that are accurate, timely, sufficiently disaggregated, interoperable, relevant, open and easy to use, so that informed decisions on risk can be made; irrespective of whether it is a decision-maker at the highest policy or political level or the individual public. In illuminating the interlinkages between the SDGs and the Sendai Framework, countries can develop their capacity to enable the transformation towards sustainable and effective risk management institutions and approaches.

The goal of the transformation is the decoupling of economic activity from environmental degradation, in other words, shifting from an unsustainable development model to a risk-informed one that restores and regenerates natural systems to ensure that 'no ecosystem is left behind'. The resilience and stability of natural ecosystems, their restoration and regeneration are of imperative if systemic risks are to be managed.

Through quantitative assessment and correlative analysis, the GAR 2022 aims to discern relationships between efforts pursuing the global targets of the SDGs and the Sendai Framework. It will support a body of work that will continue in successive GARs through to 2030, and which seeks to identify outcomes of such efforts.

PART of this discussion will include identifying how to mitigate the trade-offs that are often encountered by countries, where the pursuit of sustainable development outcomes has resulted in an increase in risk and diminished resilience, or vice versa, where approaches to reduce risk and increase resilience to natural and man-made hazards and risks have reduced risk but impeded realisation of positive sustainable development outcomes.

One possible way to assess the interlinkages, synergies and trade-offs arising when simultaneously accelerating activity to realise the targets of the SDGs and the Sendai Framework is to use the systems approach to sustainability[17]. This puts sustainable development at the intersection of goals attributed to

[17] UNDRR will engage competent bodies and authorities in the determination of an appropriate methodology to achieve the stated objectives.

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environmental, economic and social systems, in other words the intersection between natural and manufactured capital. This has been done in various studies regarding synergies and trade-offs within the SDGs and provides a basis to understand the metrics 'to trade with' and demonstrate how these metrics strengthen and/or weaken resilience.

GAR 2022 proposes to examine trends in the SDGs against progress in achieving Sendai Framework global targets. The analysis of data and information pertaining to disaster risk reduction and sustainable development and the implementation of the Sendai Framework and the 2030 Agenda provides evidence of how progress towards one goal or target – or the lack of it – may impact risk and resilience, or vice versa. There is a gap between the measurement and monitoring of the Sendai Framework and the SDGs, but one that GAR 2022 can help illuminate by examining the interlinkages and synergies, while demonstrating how the SDGs can complement the implementation of the Sendai Framework.

The ultimate goal is the determination of win-win scenarios for risk-informed sustainable, regenerative development pathways, by applying a risk lens to the SDGs. The analysis will leverage statistical, geospatial and earth observation data, as well as disaster loss data. In particular, the analysis will benefit from the data in the Open SDG Data Hub, a system of national data hubs on SDGs, where each country-owned data hub contains geospatially-enabled datasets pertaining to specific SDG indicators, allowing for the integration of multiple data layers. The Open SDG Data Hub will facilitate the exploration, analysis, and use of SDG data and statistics that are now available at the global, national and subnational levels.

PARTners include: the Statistics Division of DESA, as the custodian of both the official global SDG indicator database and the UN SDG Open Data Hub, and leading the work on geospatial information in the UN; the Group on Earth Observations, UNDP Human Development Report and Multidimensional Poverty Index Office;, Scientific and academic partners including from the Future Earth community, the International Council for Science.

2.2 Synergies and interlinkages – possibilities and trade-offs in pursuing the Paris Agreement and the SDGs and the implications for the Sendai Framework

CAs: Diana Liverman, Regents' Professor, School of Geography and Development and IPCC lead author (TBC); Aromar Revi, IPCC author (TBC); UNDRR Bonn Team

Consideration of climate change modifiers is implicit in analysis of synergies and trade-offs, not least in analysis of efforts to achieve the targets of the Sendai Framework and SDG 13 on 'Climate Action'. GAR 2022 acknowledges the severity of the climate crisis and will establish links with the findings of the ongoing IPCC assessment and analysis. Notably in respect of 'synergies and trade-offs between the SDGs and the Paris Agreement towards climate resilient sustainable development pathways', which will be featured in the IPCC 6th Assessment Report (AR6), due to be released in 2022 and inform the first global stocktake under the Paris Agreement.

The subchapter will assess the implications of such synergies and trade-offs for reaching the Sendai Framework global targets, specifically in relation to adaptation pathways. Analysis will address transformation and economic diversification, technologies, and strategies that strengthen resilience, reduce inequalities, and improve climate-related human wellbeing, as well as the synthesis of risks and

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levels of adaptation in climate resilient pathways - a focus of the AR6 as underlying systemic drivers of disaster risk and resilience.

The subchapter will also identify interlinkages between the Sendai Framework and the SDGs in relation to the Climate Change goal, illustrate concrete ideas and provide case studies to showcase good practice.

This subchapter may also assess synergies with environmental conventions monitored under UN Environment, IPBES among others, as well as the SAMOA Pathway, the New Urban Agenda, health-related conventions addressing climate change etc.

2.3 Policy agendas separated by shared outcomes – how distinct frameworks provide opportunities, and how to align these opportunities

CAs: UNDRR SAMSFI; UNDRR Regional Offices**;** National Sendai Framework FPs; UNDRR Bonn Team; Stephane Hallegate, WB (TBC)

The subchapter will provide real-world examples of the application of a risk lens to the SDGs, by showcasing how government counterparts struggle and have solved the oft divided SDG, disaster risk and climate change agendas at country level. A division that hampers implementation despite the urgency brought by the climate crisis.

Although at global level there are calls for a common agenda to pursue risk-informed and climate resilient development pathways as the only feasible way forward while ensuring that no one is left behind, and that we avoid ecological systems collapse, at the national level, funding streams and institutional responsibilities are often separated, departmentalised. The pursuit of sustainable development, climate change mitigation and adaptation and disaster risk reduction are thus commonly pursued independent of each other, with corollary trade-offs often missed or ignored.

This subchapter proposes to explore from a national government perspective, common drivers of the siloed approach to the three agendas at national level as well as the most damaging trade-offs that manifest. The cases will be provided by national Sendai Framework Focal Points and will be complemented by accounts of institutions coordinating work on climate change adaptation and sustainable development.

The subchapter will explore examples of successful integration and creation of synergies between the agendas at national level. It will analyse the pre-conditions driving integration, and present recommendations for replication in other country contexts.

It will address gaps in the SDG/Sendai Framework analysis and foster coherence between the two frameworks – and interlinkages with other frameworks. It will further provide practical examples at the country level and complement the analysis through new sources to augment traditional data sources, such as earth observations, new technologies and data streams (for example data from contact tracing, citizen science etc.).

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2.4 Breaking the cycle of trade-offs for a win-win

CAs: UN Economic Commissions; UN DESA; think tanks, academic institutions, UNDRR Bonn Team

GAR 2022 will make recommendations to policy-makers and practitioners as to how trade-offs and implementation delays can be minimised while promoting positive interlinkages and synergies. It will also suggest how implementation can be accelerated, all the while promoting the wellbeing of humans and ecological systems.

Such recommendations seek to support decision-makers in cultivating strategies and activities that generate interlinkages and synergies that do not exacerbate risk but strengthen capacity towards risk awareness and mitigation and helping 'break the cycle of trade-offs for a win-win'.

Bridging this gap will be enabled by the broader opportunities provided by digital transformation, frameworks and associated technologies towards achieving 'win-win' scenarios.

One such transformative technology is the UN DESA Open SDG Data Hub – a principal partner for this chapter – which promotes the exploration, analysis, and use of authoritative SDG data sources for evidence-based decision-making and advocacy. Its goal is to enable data providers, managers and users to discover, understand, and communicate patterns and interrelationships in the wealth of SDG data and statistics that are now available. These national, traditional, public sector data can be complemented with additional data sources, such as those curated by UN SDSN, citizen science and others to provide a more complete analysis to bridge the gaps and limitations of the management of risk data currently.

