European Environment Agency

30 YEARS

Governance in complexity

Sustainability governance under highly uncertain and complex conditions

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Foreword

More than 50 years have passed since the 1972 United Nations Conference on the Environment in Stockholm, the first global conference to explicitly acknowledge the intrinsic value of the natural environment. Since then, our activities have intensified, expanded and become more harmful to the environment. This poses fundamental questions about our capabilities to halt or reverse these trends by 2030 and meet the United Nations' sustainable development goals.

In today's world, terms like complexity, volatility and crisis are increasingly used to describe the context and conditions we live in. The dramatic effects of biodiversity loss, climate change and pollution create an almost existential sense of urgency to act. At the same time policymakers also grapple with crises like war, pandemics, rising cost-of-living, deteriorating mental health, and disinformation. These challenges are visibly interconnected and complex, and most of the time impossible to disentangle and solve. This may feel overwhelming and paralysing. However, this is our reality: social, economic and environmental dimensions have been and will always be tightly intertwined in complex and unpredictable ways.

This raises questions regarding the types of knowledge and governance models needed to transform societies towards sustainability. The EEA has produced knowledge on the systemic drivers of environmental challenges in Europe for over three decades. When identifying challenges across key societal systems like food, mobility, energy and the built environment, it is also our job to understand *why* there is not more progress. Issues related to environment, climate and sustainability are often complex and ridden with uncertainty. For this reason, experts in our field know well that *what* to measure and *how* to measure are not always clear-cut questions. Models and predictions are essential but never perfect. Some issues are notoriously complex and can open existential questions of philosophical nature, like the relationship between humans and nature.

Only by truly understanding and appreciating the nature of sustainability challenges can we meaningfully respond. Such an understanding is essential for the upcoming 2025 edition of our flagship assessment *The European environment — state and outlook* and to provide actionable knowledge in support of sustainability transitions.

As a minimum, the gravity of a situation that talks of multiple crisis and existential risks calls for an attitude of openness in responding to them. This report should not be understood as a blueprint approach to governing sustainability challenges. It is instead an invitation to develop knowledge that acknowledges the many legitimate perspectives that exist on issues of sustainability and reflect on the ways society can navigate and resolve them.

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Executive summary

The triple planetary crisis of climate change, biodiversity loss and pollution is just one of many interconnected and mutually exacerbating socio-economic crises currently challenging European and global societies.

These accelerated and deeply interconnected crises challenge the conventional approach to governance in several ways. Firstly, previously well-tested and effective tools and practices of problem-solving are less suited to providing systemic solutions. This is demonstrated by the lack of progress towards sustainability: European policies have yet to produce more than mixed progress towards the UN sustainable development goals (SDGs). Similarly, the outlook for reaching the EU's long-term vision of 'living well within the limits of the planet' is not encouraging. Secondly, failing to acknowledge and absorb the many different understandings of complex problems — and the inherent difficulties of governing multi-faceted and systemic challenges — weakens the legitimacy of any transition toward sustainability. This can strain societal stability and cohesion, as is visible in several parts of Europe already.

This report outlines an alternative concept of 'governance in complexity', based on an evolving understanding of sustainability challenges and how to govern them. The approach of governance in complexity is targeted to deal with complex and systemic challenges by recognising that each has many possible framings, where uncertainty will always be present. If there are always competing and irreconcilable understandings, as was the case with COVID-19 measures, working to resolve challenges is the only realistic approach. If solving problems is impossible, including more perspectives and extending the basis on which to draw resolutions from is the best solution. In contrast, presenting 'win-win strategies' when there are in fact underlying trade-offs would only conceal issues that need to be mitigated and navigated towards a compromise.

Governance in complexity should be understood as a perspective and frame of mind rather than a set of tools. This is most evident when applying the six principles that are central to the governance in complexity approach: experimentation, systems thinking, participation, precaution, anticipation and care. Without accepting uncertainty, the principle of anticipation in sustainability governance can become a futile attempt at predicting the future, rather than a way to adjust current behaviours. The same is true for the principle of precaution, which becomes especially contested and challenging to uphold if the ever-present existence of uncertainty is not recognised — as demonstrated by the difficulties of applying the precautionary principle as formulated by the European Union's legislation. Without acknowledging that different perspectives and framings of sustainability challenges are legitimate, participation can similarly be perceived as a meaningless exercise. Governance approaches to complex sustainability issues require reflexive mindsets which emphasise experimentation, trial and removal of error.

Several real-life examples of governance of sustainability issues — from the local to the European level — illustrate that new approaches are already emerging that are better adapted to the complex nature of sustainability transformations. These best-practice examples help refine what governance in complexity looks like in reality and serve as inspiration.

Similarly, at the EU-level, the context of uncertainty, complexity and crises are already encouraging governance in complexity. Four examples of governance processes in the EU policy context to mitigate complexity and crisis — the energy crisis caused by Russia's invasion of Ukraine, the COVID-19 pandemic, biodiversity loss and discussions of the environmental impacts of sustained economic growth — demonstrate that principles of systems thinking, anticipation, precaution and care are present in EU policy responses.