Advances within global geospatial information management can also inform the strengthening of risk capacity. Through the implementation of the Global Fundamental Geospatial Data Themes[18], a minimum set of fundamental data themes that enable the measurement, monitoring and management of sustainable development in a consistent way over time and to facilitate evidence-based decision-making and policy-making, also of relevance is the Integrated Geospatial Information Framework[19], as highlighted in GAR 2019, as a basis and guide for developing, integrating, strengthening and maximizing geospatial information management and related resources in all countries.

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[18] http://ggim.un.org/meetings/GGIM-committee/9th-Session/documents/Fundamental_Data_Publication.pdf and E/C.20/14/Add.1

[19] https://ggim.un.org/igif

PART II – Unpacking and revealing characteristics of vulnerability, exposure and managing systemic risks

Much of PART I of the GAR 2019 on risk trends focused on presenting the hazard landscape – introducing additional biological, environmental and technological hazards and risks and opening the door to new ways of understanding exposure and vulnerability. PART II of GAR 2022 proposes to assess trends and distributions in vulnerability and exposure, including an examination of underlying drivers and triggers, and emerging approaches to understanding those elements as they drive all forms of risk.

This part will honour the fact that many jurisdictions and actors are trying to do well by their constituents and that they are using risk information resources that suit their needs and are at their disposal. In some cases, these may facilitate systemic perspectives or systemic risk reduction. Whereas PART IV will delve into systemic risk governance, PART II will start from the present and seek to project how existing practices and ways of working can be extended to eventually form the foundation of that systemic governance.

This involves integrated thinking about risk and harnessing risk information across different global frameworks and indicators that can be used to compare outcomes and changes over time – among and within countries and households. This can examine the dynamics of exposure and vulnerability through case studies on, for example, climate change effects on security, migration, agricultural production to human health and biodiversity etc.

Chapter 3 – No more magic numbers

CLAs: Graham Turner (Melbourne Sustainable Society Institute) with support from Susanne Hanger-Kopp (IIASA), Ilcheong Yi (UNRISD)

Policy-makers seek certainty about the future and turn to risk assessments to compensate for the anxiety they may feel about making choices that will affect the communities they represent or to meet the requirements of strategies or plans that require them. But risk is complex and assessments from one year may not be valid the next year or may assess hazards, elements of exposure or vulnerability that are no longer relevant to the new context. Or they may fail to take into consideration the realities of the complex networks of systems that propel us into unseen new risk but also that buffer some of us from events that might be disasters in their absence.

Examples of changes to drivers we have long taken as static assumptions: Climate Change effects, changes in government, economic growth or crash, major infrastructure projects, construction of an airport or opening a canal must cause us to fundamentally reassess everything.

3.1 Why is it so hard to get risk assessment right?

Risk assessment is not difficult. But it is very difficult to assess risk in a way that meets the needs of decision-makers, addresses the limitations they face, connects to the policy and resource constraints under which they operate, communicate probability in ways that produce clear options, take into consideration the needs of the most vulnerable, incorporate drivers that are not well understood and anticipate highly

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unlikely events that could be catastrophically damaging. One of the by-products of COVID-19, there will be intense academic and political interest in formulating scientific, modern processes and methods that will make sure that we never miss the signals of another event of that scale. That a sufficiently rigorous scientific approach could anticipate and permit risk management of future events at the edges of probability is a false hope –the edges are multiplying as systems interconnect ever more intimately.

The most practical course of action is to step back and address the question from principles and the foundations that underpin our understanding. This was started in GAR 2019 with the emphasis in Chapter 2 on the systemic nature of risk and the importance of seeking to manage risk systemically. Systemic risk governance is an ideal end-point of a fundamental re-assessment of both the inputs and the processing of information – it is not simply a new set of ingredients to mix in new ways. But we must have a starting point today, and the starting point is not from a hopeless position. Phenomena like COVID-19 and Climate Change have demonstrated to all but the most intentionally obtuse that one thing is not just connected to the other, but that almost everything is part of multiple, overlapping and interconnected webs and that decisions in one domain do affect outcomes in others. Even risk assessment is seeking to engage richer sources of information, blending local and global datasets and using multi-comparison modelling to project probabilities of changes over time.

3.2 Dynamic drivers of risk

Evaluation of the pace of change and how it creates moving targets for risk assessment. The economies of Bangladesh, Côte d'Ivoire and Rwanda have been growing more than 5% per year for most of the past decade; rates that would be the envy of any Minister of Finance, and imply dramatic compound changes in physical exposure alone, to say nothing of the ways employment, food security or informal settlement are affected. Insurance penetration rates in the same countries of less than 2% give an indication of the growing gap in protection – in this case, only as it relates to risk transfer. Comparing those growth rates to public expenditure in risk reduction reveals a starker prospect for managing shocks – particularly those that transcend individual sectors or that implicate cross-border collaboration.

Taking a broader view of economic growth as a driver of risk is perhaps the simplest case. Dynamics related to irreversible changes caused by climate change are decidedly more complex. Further complicating the matter is that many of the drivers are highly contextual. Air quality concerns prompt very different decisions in Korea, Australia and Poland. Aging infrastructure has different implications in Montreal, Genoa and Port-au-Prince.

The tools to measure these drivers are also not well developed nor do they have clear connections to each other. Stock-and-flow models can be useful heuristics for understanding how systems interconnect and have been used to teach systems modelling to secondary school students. Rather than providing solutions, they rather give a sense of the scale of the problem.

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3.3 Complexity and uncertainty

[Link to PART III] [Link to GAR 2019 Chapter 2] Understanding risk, let alone managing it requires a different mindset than we have previously used to approach it. GAR 2019 highlighted that most risk is complex (not simply complicated) – what does this mean in practice? This section will include, inter alia, discussion of the interaction among hazards, lag times (extinction debt and carbon debt as time-bombs of future impact) and the difficulty of modelling in circumstances of unprecedented uncertainty.

Political decision-making often implies striking a very fine balance between what is possible, affordable, practical and popular. Politicians are accustomed to navigating these perilous waters through digestible, accessible principles and mnemonics that nonetheless validate their political leanings. Insisting on the inherent unknowability of future states will do nothing to support risk informed decision-making.

There are options. One is to treat decision-making as being about risk and not as the sole purview of politicians or even governments. Making more actors informed about risk will both enable better informed decisions at all levels but will reinforce an expectation of the same from governments. Another option is to think about ways to make complex considerations about risk more easily internalized and accommodated.

Preview of arguments about epistemic uncertainty and uncertainty as a barrier to individual and collective decision-making forthcoming in PART III.

3.4 Tipping points

The question of carbon debt and extinction debt leads smoothly to the effect of tipping points on the both our understanding of risk as well as appetites for and hopelessness about addressing risk beyond the frontiers of reliable models [Link to PART IV, Chapters 11 and 13]. This section will treat the planetary boundaries (possibly linked to doughnut economics) as they relate to conventional risk assessment. The trends we have been accustomed to tracking to understand risk are beyond the models.

1. Climate change
2. Biodiversity loss
3. Biogeochemical
4. Ocean acidification
5. Land use
6. Fresh water
7. Ozone depletion
8. Atmospheric aerosols
9. Chemical pollution
10. Plant production
11. Social floor

Risk assessments that produce magic numbers without explicitly highlighting their limitations, context and validity, are more dangerous than no risk assessment at all; they can lead to a false sense of certainty that well-meaning risk reduction actions will solve the risk.

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Chapter 4 – Trends in understanding risk

CLAs: Alonso Brenes (CLACSO Global Ambiental) with support from Carolina Adler (Mountain Research Institute), John Rees (British Geological Survey), Katie McPherson (City of Vancouver)

The next steps include not simply disabusing decision-makers of their expectations of magic numbers that will salve their helplessness at not being able to know everything; but of supporting them in re-discovering what models, statistics and projections can do. Even with limited analysis or processing power, there are some decisions that are decidedly overbalanced toward risk creation such as cutting social services, fracking fossil fuels, building on floodplains. Finding ways to both reinforce incentives and insist upon transparently evidence-based decisions would be a massive advancement in the reduction of risk.