To shift dominant governance approaches towards a governance in complexity approach would require changes at individual, organisational, institutional and broader societal levels. At the individual level, governance in complexity mindsets can be cultivated through contemplative practices and experiences with nature, as well as knowledge from social sciences and the humanities. At the organisational level, governance in complexity means allowing and accepting many forms of knowledge and perspectives — including those seen as radical and which challenge the very foundation of the organisation. At the institutional level, it is necessary to explore barriers to change, acknowledging that transformative change runs counter to power structures and widely-accepted discourses of economic growth and material wealth.

As demonstrated by the already shifting landscapes of governance presented in the report, social norms and discourses in transitioning societies would change organically. Governance in complexity is first and foremost a tool to shed light on and enhance such expanding and complementary practices.

1 The evolving context: sustainability in turbulent times

Key messages

- Interconnected environmental and societal crises put severe pressure on life-sustaining systems, human health, economic prosperity and social welfare, leading to a transgression of critical planetary boundaries.
- The current 'polycrisis' of multiple, deeply interconnected economic, social and political challenges is a symptom of 'systemic unsustainability'.
- There may be no all-encompassing, optimal solution to overcome or recover from crises without tackling underlying political, social and environmental challenges.
- The types of measures needed to protect the environment may have to be revised to be more responsive to complex, evolving and emerging challenges. Well-tested practices of problem-solving and conventional modes and instruments of governance might not be enough to provide systemic solutions.

Today's challenges of environmental governance and sustainable development seem increasingly complex and multidimensional. There is robust scientific basis behind the claim that several interconnected environmental and societal crises put severe pressure on life-sustaining systems, human health, economic prosperity and social wellbeing. This Chapter explores the context of addressing sustainability challenges, which in this report has been termed as 'turbulent times'.

1.1 Multiple environmental and societal crises as signs of turbulent times

The period since the 1950s — known as 'the Great Acceleration' — has seen unprecedented and accelerating human-induced global change (Steffen et al., 2015). This time brought extraordinary improvements in living standards but also caused massive pressures on Earth's life-support systems (EEA, 2019b, 2020b).

Pressure has increased to the extent that Earth is now well outside of what has been considered the tentatively safe operating space for humanity (Richardson et al., 2023). According to the latest planetary boundaries framework update, six out of nine boundaries that are critical for maintaining stability and resilience in Earth systems have been transgressed (Richardson et al., 2023). In addition, transgression has increased for all boundaries that were already overstepped. While boundaries related to climate change are the most discussed, transgression is even more pronounced in genetic and functional biosphere integrity, biogeochemical phosphorus and nitrogen flows and for novel entities in the environment.

According to the Intergovernmental Panel on Climate Change (IPCC), human-induced climate change 'has caused widespread adverse impacts and related losses and damages to nature and people' (IPCC, 2023). This includes impacts on ecosystems,

food and water security, human health, livelihoods, infrastructure and economic activity. Equally, the annual extraction of materials has more than tripled since 1970 and continues to rise. This increasingly impacts the environment and human health, and the effects are unevenly distributed across countries and regions (UNEP, 2024). As a direct consequence of human actions, nature and its contributions to people are deteriorating worldwide, with biodiversity declining faster than at any other time in human history (IPBES, 2019).

In 2022, the Organisation for Economic Co-operation and Development (OECD) reported the highest number of extremely fragile ([1]) contexts in the world since 2005, the first year it published a *States of Fragility* study (OECD, 2022). The OECD concluded that the scale and severity of ongoing crises are 'putting the achievement of the 2030 Agenda for Sustainable Development at risk'.

At the same time, the UN *Human Development Report* of 2021/2022 noted for the first time a decline in the Human Development Index (HDI) for two years in a row (UN, 2022). Acknowledging the impacts of the COVID-19 pandemic, the report also describes a new 'uncertainty complex' created by the entanglement of dangerous planetary change, sweeping societal transformations and increased societal polarisation. This polarisation is seen as one of the largest risks globally, today and over the next 10 years (WEF, 2024). According to the UN, this uncertainty complex threatens livelihoods and well-being across the planet, leading to increased insecurity and distress among people, in affluent societies as well (UN, 2022). The 2023/2024 Human Development Report documented that recovery after COVID-19 was unequal and uncertain. This brought into question whether a permanent (negative) shift in the human development index was taking place (UN, 2024).

Moreover, despite remarkable economic growth and improvements in living standards over recent decades, the World Social Report 2020 warned of high and rising inequality within and across countries (UN, 2020). Circumstances beyond the control of an individual, such as gender, ethnicity and race, being a migrant, and socioeconomic and disability status continue to affect one's chances of succeeding in life. Rising inequality creates discontent, jeopardises trust in politics and public institutions, and can lead to violent conflict (Stiglitz, 2013).

Socio-economic challenges are also increasingly visible in European policy priorities (EC, 2023b). Extreme climate events, the COVID-19 pandemic, Russia's war against Ukraine, high inflation and the sweeping polarisation caused by the current Israel-Gaza war (and the conflicting Member State responses to it) have all entailed new and significant risks to the well-being of European residents. Such vulnerabilities might exacerbate and multiply in the future due to multiple drivers of change of a civic, political, technological, economic, environmental and geopolitical nature, each interacting and compounding each other across levels and scales (Spain's National Office of Foresight and Strategy, 2023; EEA, 2020).

Multiple and mutually exacerbating challenges are the result of complex interactions between environmental and social systems, each undergoing different degrees of destabilisation, breakdown or collapse (EEA, 2021a; Heinberg and Miller, 2023). Several attempts have been made to capture and describe such complexities: concepts like a VUCA world (VUCA stands for volatility, uncertainty, complexity and ambiguity), polycrisis, systemic risks, multiple shocks, drivers of change and the uncertainty complex have been used to make sense of the evolving context of

([1]) According to the OECD (2022), fragility 'is the combination of exposure to risk and insufficient coping capacities of the state, system and/or communities to manage, absorb or mitigate those risks. It occurs in a spectrum of intensity across six dimensions: economic, environmental, political, security, societal and human'.

various crises. For example, the concept of polycrisis (Morin and Kern, 1999) became widespread in the 2010s and 2020s, often with reference to the financial crisis in 2008-2009. In a polycrisis, the consequences of each crisis interact and typically (though not necessarily) reinforce each other into escalation.

Interdependencies and feedbacks within and between systems and sectors can give rise to systemic risks (Sillmann et al., 2022). Such risks can propagate within and between systems and sectors, creating multi-hazards and cascading impacts. Complex systems may have tipping points that make 'safe operating spaces' exceedingly difficult to identify and operate in. While the exact definition of tipping points in environmental and social systems remains unclear, there is growing consensus around their importance (EEA, 2019b; Pörtner et al., 2022; Moore, 2018; Lenton et al., 2023).

The theoretical knowledge that the planet is a complex socio-ecological system is not new. Socio-economic systems are deeply dependent on ecosystems, both as providers of materials and energy and as sinks for emissions and pollution. Calls for forceful and urgent action to change the dynamics of human-induced environmental and climate change have also been made for decades, based on the scientific understanding of systems. What is different in the 2020s, is that the humanitarian effects of destruction, such as polarisation, instability, precariousness, insecurity and distress, are becoming more evident worldwide, also in affluent parts of the world (UN, 2022).

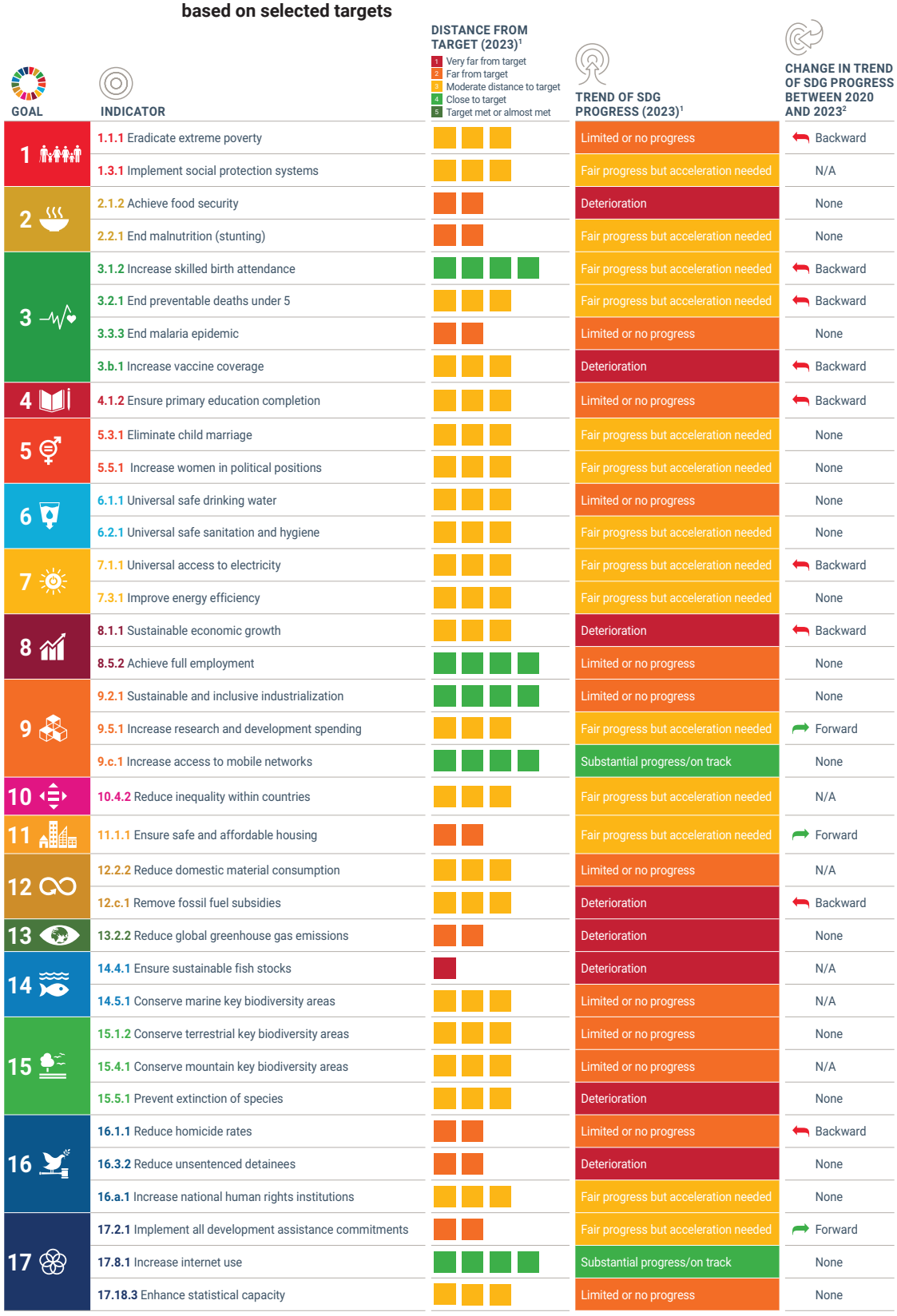
It is entirely possible that the situation of multiple crises is one that will not pass and that for the foreseeable future, we are now living instead in turbulent times (Felt et al., 2013) with a wounded earth (Haraway, 2016) — a period described by some as 'the Great Unravelling' (Heinberg and Miller, 2023). New future shocks should therefore be anticipated (EP et al., 2023b). The concept of 'turbulent governance' (Ansell et al., 2016) has been proposed to describe the EU's European Green Deal (EGD) policy framework as a response to turbulent times and the shifting context in which governance occurs (Dupont and Torney, 2021). There may be no shortcuts out of this predicament. Yet this does not preclude the possibilities of finding dignified pathways within it through fundamental changes to human economic activities and their governance (EEA, 2023g). This would address the drivers of the situation rather than searching for easy ways out (Spangenberg and Kurz, 2023).