4.1 Trends in understanding hazard

How is global understanding of hazard changing? Have some parts of this research peaked? Are others forgotten or emerging? Risk assessment depends on a scientific approach to understanding hazard, what are the implications for deterministic and a priori hazards? To what extent are scenarios useful? Does the fact that we have transgressed some planetary boundaries affect our understanding? How are hazards understood from a public safety perspective? Is hazard-agnostic probability of impact assessment a useful way of bypassing the challenge of understanding all the drivers of all hazards? What lessons can we draw from the way communities understand the hazards they face?

4.2 Trends in understanding exposure

[Link to GAR 2019 Chapter 3] Understanding exposure has often been limited to identifying where the major assets of the world are located and what purpose they have and what they are worth. This has been of keen interest to insurance companies and for cost-benefit calculations but falls dramatically short when seeking to understand drought, epidemic, plant blights and other events that have largely indirect impact to say nothing of compound, complex and cascading events. Economic calculations of exposure are limiting and depersonalizing and measuring Disability Adjusted Life Years (DALY) lost is distasteful for other reasons. But it is important to try to be more complete in our understanding both to increase accuracy of our understanding of risk and to pay appropriate respect to the value of those people or things at risk. Where are the biggest unmeasured sources of exposure and what can be done to fill the gap?

4.3 Trends in understanding vulnerability

[Link to GAR 2019, Chapter 3] Understanding vulnerability as it relates to risk requires integration of concepts from a host of disciplines not typically connected to risk science. Understanding hazard is hard enough and the metrics from development economics, social work, epidemiology and agriculture do not translate naturally to existing ways of working. The fact that human vulnerability is multi-layered, compounding and very hard to map could help explain why it has not crossed over easily. But not measuring it is doing nothing for the accuracy of risk assessment and not managing it systematically produces more and different kinds of vulnerability.

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4.4 Understanding systemic risk; best practice from sectors and regions

[Link to PART IV] Coming to grips with risk that is, by its nature, systemic may not happen with a great disruptive revolution toward risk governance regimes – many sectors and jurisdictions are managing and reducing risk now and we can learn from their examples.

Some sectors are better able to understand and explain risk in their own limited context and in their own terms. This subchapter will explore what we can learn from sectors such as public health where the consideration of political dimensions, behavioural economics and surveillance and monitoring systems consider not only response but risk reduction. The engineers that plan the system that ensures steady flows of electrical power are accustomed to adapting to known and novels strains on the robustness of the networks they manage. They anticipate, stress-test and largely manage to avoid catastrophic failures. There are similar lessons from municipalities, where ministry siloes, and partisan politics can be more muted and the decision-makers are closer to their constituencies. What other sectors or jurisdictions can serve instructive lessons in thinking and working to reduce risk systemically?

Chapter 5 – The state of risk information

CLA: TBD

[Link to GAR 2019 Chapter 5] [Link to PART IV Chapter 11] What is the current state of risk information for risk reduction? The modernist interpretation is that the limits of our ability to understand risk are technological, scientific or methodological – and those may indeed be important boundaries – but are there other ways of understanding what we know today, what is proximal and what seems impossible?

5.1 What impact data can explain about risk

CAs: Tom de Groeve (EC JRC) TBC; Risk Modelling Steering Group, Insurance Development Forum TBC

[Link to PART I] [Link to PART III (the parts that will discuss preference for perceived certainty and recency bias)] [Link to Chapter 3 – planetary boundaries] Disaster impact is *ex post facto*, but it has been instructive of our projections of risk. UNDRR's own global risk model used to link recent experienced losses with modelled return periods spanning hundreds of years to yield hybrid loss exceedance figures. Under stable conditions, with a handful of natural hazards and proxy calculations of economic value of the losses, it projected what the average annual loss a country could expect to suffer in a given year as well as probable maximum loss. This model – and many insurance models like it are defensible because they are controllable, based on past conditions and produced economic figures. What can it show us about the future? How will impact assessment of climate change, COVID-19, Fukushima, teach us about *ex ante* risk?

5.2 Shortcuts and thin slices

CA: Global Earthquake Model (GEM) TBC

[Link to GRAF and National Pilot] Measuring disaster impact (past) or disaster risk (future) always implies aggregates and averages. How can risk assessment make better use of more granular data or broader, richer global information? (Example from UNDRR ACP-EU project with schools in UR Tanzania). Member States, communities and individuals have data that could be useful to understand risk, but it is often

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heterogenous, disparate, locked or unknown. What can be done to support collection and use of more sources of data? How can its systematization be stimulated? This will likely imply concessions in rigour in favour of breadth. Just as resources are shared unequally across states, communities and even households; how do we reduce risk for everyone when the data rarely reaches that level?

What do proxies and thin slices impart and what do they sacrifice?

5.3 Information availability and gaps

A genie's lamp offers all the data and information needed to understand risk perfectly and craft excellent decisions. What do you ask for that which doesn't currently exist? If you are an urban planner? If you are a mutual insurance operator? If you are a programme chief for the United Nations in a particular country? If you are a municipal fire chief or curriculum planner? The availability of some kinds of information is instructive itself. Randomized cell tower signals, aggregated trend data, Internet of Things, sentiment analysis all hold great promise for learning more about key elements of risk, but they are all extensions of the modernist's illusion.

This subchapter will also explore practical ways to include stakeholders who have not historically been part of risk reduction practice, how to connect good intentions with the policies, resources and multipliers that will empower them to contribute. Further, how to build on stakeholders decision-making priorities to link their capacity to risk information for good decisions.

Chapter 6 – Managing the drivers of risk

CLAs: John Rees (British Geological Survey) and GRAF Working Group on Exposure and Vulnerability, Connie Bayudan, Daniel Aldrich (Northeaster University)

6.1 Best practice in managing hazards

Experience from jurisdictions that have taken steps to manage hazards. This is particularly interesting in cases where it takes place without the catalysing impetus of a major event. Cases that specifically seek to mitigate anthropogenic hazards are equally interesting and good cases will be instructive. The most interesting prospect is when hazard reduction is integrated into political budget/planning for the long term and where hazard management is integrated into society/culture.

- Examples from Forecast Based Financing as a tool for motivating community-driven risk reduction.
- Hazard reduction linked to school curricula or public messaging.
- Hazard reduction that drives other development agenda priorities.

6.2 Best practice in managing exposure

CAs: IDF; UNDP TBD

[Link to PART IV about burden-shifting and formulating holistic risk governance systems for an unknown future] Managing exposure is challenging because it is difficult to do without sacrificing growth. In some cases, generating new exposure is limited in particularly dangerous sectors or regions – typically after a transformative event. It is frequently seen as anti-growth, something that has recently been highly

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unpopular and effectively impossible for countries receiving structural assistance from major development banks. In other cases, it is very creative.

But managing exposure is also people-centred and aligned to many of the Sustainable Development Goals. Is it only for developing countries? There is research regarding priority setting and finding practical paths to achieve environmental targets while also protecting food security and biodiversity.

This sub-chapter will also examine the role of insurance and project finance in promoting resilient behaviour.

6.3 Best practice in managing vulnerability

Managing vulnerability without adding new vulnerability is very elusive in risk governance. In an age when public funding for reducing vulnerability is frequently the first cut from the budget, what are good examples of ways to reduce or manage vulnerability? Social bonds and community culture appear to be an important possibility. Challenges related to addressing the highest number of vulnerable people versus the people who are most vulnerable divide perspectives in many jurisdictions. How is the value of supporting vulnerable people rationalized as a priority against others?

What of non-human vulnerability? How are vulnerable systems such as food security, cold-chain protected? How do farmers protect vulnerable assets?

How has COVID-19 prompted evaluations of systemic vulnerability from sectors that may not have given it much thought?