1.2 Insufficient progress towards sustainability

The 17 interlinked Sustainable Development Goals (SDGs) lie at the heart of the 2030 Agenda for Sustainable Development, adopted by all United Nations (UN) member countries in 2015. The 2019 *Global Sustainable Development Report* (GSDR) concluded that the world was unlikely to achieve the SDGs by 2030 (UN, 2019). In 2023, halfway to 2030, the situation was already much more dire due to slow SDG implementation and a convergence of interrelated crises such as the COVID-19 pandemic, the cost-of-living crisis, extreme weather events, unrest and armed conflict in many regions (UN, 2023). Only two of the 36 targets assessed are on track to be achieved: access to mobile networks (indicator 9.c.1) and internet access among individuals (indicator 17.8.1). Progress on eight targets is deteriorating, including on achieving food security (indicator 2.1.2), reducing global greenhouse gas (GHG) emissions (indicator 13.2.2) and preventing the extinction of species (indicator 15.5.1) (UN, 2023) (Figure 1.1). In the United Nations Economic Commission for Europe (UNECE) region ([2]), just 20 of the 117 SDG targets measured are on track for 2030 (UNECE, 2024). While this lack of progress is universal, it is the world's poorest and most disadvantaged who are suffering disproportionately from the impacts.

([2]) The United Nations Economic Commission for Europe (UNECE) is one of five regional commissions of the United Nations and today includes 56 member States in Europe, North America and Asia.

Figure 1.1 **Current state of progress towards the Sustainable Development Goals based on selected targets**



[1] Distance from target (2023) and trend of Sustainable Development Goasprogress (2023) refer to current level and trend information for the latest available data utilizing the calculation methodology from the Sustainable Development Goals 2022 Progress Chart Technical Note. Latest available data as of May 2023 from the SDG global indicator database. Please note that information for indicators 1.1.1, 10.4.2, 13.2.2, 17.2.1 and 17.18.3 are from the Sustainable Development Goals Progress Chart 2022.

[2] To capture the impacts of the COVID-19 pandemic on progress of the Sustainable Development Goals, a comparison of the trend assessment from the Sustainable Development Goals 2020 Progress Chart and the trend of progress of the Goals (2023) was made, with some indicators showing reversal or slowed progress.

N/A: trend comparisons unavailable due to: i) lack of trend analysis from insufficient data; ii) indicator not included in the 2020 Progress Chart; or iii) indicator has changed between progress charts.
Source: Calculations based on United Nations Department of Economic and Social Affairs, 2023b.

Source: UN, 2023.

The EU is committed to delivering on the 2030 Agenda for Sustainable Development and its SDGs (EC, 2023b). Sustainable development is a core principle of the Treaty on European Union and a priority objective for the EU's internal and external policies.

Since 2015, the EU has made progress across all SDGs, albeit unevenly. The latest monitoring report shows that while good progress was made towards many socioeconomic goals, trends in the environmental domain were less favourable over the five-year period until 2022/23 (Eurostat, 2024a) (Figure 1.2).

Figure 1.2 **Overview of EU progress towards the SDGs over the past five years, 2024**

Source: Eurostat, 2024a.

The report presents a mixed picture related to the spillover effects of EU consumption on other global regions (Eurostat, 2024a). EU consumption continues to affect environmental conditions in the rest of the world, as illustrated by increases in the EU's net imports of CO_2 emissions and by its global cropland footprint.

Despite progress on many socioeconomic SDGs, 21.6% of the EU population (95.3 million people) were at risk of poverty or social exclusion in 2022 (Eurostat, 2024a). Moreover, several regions in the EU have been stuck in the so-called 'development trap' and are unable to retain economic dynamism in terms of income, productivity and employment, leading to political discontent, polarisation and support for populist parties (EC, 2023g).

This picture suggests that achieving the SDGs in Europe remains challenging. Further implementation efforts are needed for many goals — both socioeconomic as well as those related to the protection and sustainable use of natural resources.