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PART III – Risk informed decision making in the context of uncertainty

Over the past several decades, empirical studies have been undertaken as to how individuals and institutions behave with respect to threats and disasters. The nature of the information and how the general public, key decision makers and communities respond to them will vary depending on the culture, the key issues facing their country and the agendas and values of key stakeholders. Leaders from the private and public sectors have communicated ways for those at risk to protect themselves against the consequences of future disasters in ways that reflect their values and agendas. Despite these efforts, many residents in hazard-prone areas do not invest in disaster risk reduction (DRR) measures. One reason why individuals underprepare for disasters can be found in the psychology of how humans consume and process information.

In his thought-provoking book *Thinking, Fast and Slow*,[20] Nobel Laureate Daniel Kahneman highlighted two modes of thinking based on research in psychology and behavioral economics over the past 50 years. *Intuitive thinking* (System 1) operates automatically and quickly with little or no effort and no voluntary control. It is often guided by emotional reactions and rules of thumb that have been acquired by personal experience and social influences. *Deliberative thinking* (System 2) allocates attention to effortful and intentional mental activities where individuals undertake trade-offs, recognize relevant interdependencies and the need for coordination. Intuitive thinking works well for decisions where one has considerable experience, such as knowing when to brake if a car slows down in front of you. It does very poorly when individuals have had limited past experience, as is true for disasters due to natural hazards. Figure 1 depicts the factors influencing decision making based on these two modes of behavior.

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[20] Kahneman, D. (2011). *Thinking, Fast and Slow*. New York, Farrar, Straus and Giroux

System 1 operates automatically and quickly with little or no effort

- Individuals use simple associations including emotional reactions
- Highlight importance of recent past experience
- Basis for systematic judgmental biases and simplified decision rules

System 2 allocates attention to effortful and intentional mental activities

- Individuals undertake trade-offs implicit in benefit-cost analysis
- Recognizes relevant interconnectedness and need for coordination
- Focuses on long-term strategies for coping with extreme events

With respect to the complex landscape of risk and its cascading and systemic impacts, those in hazard-prone areas who have had limited personal experience and face great levels of uncertainty can be disadvantaged by reliance on their emotions and cognitive biases in determining whether to act on the risk they face and undertake DRR measures. Although emotion and intuitive responses are critical in responding to an impending crisis, there is a tendency to ignore low probability risks until a disaster occurs and only then undertake protective measures because of worry and anxiety about a future similar catastrophe. As the memory of the disaster fades, communal motivations and priorities may shift away from DRR and towards other priorities.

A hallmark of the distinction between the two systems is that our intuition is informed by experience, and our deliberative system incorporates more abstract ideas such as risks that we haven't faced before or more systemic concepts that involve many hazards. When managing disaster risk, we must attend to these more complex concepts, even though our intuitions may not inherently include them. This discrepancy between intuitive and deliberative thinking can explain our tendency to exclude or not focus on risks that have not been previously experienced, and then lose sight of broader contexts and longer-term perspectives once an event occurs.

By understanding why intuitive thinking affects behavior, we can encourage key decision makers to undertake more systematic analysis that involves making trade-offs and developing long-term strategies for managing risk. Making the experiences of other disaster victims feel more real may be one way to communicate the consequences of low-probability events. In this regard, it will be important to frame scenarios so that key decision makers can relate and pay attention to them in their cultural environment. For example, construct scenarios that contrast the positive outcomes of those who prepared for the disaster with those who didn't undertake protective measures. Policies can then be designed to encourage those at risk to invest in DRR measures to prevent or mitigate the impact of future disasters.

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Chapter 7 – Cognitive biases and socio-economic and cultural components that drive risk perception

CLA: Prof. Nick Pidgeon (TBC)

An accurate understanding of how risk perception is shaped is crucial to develop risk information that actually reaches its target audience. But what are the factors that shape and drive risk perception?

7.1 What can we learn from attitudes towards risk?

CA: Andrew Dugan (Gallup Risk Poll)

The subchapter will start with the assessment of global data regarding attitudes towards risk – the most common attitudes, cultural and regional specificities – based on the Gallup World Risk Poll among other data sources. This will provide important insights for the development of risk information and DRR measures, that are tailored to regional and cultural attitudes towards risk.

It will examine how general views of risk and safety vary, by region (culture) and individually (person/country), gauging perceptions of sensitivity to risk of populations considered more socially vulnerable. The subchapter will examine how risks perceptions are formed, reviewing salient demographic/attitudinal factors that are associated with likelihood, and examine the role of past experience and perceived likelihood.

'Big-picture' or long-term, societal-level risks, including artificial intelligence and climate change, will be broached, as well as aspects of trust, who people turn to for risk information.

7.2 How cognitive biases skew the perception of risk

CAs: Michelle Wuckers, Ola Rosling (gapminder foundation) TBC

This subchapter will outline the collective cognitive biases that drive risk perception and the understanding of complex and systemic risks in communities, as well as risk perceptions among decision-makers. Laypeople and experts for example often disagree on risk with differing perceptions of the biggest risks.

7.3 How socio-economic factors skew the perception of risk

CAs: TBD

The subchapter will assess the influences of socio-economic factors such as gender, age, expert knowledge/education, economic income group, cultural factors and experiences that influence risk perception. In heterogenous societies cognitive biases rarely manifest in the same way. These elements must be considered in developing risk information or proposing risk reducing measures. For such tools to have maximum impact implies the need to collect a minimum amount of information about the target audience/end users and then tailor risk communications and risk reducing interventions accordingly.

This subchapter will draw from the realm of behavioural economics, to assess consumption of risk information and acceptance of proposed risk reducing measures in an environment of risk and uncertainty. The characteristics of target audience – such as age, gender, and cognitive needs, professional knowledge and personal experience, as well as initial anchor value (risk information), all have a significant impact in judgement of a risk.

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7.4 Risk perceptions among decision-makers

CAs: Gerard Finnigan (TBC), Ailsa Holloway, ADPC (TBC)

This subchapter will explore how risk information is considered in decision-making, depending on influences at the family/community/societal level (e.g. norms), personal levels of self- and collective-efficacy, physical, cultural, political barriers…

It will test the hypothesis that decision-makers are *as affected by cognitive biases as the recipients of their decisions, hence a double-skewed risk perception at the end of the chain.*

Decision makers tend to miss significant risks. This can be for a multiple reasons: professional deformation – *only seeing familiar risks*, overconfidence – *refusing to consider negative scenarios*, post-purchase rationalisation – *refusing to accept new information*, confirmation bias – *filtering information according to own beliefs*, normalcy bias – *refusing to view alternatives* and many others.

Decision makers significantly overestimate or underestimate probabilities and potential impact that risks may have on a decision or an objective. In fact, cognitive biases together with a generally low statistical literacy make estimates about impact and probability borderline useless if not deceitful. Making people rate, rank or undertake qualitative assessment of risks, is little better than guessing.

7.5 How to overcome cognitive factors when communicating risk

Alternative Title: Encouraging risk-informed decision-making and acknowledging cognitive biases

CAs: Andrew Kruczkiewicz (IRI, Columbia University); Meghan Bailey (Red Cross Red Crescent Climate Centre)

The subchapter will assess methods and tools for practitioners to ensure risk information reaches end users and how to strategize to communicate complex risk and uncertainty, considering: communication across different actors (decision-makers, households); different media (face to face, online); trusted sources of information; misinformation, disinformation; and audiences. Irrational decision-making affects the ways in which risk information, including early warnings and alerts for potential extreme climate/weather events and disasters, is internalized and actioned.

This subchapter will highlight the decision pathways within disaster risk reduction practise that are commonly affected by cognitive bias (of which there are many, not all bad), and in so doing either reduce or amplify the utility of risk information. The subchapter will examine decision-making pathways from the perspective of end users, risk information producers, and practitioners.