From an environment and climate entry point, a similar conclusion was put forward by *The European environment — state and outlook 2020* (EEA, 2020b), which stated that Europe and the world face urgent, unprecedented sustainability challenges that require systemic solutions. This report painted a bleak picture of the EU's prospects for meeting its policy objectives (EEA, 2019b).

With the introduction of the EGD (EC, 2019), the EU has confirmed the gravity of the situation and committed to action. The 8th Environmental Action Programme (8th EAP) (EU, 2022b) confirms the high ambitions set by the EU to stop and reverse environmental degradation, as did its predecessor, the 7th Environmental Action Programme (EC, 2013). A significant difference between the 8th EAP and its predecessors is its emphasis on the systemic character of sustainability challenges and the resulting need for similarly systemic solutions.

The first annual report on progress towards the objectives of the 8th EAP emphasises 'the need for decisive and urgent action to protect and restore Europe's environment, mitigate climate change and prepare for better adaptation to changing conditions'. It points to the necessity of profoundly transforming core societal systems that are driving environmental pressures, such as the systems in place to meet Europe's demand for food, energy, mobility and housing (EEA, 2023b) (Table 1.1).

The insufficient progress towards sustainability has at least two important implications for governance, explored in more detail in Chapter 3. Firstly, there may be no all-encompassing, optimal solution to overcome or recover from crises without tackling the underlying political, social and environmental challenges that lie behind them. Secondly, the types of measures needed to protect the environment may need to be revised to be more responsive to complex, evolving and emerging challenges. Well-tested practices of problem-solving and conventional modes and instruments of governance might not suffice to provide systemic solutions (Funtowicz and Ravetz, 1993; Head, 2022; Strand, 2002; Oliver et al., 2021). The topic of this report is one possible approach that can contribute to a paradigm shift in environmental governance.

Table 1.1 **8th Environmental Action Programme monitoring scoreboard results, 2023**

8TH EAP PRIORITY OBJECTIVES AND ENABLING CONDITIONS **8th EAP indicators** Monitoring targets	Outlook of meeting the targets by 2030 It is very likely	It is likely but uncertain	It is unlikely but uncertain	It is very unlikely
CLIMATE CHANGE MITIGATION				
Greenhouse gas emissions Reduce net GHG emissions by at least 55% by 2030 from 1990 levels		●		
GHG emissions from land use, land-use change and forestry Increase net GHG removals by carbon sinks from the LULUCF sector to -310 million tonnes CO_2 equivalent by 2030				●
CLIMATE CHANGE ADAPTATION				
Climate-related economic losses Reduce overall monetary losses from weather and climate-related events			●	
Drought impact on ecosystems Decrease the area impacted by drought and loss of vegetation productivity			●	
A REGENERATIVE CIRCULAR ECONOMY				
Raw material consumption Significantly decrease the EU's material footprint, by reducing the amount of raw material needed to produce the products consumed in the EU			●	
Total waste generation Significantly reduce the total amount of waste generated by 2030			●	
ZERO POLLUTION AND A TOXIC FREE ENVIRONMENT				
Premature deaths due to exposure to fine particulate matter Reduce premature deaths from air pollution by 55% (from 2005 levels) by 2030	●			
Nitrates in groundwater Reduce nutrient losses by at least 50% in safe groundwater resources			●	
BIODIVERSITY AND ECOSYSTEMS				
Designated terrestrial protected areas Legally protect at least 30% of the EU's land area by 2030			●	
Designated marine protected areas Legally protect at least 30 % of the EU's sea area by 2030			●	
Common bird index Reverse the decline in populations of common birds			●	
Forest connectivity Increase the degree of connectivity in forest ecosystems with a view to creating and integrating ecological corridors and increase climate change resilience			●	
ENVIRONMENTAL AND CLIMATE PRESSURES RELATED TO EU PRODUCTION AND CONSUMPTION				
Energy consumption Reduce by 2030 the primary and the final energy consumption levels to respectively 992.5 and 763 million tonnes of oil equivalent				●
Share of renewable energy in gross final energy consumption At least 42.5% of energy from renewable sources in gross final energy consumption by 2030			●	
Circular material use rate Double the ratio of circular material use by 2030 compared to 2020				●
Share of buses and trains in inland passenger transport Increase the share of collective transport modes (buses, coaches and trains)			●	
Area under organic farming 25% of EU agricultural land organically farmed by 2030				●

8TH EAP PRIORITY OBJECTIVES AND ENABLING CONDITIONS

8th EAP indicators
Monitoring targets

	Outlook of meeting the targets by 2030			
	It is very likely	It is likely but uncertain	It is unlikely but uncertain	It is very unlikely
ENABLING CONDITIONS				
Share of environmental taxes in total tax revenues Increase the share of environmental taxes in total revenues from taxes and social contributions		●		
Fossil fuel subsidies Reduce environmentally harmful subsidies, in particular fossil fuel subsidies, with a view to phasing them out without delay			●	
Environmental protection expenditure Increase spending by households, corporations and governments on preventing, reducing and eliminating pollution and other environmental degradation	●			
Share of green bonds in total issued bonds Increase the issuance of green bonds to boost public and private financing for green investments		●		
Eco-innovation index Increasing eco-innovation as a driver for the green transition	●			
LIVING WELL, WITHIN PLANETARY BOUNDARIES				
Land take No net land take by 2050			●	
Water exploitation index plus Reduce water scarcity			●	
Consumption footprint Significantly decrease the EU's consumption footprint, i.e. the environmental impact of consumption				●
Employment in the environmental goods and services sector Increase the share of green employment in the whole economy	●			
Gross value added of the environmental goods and services sector Increase the share of the green economy in the whole economy	●			
Environmental inequalities Reduce environmental inequalities and ensure a fair transition			●	

Source: EEA, 2023b.