It will demonstrate this by using real-world examples (including seasonal forecasting in the Sahel, cyclone forecasts in Bangladesh, institutional mimicry blind to efficacy, cognitive dissonance in respect of new information, etc.) and make suggestions for how risk information and early warning systems could be improved by integrating what is known within the field of decision-science and psychology. The subchapter will share practical techniques that can be used to communicate risk successfully, ultimately supporting risk reduction decisions (by all stakeholders) that are robust and less irrational.

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Chapter 8 – Ability to act / Options

CLA: Conor Seyle (One Earth Future Foundation); Julie Downs (Carnegie Mellon University

8.1 Cognitive reasons for attitudes towards risk

CA: Conor Seyle (One Earth Future Foundation)

The subchapter will assess how attitudes towards risk are created: short-termism, risk myopia, etc. - to understand why individuals seek out or avoid information on a particular issue, and how individuals manage uncertainty surrounding an issue that they deem to be important or challenging.

8.2 Decision paralysis, resistance to change and holding on to the familiar

CAs: Nadeja Komendatova (IIASA); Julie Downs (Center for Risk Perception and Communication, Carnegie Mellon University, Pittsburgh)

The subchapter will assess what makes communities able or unable to act, examining individual factors such as self-efficacy as well as socio-economic factors.

The process of implementation of disaster risk reduction measures is a so-called wicked policy process which requires involvement of various stakeholders who might have conflicting opinions and positions. The subchapter is based on the hypothesis that the support of laypeople towards disaster risk reduction, and especially prevention measures, should go beyond passive, social acceptance in top-down governance models to involve participation and initiative. Social acceptance is frequently observed in the case of policy options in which the ability to change or influence is felt to be nil. It is also frequently discussed in frames of the so-called Not-in-My Back-Yard (NIMBY) or Decide-Announce-Defend (DAD) models. This subchapter addresses social and human factors – such as willingness to participate in disaster risk reduction activities (e.g. voluntary organisations, training, implementation of disaster risk reduction practices etc.) – as well as willingness to participate in decision making in, and implementation of, disaster risk reduction measures.

Social acceptance and willingness to participate or to act are both connected with awareness of the need for action. However, awareness does not necessarily lead to an active position, to willingness to act (especially if it relates to a change in the daily routine), nor to a change in behavioural practices. This subchapter discusses drivers of the move from awareness to willingness to act. These factors are related to how people are making choices and what is influencing their choices. The subchapter explores preferences and rationalities when it comes to available alternatives. It will also feature examples of how various rationalities (e.g. economic) influence people's choices and their willingness to act.

Based on cognitive patterns and world views, stakeholders have several options to select from available alternatives (when such alternatives exist). Many methods exist to help understand the process of decision-making and choice among available alternatives. The methodological basis of this subchapter draws inter alia from theories of: planned behaviour, reasoned actions, human belief model, social cognitive theory and discourse analysis.

Various methods will be employed to understand social and behavioural factors as well as conflicting positions of various stakeholders, and may include games, multi-criteria decision analysis, discourse analysis among others. The method of games was developed to raise awareness and to teach about certain societal issues and was further expanded to the research area to provide understanding of stakeholders'

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choices and reasoning. The multi-criteria decision analysis allows evaluation of various conflicting criteria in the decision-making process of one person or for various groups of stakeholders. The method can be also used as a mediation tool to develop compromise solutions for conflicting options.

8.3 Options available, choice hierarchies

CA: Walid Afifi (University of California)

The experience of uncertainty – the perceived inability to predict or explain outcomes – is multiplicative (uncertainty about one outcome typically creates uncertainties about others), is subjective (individuals affected by the same disasters experience different levels of uncertainty), is culturally shaped (some social groups are more accustomed to uncertainty than others, thereby respond to it differently), and is generally associated with anxiety and deficits in mental health. It is also a central feature of disasters. For example, one study reported nine types of uncertainty in a community plagued by invisible environmental contaminants, ranging from uncertainty about the level of exposure to a lack of confidence about the financial repercussions of such exposure. More recently, a study of uncertainty experiences during the COVID-19 pandemic revealed elevated levels of uncertainty about a wide range of issues, with uncertainty experiences associated with depression, psychological distress, and dysregulated anger.

Given the centrality of uncertainty in disaster experiences, understanding the ways in which individuals manage these states is critical to promoting community-wide risk reduction efforts. A particular challenge in the context of disasters is that so much of the uncertainty is tied to conditions outside the control of those most impacted by it. Another difficulty is that information – the commonly-believed antidote to uncertainty – often brings about more or new unknowns about the disaster, thereby exacerbating uncertainties.

Three strategies stand out as particularly important to disaster risk management and disaster response. First, recognize the potentially deleterious consequences of incomplete or inconsistent information for uncertainty, and implement a communication strategy that avoids those information traps. Second, critical to successful efforts at buffering the negative effects of uncertainty is the ability for community members to regain a sense of control, even if in contexts secondary to the main area of uncertainty. For example, the anxiety caused by uncertainty about the path of a wildfire is ameliorated by confidence in the ability to escape to a known evacuation site. Effective responses must provide individuals with the efficacy to successfully manage as many secondary or tertiary targets of uncertainty as possible. Finally, individuals often turn to others for assistance in times of uncertainty. Communities with members who have confidence that they can rely on one-another in times of crisis fare better than those who do not. Taking active steps to create structures and communication channels that build a sense of community within and between neighbourhoods in advance of disasters is likely to set a lower ceiling for its negative effects.

This chapter will review these and other protective factors against the most negative effects of uncertainty in the context of disasters. It will also discuss the role of chronic uncertainty in affecting perceptions of risks and related behavioural decisions.

8.4 What do we learn from this?

CAs: Juan Pablo Sarmiento (Florida International University) TBC; Benouar Djillali (Algiers University) TBC; Roger Pulwarty (NOAA) TBC; Fadi Hamdan (TBC);

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[Link to PART II and PART IV] The subchapter explores how attitudes and ability to act can be influenced? How can options be provided to communities where there seem to be none? The DRR community has traditionally focused much of its effort on assessing risks and providing data, information and knowledge on risk that is as accurate as possible. However – and despite advances in the availability and accuracy of risk-related data, models and prediction tools – risk-informed decision-making remains the exception and not the rule. An enhanced understanding of what drives behaviour in the context of known risk can assist decision-makers develop solutions that are not only logical but are cognisant of prevailing risk behaviours, wherein the likelihood of acceptance and implementation is improved.

Chapter 9 – Governance / Institutional influences

CLA: Howard Kunreuther (University of Pennsylvania)

Chapter 9 will build on Chapters 7 and 8 that discuss cognitive biases and how they influence risk perception and will address challenges and opportunities facing key interested parties in getting individuals and communities to invest in protective measures (e.g. risk reduction, mitigation, risk transfer mechanisms) and how to implement them.

9.1 What can decision-makers do to increase chances of acceptance of DRR measures?

CAs: Elke Weber, Princeton University (TBC); Wouter Botzen (University of Amsterdam (TBC)

The sub-chapter will explore biases due to intuitive thinking versus deliberate thinking and decision-making related to disasters. It will outline thinking and decision-making in the face of low probability-high consequence (LP-HC) events or intensive risk-related disasters caused by natural hazards or other (building on concepts from Thinking, Fast and Slow by Kahneman), but also high probability-low consequence events, or extensive risk-related disasters, which however undermine resilience in the long-term, but which accumulated impact is often underestimated. The sub-chapter will explore how those biases change in environments of increased uncertainty.

The sub-chapter will then assess how decision-makers can best involve the general public, private and public sector institutions in developing options for implementing DRR measures such as resettling people, investing in cost-effective protective measures. The policy options for implementing these measures include risk communication, economic incentives, insurance, regulations and new institutions and governance arrangements.

9.2 How do individuals and communities respond to risk and how to improve their decisions

CAs: Robert Meyer (University of Pennsylvania) (TBC), Kate Orkin, Centre for the Study of African Economies

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Individual response patterns to the same problem (risk) often repeat, blind to long-term solutions, because the brain is hardwired as such. This generates short-term responses to risk rather than long-term resilience building. The sub-chapter will provide examples for cognitive biases and heuristics that lead to a failure to invest in disaster risk reduction (DRR) measures such as: myopia (excessive focus on short-term horizons) , optimism (underestimate the risk), simplification (focus only on low probability not consequences prior to a disaster), herding (imitating the behavior of friends and neighbors who also exhibit

The sub-chapter will then address how to address these biases through a behavioral risk audit that highlights the role that choice architecture by reframing the options coupled with economic incentives and regulations can improve decision making by individuals and communities by focusing on long-term solutions. Two examples which the sub-chapter will assess are:

(1) stretching the time horizon to address the *optimism* and *simplification biases*. Individuals pay attention to 1 in 5 chance of a disaster in 25 years but don't focus on 1 in 100 annual probability
(2) long-term loans to spread the upfront costs of cost-effective DRR measures coupled with insurance premium discounts that are lower than the annual costs of loan to address the *myopia bias*.

9.3 How to overcome governance challenges and institutional influences

CAs: Roger Kasperson Clark University (TBC), Paul Slovic, University of Oregon (TBC)

The sub-chapter will provide suggestions and recommendations on how to overcome both governance challenges and institutional influences to create accurate and appropriate risk information and communication that incentivize adoption of cost-effective risk-reducing measures by learning from the coronavirus pandemic.

It will include lessons learned such as listening to the experts (e.g. epidemiologists), recognizing the need to understand biases (e.g. failure to appreciate exponential growth, myopia, optimism) that led to the pandemic, and the importance of national leadership and the role of global organizations (World Health Organization) in managing uncertainty and guiding global, regional and local measures to manage the impact of a pandemic.

The sub-chapter will then apply these lessons to climate change, and provide recommendation such as listening to climate scientists, using the behavioral risk audit to address biases and heuristics and projecting long-term consequences of failure to reduce CO_2 emissions now (e.g. catastrophic disaster losses in the future) These recommendations could be incorporated in global treaties, such as the Paris Agreement, via well-enforced regulations and short-term economic incentives to encourage investments in DRR measures now.

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Chapter 10 – Communicating risk for decision-making, action, and change

CLA: Andrew Revkin (The Earth Institute); Lisa Robinson (BBC Media Action)

10.1 Influencing risk perceptions and creating a positive culture of risk

CA: Lisa Robinson

10.2 Communicating uncertainty (to communities/end users and decision-makers)

CAs: Andrew Revkin (Initiative on Communication & Sustainability, The Earth Institute); Iain Stewart (Plymouth University)

10.3 Managing mis/disinformation, including practical cases (including COVID-19)

CAs: Emmanuel Raju (Copenhagen Center for Disaster Research) TBC

10.4 Informed public dialogue around risk and responsibilities (from individual to government)

CA: Costis Toregas (George Washington University)

10.5 What decision-makers need to consider when designing risk reducing measures in uncertainty

Alternative Title: How science information is valued against other relevant inputs in risk reduction decision-making involving uncertainty

CAs: Anna Steynor (Climate System Analysis Group - CSAG, University of Cape Town) TBC); Mark C. Quigley (University of Melbourne)

[Link to PART IV, Chapter 13] All science contains uncertainty, as do many other relevant inputs that inform risk-based decision-making. This subchapter uses case studies to investigate how scientific inputs were valued against other inputs in contemporary decision-making.

Topics include: What happens when science-based evidence for precautionary approaches to disaster risk conflicts with economic forecast models and other relevant inputs that favour alternative approaches? How does the strength of prevailing scientific evidence and effectiveness of its communication influence the trajectory of decision-making and its enacted decisions? What are the advantages and disadvantages of precautionary decision making with adaptive capacity? Recommendations for decision-makers grappling with multi-input decision-making are offered.

10.6 Cases of widely accepted risk reduction measures addressing systemic risk – sustainable change

CAs: Manny de Guzman (Commissioner of the Philippine Climate Change Commission) TBC; WHO (TBC)

10.7 Cases of risk communication that led to behavioural change

CAs: Pablo Suarez (Pardee School of Global Studies; Red Cross Red Crescent Climate Centre); Rajib Shaw (Keio University)

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PART IV – Managing and governing systemic risks – emergent solutions

Recognising that many decision-makers baulk at the complexity of understanding systemic risks and the challenge of developing systems-based approaches to address multidimensional challenges in contexts of uncertainty, this PART offers an exploration of effective and emergent approaches to managing systemic risks to sustainable and resilient societies and ecosystems.

Whereas the adoption of systems-thinking and systems-based approaches to understanding and managing risk have long existed in some fields – public health management, construction engineering, design schools – other disciplines are increasingly recognizing the imperative to assess, analyse and manage risk using approaches that adopt a systems perspective.

In exploring emerging threats to human and natural systems and the infrastructure upon which these systems are built, GAR 2022 proposes to explore approaches to understanding and managing risk through a systemic lens, emphasising systems-based approaches being employed at differing scales, and examining the consequences for sustainable development, the ramifications for the decision-maker and the institutions, governance and financial architecture in which systemic risk will need to be managed.

Chapter 11 – Understanding and assessing systemic risks

CLAs: Michael Obersteiner (ECI, University of Oxford), Stefan Thurner (Complexity Science Hub)

Building on the enquiry presented in GAR 2019, this Chapter will review the state of the art in approaches to define, characterize, measure and assess systemic risks. Still in its infancy, new approaches to provide material evidence of the very existence of systemic risk are required if the incentives that will drive policy makers to go beyond the conventional view of risk, are to be developed.

The Chapter will present and assess innovations in systemic risk assessment and analysis, including but not restricted to the use of multi-agent systems research, systemic risk modelling, collective decision making, collaborative planning that deals with uncertainty and scenario building. It will support improved learning of systemic risks and promote transdisciplinary approaches, with the goal to develop operational decision support systems that help reduce systemic risk, describe uncertainty, identify spots of ignorance and are robust against potential misinformation.

It will showcase research and demonstrations of how new technologies and science are, and will be, applied in risk assessment for risk reduction. The Chapter will also lay out the role of new data generating observing systems and information systems allowing for bidirectional information flows with risk reduction stakeholders and that seek to enhance learning about systemic risk processes.

The PART will also provide country examples showcasing the outcome of systemic risk assessment as the practical application of the Global Risk Assessment Framework (GRAF).

11.1 Systemic analyses

CAs: Mark Stafford-Smith (CSIRO); Celine Rozenblat (University of Lausanne) TBC

The subchapter will examine transdisciplinary science and research for systems-based decision making; complexity science and systemic risk assessment; and examine definitions of systemic risk that will guide this PART.

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11.2 Characterisation, measurement and assessment of systemic risks

CAs: Franziska Gaupp (IIASA); Michael Obersteiner (ECI, University of Oxford).

Fostering transformative change towards resilient societies - using systems analysis (and quantitative and qualitative modelling tools). Core elements to include:

- Characterizing types of systemic risk – illustrated by simple, multi-scalar examples and building on GAR 2019.
- Qualitative and quantitative methods and tools describing systemic risks.
- Theory and practice of measurement of systemic risk.
- Role of uncertainty and ignorance in systemic risks, including concepts of learning.

Use cases : From assessment to accessible decision support in systemic risk reduction

CAs: Stefan Thurner (Complexity Science Hub) ; Jim Hall (ECI, UoO); John Ingram (University of Oxford). TBC

Case studies of systemic risk modelling and assessment approaches. Potentially to cover infrastructure, food systems, systems analysis of economic networks, correlated tail risks of weather events and robust decision making for systemic risk mitigation. Modelling complex systems, developing exemplar system architectures for next generation systemic decision makers (food systems).

11.3 Drivers of systemic risk and attribution of driver specific strength for systemic risk mitigation

CAs: Stefan Thurner (Complexity Science Hub) ; Sibel Eker; Klaus Kelle TBC

This subchapter will explore experimental design for intervention-targeted system simulations. It will unpack the identification of key drivers and quantification of driver strength.