Note: The 8th EAP indicators and monitoring targets were outlined in the European Commission Communication on the 8th EAP monitoring framework (COM(2022)357).

2 The evolving understanding of sustainability challenges

Key messages

- Environmental and sustainability challenges can be classified as specific, diffuse, systemic or complex.
- Complex challenges are systemic challenges that are also characterised by uncertainty. Various actors often have different ways of characterising them, in terms of their framing, knowledge base and uncertainties.
- Many conceptual frameworks have been developed to describe and diagnose systemic and complex challenges. The frameworks of systemic risks, Cynefin and VUCA, are most useful in situations where challenges are systemic but uncertainties are limited. The concept of 'wicked problems' and the framework of post-normal science are most useful in very uncertain situations where controversy or indecision persists.
- These frameworks offer heuristics to diagnose and understand the challenges and inspirational ideas for action, such as uncertainty management and deliberative approaches to knowledge production.

As described in Chapter 1, the understanding of environment and sustainability challenges has evolved significantly since they were first introduced as core principles of EU development. The complexity of sustainability challenges has become especially visible in the context of recent crises. This is clearly illustrated by the concept of the 'triple planetary crisis', referring to the challenges of climate change, pollution and biodiversity loss. This clearly demonstrates the interconnected nature of various dimensions of environmental degradation (UNEP, 2022). This Chapter looks more closely at the characteristics of systemic and complex challenges. It also presents some key frameworks developed to meet the specific character of such problems.

2.1 A typology of challenges

The insight that sustainability challenges are systemic and complex (Allen et al., 2003; Giampietro, 2021; Kovacic and Di Felice, 2019) is now widely acknowledged by international organisations at the science-policy interface (Pörtner et al., 2022; Sillmann et al., 2022; UNEP and IRP, 2015) as well as in policymaking. The recognition of sustainability challenges as systemic and interlinked also lies at the core of the European Green Deal (EGD) (EC, 2019). Several of the EU's main policy packages deliberately adopt a systems-based framing (e.g. Farm-to-Fork Strategy; Fit for 55).

In parallel with the evolving understanding of challenges, the need for 'sustainability transformations' has been increasingly recognised as a more fundamental, cross-cutting and systemic form of change (EEA, 2021a). This is clearly reflected in the *Global Sustainable Development Report 2023* (UN, 2023), the ongoing

'transformative change assessment' developed by IPBES and the focus of the EU's 8th EAP on 'systemic change'. The 8th EAP calls for 'fundamental, transformative and cross-cutting form of change that implies major shifts and reorientation in system goals, incentives, technologies, social practices and norms' as well as a 'transformation of production and consumption patterns' (EU, 2022).

This call for sustainability transformations is now also evident at a global scale. The current design of the Sustainable Development Goals (SDGs) (UN, 2015) reflects the evolving understanding of sustainability. While the UN development agenda used to be more narrowly focused on economic and social development and on less-developed countries, the SDGs speak to a broader understanding of the interconnectedness of sustainability and development challenges for the whole world.

Recognising a need for systemic change also entails changes in knowledge and governance practices (EC, 2022b; Visseren-Hamakers et al., 2021; Turnhout et al., 2021). As an example, since the approval of the EGD in 2020, shocks and multiple, interrelated crises have made concepts like anticipation, foresight, preparedness, responsiveness and resilience more central to knowledge and governance systems in Europe and around the world. The concept of resilience refers especially to a system's ability to recover after adversity, be it sudden shocks or long-term stressors (de Smedt et al., 2018). Resilience can refer to ecosystems that sustain human and other life, or the socio-economic system. It is connected to objectives like making non-sustainable economic systems more resilient (de Smedt et al., 2018).

The systemic character of policy and governance issues has been recognised for several decades (von Bertalanffy, 1968). The rapid growth of environmental system sciences such as ecology and climate science in this period was in itself a response to this recognition. Since the 1990s, environmental science has increasingly integrated human, social and political dimensions into the study of socio-ecological systems (Funtowicz and Ravetz, 1994a).

When describing sustainability challenges, terminologies like polycrisis, systemic risks, drivers of change, uncertainty and complexity have two key characteristics in common: (1) 'uncertainty' understood as a lack of predictability with consequent surprises; and (2) 'complexity' understood as inextricable multi-causality between factors, perceived as interconnectedness.