11.4 Improving learning about systemic risks – new / emerging technologies and science in complex systems modelling

CAs: Bob Bishop (ICES Foundation) ; Dirk Helbing (ETHZ).

[Link to PART II Chapter 5] In seeking to enhance our understanding of systemic risks, this Chapter will examine efforts:

- bringing modelling and computer simulation of social processes and phenomena together,
- combining perspectives of different scientific disciplines (e.g. socio-physics, social, computer and complexity science), and
- bridging between fundamental and applied work.

11.5 Decision support systems for systemic risk reduction in conditions deep uncertainty and potential misinformation

CA: Stephen Passmore (Resilience Brokers); Steve Lade (Australia National University, Stockholm Resilience Centre) TBC; Gavin Starks (IcebreakerOne) TBC; Jim Bendell (Deep Adaptation) TBC

- Systems-based approaches to transforming information availability.
- Complex systems: modelling resilience, regime shifts, social-ecological systems, traps, transformations.

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- Innovative finance, sustainable urban development, infrastructure, health and DRR applying agent-based modelling in developing country and developed country contexts.
- Approaches to inform systemic perspectives based on the 4Rs approach (resilience, relinquishment, restoration, reconciliation).

Chapter 12 – Systemic approaches to managing systemic risks

CLAs: Scott Williams (GRAF WG Fostering Systems Thinking; UNDP); John Atkinson (4SD; Heart of the Art; Office of the S.E. on COVID-19)

Providing the bridge between systemic risk assessment and governance, this Chapter will explore the practical implementation of efforts to build collective intelligence and approach complex and systemic challenges informed by a transcontextual perspective. Opening with an exploration of overarching principles that can guide the process of understanding and managing risk through a systemic lens, navigating trade-offs, and providing examples of both effective and ineffective approaches to bring forward portfolios of solutions, as well as the means to resource such systems-level transformations. Selected case studies will examine experimental processes, and collaborative networks that like systemic risks, span spatial, temporal, and institutional scales and so contribute to the global discourse on how to manage complex systems trade-offs when pursuing risk-informed sustainable development in a changing climate.

This Chapter will highlight both proven and feasible solutions, as well as in-progress approaches to transformational change. In so doing, it begins the systematic framing of such solutions to support access, selection, and application by decision-makers; incorporating aspects of inter alia scale, articulated demand, decision-making behaviour, and scalability. Recognising that cases are not necessarily exportable beyond context and the need to embrace diversity in solutions, the Chapter will unpack principal components that may be more readily transferable, as well as examining essential elements in building collective intelligence and generating relational information that enable a better understanding of complex systems.

The Chapter will review an array of responses, including low-cost approaches that generate long-term (even lifelong) positive dividends. It will also examine barriers to workable solutions, including the tension that can exist between the pursuit of efficiencies and resilience.[21]

Cases will seek to integrate aspects of some of the systemic transitions being mainstreamed into development and efforts to promote social, economic and ecological resilience, potentially to include: 1. Energy systems / infrastructure, 2. Land, oceans and ecosystems, 3. Urban infrastructure, 4. Industrial sector / infrastructure, 5. Societal transitions.

12.1 A systems view of life: regenerative systems dynamics

CAs: Daniel Christian Wahl (Regenerative Cultures); Fritjof Capra (University of California; Schumacher College)

[Link to Chapter 13] Organisations as living systems, the importance of humility and precaution to inform a systems perspective. The abundance revealed through collaboration and sharing, and the creative challenges of converging crises to build collective intelligence.

[21] A system may be made more resilient by the application of multiple concepts, an approach that can also result in redundancies.

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12.2 Experimental systemic risk management in the living systems of organisations and institutions

CA: John Atkinson (4SD; Heart of the Art; Office of the Special Envoy on COVID-19)

Through real-world cases, the subchapter will present systems-based approaches in local (and national) government for managing systemic risks; for example Total Place, bringing together different government bodies in a whole area approach to specific problems. It will examine enabling conditions and approaches, practice and lessons learned – including in adaptive and collective decision making, collaborative planning that deals with uncertainty, trade-offs, scenario building, as well as dialogic and enquiry-based approaches.

Use cases : Systemic risk management in practice: the SDGs and the GRAF

CAs: Dave Griggs (Monash University; International Science Council); Mario Boccucci (UN-REDD) TBC; UNDRR and government counterparts of GRAF national pilots

These cases will explore the development, provision and utilisation of (transdisciplinary) science and systems-based approaches in addressing systemic challenges to the achievement of specific SDGs, including insights from preliminary activities in GRAF national pilot countries.

12.3 Bridging the science policy divide: applied approaches to strengthen the interface

CAs: Peter Gluckman (International Network for Government Science Advice, ISC) TBC; Laura Smillie and David Mair (EC Joint Research Centre)

[Link to PART III] The subchapter will explore science and context, including uptake and barriers to systemic approaches. Unpacking the conditions for evidence informed policy making approaches to flourish.

Use case : Systemic risk management in practice: COVID-19 and pandemic risk management

CAs: WHO ; National University of Singapore; London School of Hygiene and Tropical Medicine; Imperial College, London TBC

COVID-19 and future pandemic risk management informed by systemic perspectives.

12.4 Systems innovation approach in practice: building collective intelligence thorough experiential learning

CAs: Tom Mitchell (Climate-KIC); Scott Williams (GRAF WG on Fostering Systems Thinking; UNDP)

Specific use cases developing radical transformational approaches and building collective intelligence using the Deep Demonstration Methodology in 15 cities, 4 vulnerable regions, 3 maritime hubs, and a number of coal/ industrial regions in transition. Aral Sea region zone of ecological innovations and technologies.

Use case : Challenging orthodoxy: new approaches unlocking solutions in complexity

CAs: Pablo Suarez, Rebeka Ryvola and Bettina Koelle (Red Cross Red Crescent Climate Centre).

Innovative systems-based approaches to building resilience, managing crises / shocks, including the use of humour, art, games and other universal approaches to engage and activate stakeholders in complex, systemic risk contexts.

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12.5 Sense-making and generating transcontextual, relational information

CAs: Giulio Quaggiotto (Regional Innovation Centre, UNDP); Nora Bateson (International Bateson Institute)

Sense making and the generation of transcontextual and relational information in understanding systemic interdependencies and identifying holistic, culturally relevant and context-informed risk management solutions. Building solidarity through rediscovery and sense-making of interdependency. Constructing collaboratives, pursuing portfolio-based solutions to systemic risks.

12.6 Financing systemic risk management approaches: portfolios not projects

CAs: Mikael Seppälä (Sitra Lab, Sitra Fund); Dominic Hofstetter (Climate-KIC); Phoebe Tickell (National Lotter Community Fund) TBC

Systems innovation portfolio and transformational capital approaches to develop both public and private funding and financing informed by the systemic perspective.

Use cases : Integrated systems planning, decision making and financing

CAs: Stephen Passmore (Resilience Brokers); Gianluca Pescaroli (UCL)

Innovative finance, sustainable urban development, infrastructure, health and DRR applying multi-layered, risk-informed, ecological, resource technology network (rtn) and agent-based modelling in developing country and developed country contexts. Use cases of innovative systems modelling tools supporting data driven, city-region and regional planning, policy and investments.

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Chapter 13 – Transitions to systemic risk governance arrangements

CLAs: Franz Gatzweiler (Institute of Urban Environment, Chinese Academy of Science); Roger Pulwarty (NOAA); Joanne Linnerooth-Bayer(IIASA); Marie-Valentine Florin (IRGC)

Propelled by Chapter 2 of GAR 2019, building on Chapter 11, and drawing on the implementation focus of Chapter 12, this chapter examines the question of "How to?". It proposes to: i) work with a typology of various types of risks, ii) work with the input of an interdisciplinary collaborative community of practice, and iii) include and learn from 'real-world' cases.

The chapter seeks to be relevant and practical to specific stakeholders seeking to implement and make the transition to improved systemic risk (SR) governance arrangements. It will build on the definition outlined in preceding chapters of stakeholders[22] and types of systemic risks[23], wherein the distinction between traditional and SR is suggested as: *traditional risks* - linear or well-established cause-and-effect-relationships are simple or easy to understand; *systemic risks* - complex causal structures and dynamic evolutions (multiple causes and effects with feedback mechanisms).

Mismatches have occurred between rapidly changing social, ecological and technological environments during the Anthropocene, and how people think about and act upon them. These mismatches have led to systemic risks which threaten the health and wellbeing of people and the planet, but also open opportunities for systemic readjustments in the form of adaptations or transformations.

In exploring governance transitions, the chapter recognises that such transitions encompass changing human and institutional behaviour and thinking in changing environments/circumstances. Transitions of systemic risk governance, happen in order to reduce the costs imposed to people and ecosystems due to a systemic failure/collapse, but also to seize the opportunities of changing a system for the better.

This chapter addresses the challenge of how to adapt ways of thinking about, and acting in, rapidly changing social, technological and ecological environments – to move towards systems thinking. It seeks to help stakeholders recognize that they are approaching critical systemic risk levels and help identify and recognize opportunities for proactive, and not just reactive, action.

The G20 Summit2020 amongst others, emphasized the need for new governance regimes to shift focus from being centred around finance and trade, towards the provision of global public goods.

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[22] **Stakeholders** suggested as those that have an interest in better governing SR, noting that it depends on their position within the system and perspective on the risk / possible damage to them. Suggested: a) Individuals (health); b) Organisations, corporations; c) Governments.

[23] **Systemic Risk Types** suggested examples: a) Health related (COVID-19); b) Financial; c) Climate change, biodiversity & ecosystems, incl. oceans; d) Natural hazards; e) Cyber/Internet. Noting that the very nature of SR implies that their effect manifest in / cascades to various domains, and identification of source may be difficult. This typology follows from the different types of flows in the anthropogenic and natural metabolism (socio-ecological systems). Flows of data, resources, energy, money.

To support such transitions this chapter:

- Describes the nature of SR governance and how it differs from non-SR governance.
- Provides guidelines on adaptation and mitigation measures for SR, suggesting a typology of measures.
- Identifies SR types and governance strategies and gives examples of multi-level and polycentric governance of SR in different geographical and socio-cultural contexts.
- Describes possible transition pathways through changing SR governance environments, including aspects of responsibility and incentives

13.1 Introduction: what is SR governance and how is it different.

The introduction to the Chapter will unpack SR governance, explore how it differs from non-SR governance, and examine different SR governance arrangements. This section explains why it is critical to build capacity in systemic risk governance, how to build it and when and how to move (transition) from the existing to an improved risk governance regime. It will discuss the important role of (global) public goods, e.g. health.

CAs: Joanne Linnerooth-Bayer (IIASA); Franz Gatzweiler (Institute of Urban Environment, Chinese Academy of Science)

13.2 Prevention, mitigation and adaptation SR governance mechanisms.

This subchapter will examine what is currently being undertaken in terms of SR governance mechanisms, incentives, guidelines to mitigate and avoid the emergence of systemic risks and what needs to be done (better) in future. Emerging systemic risks indicate that a system is leaving its stable state and is heading towards a tipping point after which a systemic collapses/change is possible.

The subchapter will suggest a typology of measures, and explore organizational learning. It will explore aspects of flexibility and continuous adaptation to context in systemic risk governance, including decision making, accepting and resolving trade-offs.

CAs: Marie-Valentine Florin (International Risk Governance Council - IRGC); Robert Constanza (Australian National University; Club of Rome) TBC; Marja Spierenburg (Leiden University / Stellenbosch University) TBC; Jack Radisch and Stephane Jacobzone (OECD) TBC; Melissa Leach (University of Sussex) TBC

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13.3 SR governance types and strategies.

While transitions in risk governance landscapes take place by changing the rules of the game (institutions), there are different strategies for "playing of the game" (governance). This subchapter introduces and explores [24]:

- four governance types: fragile, robust, flexible, rigid,
- the role of markets, communities and governments in SR governance,
- multi-scale and polycentric governance of SR,

examining risks at different levels: global, regional/national, subnational (city) and community levels.

Given the objective to avoid or mitigate SR, the subchapter will examine multi-scale and polycentric governance of SR, including the redesign of a system's network structure of interconnectivity. It will examine how critical clusters and chains of interconnectivity are avoided and interdependencies are more evenly distributed/balanced across multiple levels and centres.

It will explore systems leadership, and how multilateralism can counteract the drivers of SR at the global scale. Systemic risk governance fomenting enhanced policy integration across goals, assisting in navigating trade-offs.

CAs: Åsa Persson and Richard Klein (Stockholm Environment Institute); Pradeep Kurukulasuriya (UNDP) TBC; Roger Pulwarty (NOAA); Rika Preiser (Stellenbosch University) TBC; Florence Lasbennes (4SD); John Atkinson (Heart of the Art; 4SD)

13.4 Transition pathways through changing systemic risk governance environments

This subchapter will examine how to enable and facilitate transition pathways through changing SR governance landscapes, for example by identifying innovation 'niches' and scaling them up. SR risk governance landscapes can be broadly defined by the potential impact from critical systemic risks or potential system collapse and the institutional capacity to absorb or integrate unintended consequences. The subchapter will describe broad categories of the systemic risk governance landscape, recognising possible cross-over, as SR evolve and adapt to a changing environment, in response to internal stressors and external shocks.

This subchapter understands that systemic risks can build up to a critical level, coinciding with tipping points, when systems fail/collapse or become dysfunctional. Critical levels of systemic risk are built up when the network of rules regulating the system (institutions) does not have the capacity to internalize unintended side-effects (externalities) of actions – for example deforestation and forest ecosystem degradation / collapse, habitat loss, and emerging zoonotic diseases.

The subchapter will examine governance structures (markets, communities, governments) required to enforce / implement rules (institutions), so as to change harmful behaviour. It will investigate the importance of the integrative capacity of institutions to absorb the accumulation of systemic risks (often

[24] building on the work of Duit and Galaz on "Governance and Complexity"

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gradual, with a time-lag, and hampered by the challenge of predicting where and when systemic risk is building up), as critical and without which the functioning of the entire system is threatened. Aspects of institutional diversity will also be explored; as with species diversity, such diversity tends to mitigate systemic risks, with the contrary observable if certain institutions are maladapted or absent.

Analysis of transitions from one risk governance landscape to another recognise that these can be planned (e.g. triggered because the new regime is perceived as more desirable and managers have a capacity to act), or unplanned (if the managers of the system –provided there are any – are taken by surprise). The subchapter will explore inter alia, gaps in the web of rules; connecting behaviour to rules and incentives; reducing mismatches (including between higher/lower level institutions) to create a coherent knowledge-action system; understanding and reducing barriers and unintended consequences of current policies; involving stakeholders (including rule makers and decision makers); and experimentation / precaution.

CAs: Victor Galaz (Stockholm Resilience Centre) TBC; Franz Gatzweiler (Institute of Urban Environment, Chinese Academy of Science); Steve Polasky (University of Minnesota) TBC

Chapter 14 – PART IV Conclusion

Proposed contributors: Xue Lan (Tsinghua University; Schwarzman College); Ortwin Renn (Institute for Advanced Sustainability Studies – IASS; Stavanger University; Beijing Normal University); Katherine Richardson (University of Copenhagen); Nebojsa Nakicenovic (IIASA); Andy Haines (LSHTM); Johan Rockström (PIK); David Nabarro (WHO Director General's Special Envoy on COVID-19); Marc Gordon (UNDRR)

Systemic risks as threats to sustainable development, and the structures and processes for sustainable transformations. Systemic transitions within planetary boundaries to redress appropriation of earth system services. TWI 2050. Systemic risk management approaches - human health, planetary health and sustainability. Transforming governance for resilience to systemic risks.

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