Over the years, the EEA (2019a, 2021b) has referred to environmental and sustainability challenges as specific, diffuse, systemic and — most recently — complex (Table 2.1). In its original form, this typology contained the categories specific, diffuse and systemic (EEA, 2010, 2015b, 2019b). The fourth category of complex (originally called 'sustainability') was added in 2021 (EEA, 2021c). It had nevertheless been acknowledged for a long time, as witnessed by the following quote:

> …the situation policymakers are facing when having to decide on cases concerning the environment where the stakes are high and the issues are complex. Uncertainty regarding the eventual effects on the environment, considerable social and economic interests, and value laden arguments being used by stakeholders are common features (Domingo Jiménez Beltrán, in EEA, 1999, p. 4).

Table 2.1 **Evolving understanding of environmental and sustainability challenges at the EEA**

Key challenges	Key features	In policy since	Policy approaches (examples)	Assessment approaches and tools (examples)
Specific	Linear cause-effect, point source, local	1970s	Targeted policies and single-use instruments	Data sets, indicators
Diffuse	Cumulative causes, multiple sources	1990s	Policy integration, market-based instruments, raising public awareness	As above; and DPSIR, environmental accounts, outlooks
Systemic	Systemic causes, interlinked sources	2010s	Policy coherence, systemic focus (e.g. mobility system), long-term and multi-dimensional goals (e.g. SDGs)	As above; and STEEPV, practice-based knowledge, systems assessment, stakeholder participation, foresight
Complex	As above; and wicked problems; VUCA; intertwining nature and culture; urgent and large-scale	In focus today	As above; and open governance, public participation, co-creation, innovation, experimentation	As above; and post-normal science, response-oriented, collaborative

Source: Adapted from EEA 2019a, 2021b.

While these terms are sometimes used almost interchangeably in policy and public discourse, the distinction between 'systemic' and 'complex' deserves proper attention (see Box 2.1). There is no scientific consensus on definitions for these terms (Chu et al., 2003; Chu, 2011). Variations in the understandings of complexity are largely aligned with differences in views of how suitable conventional and established knowledge and governance systems are for dealing with sustainability challenges (Strand, 2002).

Box 2.1

What are systemic and complex challenges?

Sustainability challenges perceived as systemic would typically be those where identifying a system or a set of systems is thought to be possible. Systems can be defined through informal or formal models that include elements, causal factors, pathways and dynamics of the system, their possible nonlinearities, interdependencies, systemic risks, attractor patterns, paradoxical effects and other systemic features. Any definition of a system definition requires a deliberate process of setting its boundaries — what to include and what to exclude. A main feature with respect to governance is the reliability and validity of the model.

Complex challenges are systemic and imperfectly known (i.e. characterised by high uncertainty, see Sections 2.2-2.3). Two main features of complex challenges are how the challenge is framed by different actors and the nature of the knowledge base and its uncertainties. The knowledge base and its degree of uncertainty are again dependent on how the challenge is framed i.e. on how the boundaries and the dynamics of the problem are characterised. For example, so-called 'unknown unknowns' may escape proper attention. All of these phenomena of knowing and framing belong to human, social, political and even philosophical realm. Hence, a proper treatment of complex sustainability challenges cannot do without social sciences and the humanities.

It is important to bear in mind that the categories of systemic and complex challenges are concepts with strengths and limitations. From an operational perspective it may not be straightforward to distinguish between systemic and complex challenges. A diagnostic framework has been developed with that aim in Annex 1. This framework is based on the definitions provided in this Chapter and it is articulated in guiding questions. In the context of this report, it was used to analyse the four major crises presented in Chapter 5.

In the current circumstances, which are characterised by multiple interlinked crises, it seems that knowledge and policy approaches designed for specific and diffuse challenges are beginning to fail more often, as they do not properly account for nonlinearities, interlinkages and uncertainties. As reviewed by Oliver et al. (2021), a wealth of studies reveals insufficiencies and inadequacies in knowledge systems that address contemporary environmental and societal challenges.

Yet the need for different knowledge and governance systems should not be confused with the idea that the world and the sustainability challenges we are facing have become more complex, as discussed in Box 2.2.

Box 2.2

Has the world become more complex?

The recent focus on complexity in sustainability science, policy and governance could be taken as an indication that the world is now more complex than before. This report cautions against that interpretation. In the real world, all biological and social systems are open. They experience and depend on nonlinear interactions for their existence (Prigogine and Stengers, 1984). Furthermore, economic systems (Knight, 2014) and societies (Funtowicz and Ravetz, 1994a) cannot be deterministic and fully known. In terms of real-world socio-ecological systems, all challenges are complex. We may choose to believe that a system can be perfectly known and controlled and that a challenge is specific or diffuse. However, this choice may turn problematic as oversimplification may overshadow underlying complexities and make governance ineffective at best.

Humans create order by means of technology, infrastructure, institutions and social practices (Latour, 1993; Prigogine and Stengers, 1984). These typically work by simplifying, linearising and delimiting systems; for example by building factories, cultivating landscapes and disciplining behaviour. Examples include markets or political states, but also systems in nature such as natural reserves or single species populations. In periods of order and stability, the systems may be governed without too much failure as if they were simple and under control. Individual, collective and institutional actors may then feel that the systems are linear and challenges are not systemic nor complex. In fact, the systems may appear to be easily controllable because the perceived level of control so far has been good. However, this feeling is little more than a psychological habit (Hume, 2013). The current experience of polycrisis and turbulent times could indicate that old habits and feelings of control are becoming dysfunctional.

2.2 Conceptual frameworks for systemic and complex challenges

Since the 1990s, developments in environmental sciences have given rise to an abundance of conceptual frameworks and tools for the analysis of systemic and complex challenges. These include integrated environmental assessments, the Driver-Pressure-State-Impact-Response (DPSIR) framework, system dynamics, complex adaptive systems theory, multi-scale integrated analyses of societal and ecosystem metabolisms, nexus methodologies and multi-criteria evaluation (Toth and Hizsnyik, 1998; EEA, 1999; Rammel et al., 2007; Munda, 2008; Giampietro et al., 2009; Spangenberg, 2011; Endo et al., 2020). Governance approaches to systemic and complex challenges have also multiplied over the same period. To some extent, descriptions, analytical tools and governance approaches develop in conjunction. However, the relationship is not one-to-one (see Urbinatti et al., 2020). A selection of key conceptual frameworks for describing systemic and complex challenges is presented in Table 2.2.

Understandings of complexity

The key differences between the frameworks introduced in Table 2.2 are related to the understanding of complexity, which can be understood on a scale from thin and thick complexity (Strand, 2002). Thin/reductionist complexity concepts assume a complex 'reality' out there, which is independent of the observer. A system would accordingly be defined as complex if it is differentiated and changing, presenting non-linearity and emerging properties that challenge predictability. This concept is not too different from the 'systemic' understanding of challenges introduced in Table 2.1.

Thick complexity concepts, on the other hand, include the role of the observer and their analytical choices in the definition of complexity. In this view, complexity requires the use of multiple scales of analysis as well as perspectives, which cannot be reduced to one another (Ahl and Allen, 1996; Kovacic, 2017; Kovacic and Giampietro, 2015; Rosen, 1985; Zellmer et al., 2006).

Thin complexity approaches take some uncertainty, nonlinearity and interconnectedness into account and continue to uphold the belief that the system can be governed to some extent. Attempts to govern by using complex system models or 'digital twins' (i.e. digital replicas of a given system) is one example of that type of approach. In the context of sustainability challenges, systemic risk frameworks are another prominent example, such as those of The Knowledge-Action Network (KAN) on Emergent Risks and Extreme Events (Risk-KAN) and the International Risk Governance Council (Sillmann et al., 2022; Renn and Walker, 2008). Both are examples where the diagnosis of a problem is developed in close conjunction with advice related to action. In both, complexity is seen as a feature of a reality 'out there' independent of the observer.

Another frequently cited framework is the Cynefin model (Rancati and Snowden, 2021; Kurtz and Snowden, 2003). 'Cynefin' is a Welsh word for habitat. In short, it postulates that decision-making processes can be classified as belonging to one of five domains (or habitats) along a scale of increased complexity (currently called clear, complicated, complex, chaotic and confusion), each with their characteristics and recommendations for good practice. With thick complexity, where the person observing and/or acting on the system is unable to characterise it, confusion is a key feature. With this framework, however, the expectation is that knowledge will accumulate over time and decisions will move to increasingly benign contexts, from chaos to stability.

The VUCA framework has a similar expectation. Developed in 1987 by the US Army War College based on an empirical study of leadership (Bennis and Nanus, 1985), VUCA is an acronym for the words volatile, uncertain, complex and ambiguous. Each is seen as a characteristic of challenges for which there is a designated response.

Table 2.2 A selection of conceptual frameworks for systemic and complex challenges

Framework	Main concepts and features	Understanding of complexity
Systemic risk/ Risk governance	Systemic risks can only be understood and characterised at the systemic level. Scientific characterisation of such risks is emphasised to reduce the gap between data on systemic risks and policy making. This concept is well connected with elaborated guidelines for risk governance.	**Thin complexity**, close to the EEA concept of systemic challenges, focuses on the reduction of uncertainty. However, within the literature, systemic risk can also be seen as socially constructed and therefore indicates thick complexity (Maskrey et al., 2021).
Cynefin	Cynefin presents a typology of decision-making contexts (clear, complicated, complex, chaotic, confusion) and corresponding strategies for decision-making within each one.	There is an element of thick complexity as the possibility of chaos and confusion exists. However, the theory is **thin complexity** as it posits that contexts objectively exist, rather than being constructs themselves, and furthermore challenges will become easier to deal with as knowledge accumulates.
VUCA	The VUCA framework originated in the military context at the end of the Cold War and later gained traction in other contexts. VUCA is an acronym for volatile, uncertain, complex and ambiguous.	While VUCA concepts are flexible and in principle could be compatible with thick complexity, they are frequently combined with the understanding that volatility etc. are objective properties of an external (social) world, to be understood and governed. This makes VUCA concepts ones of **thin complexity.**
Wicked problems	The theory of wicked problems aims to account for the failure to solve or resolve planning and policy problems. It focuses on interlinkages between problems and a lack of consensus on what counts as a solution. Solution requirements are diverse and variable and the solution of one problem may create or exacerbate another problem.	**Thick complexity** as there is no definitive formulation of a wicked problem.
Post-normal science	The post-normal science (PNS) framework developed from analysing the governance of environmental problems and technological risk. PNS accounts for the persistence of controversies at the science-policy interface and focuses on characterisation and management of uncertainty. As knowledge and values are not independent, knowledge production should be extended beyond certified experts accordingly.	**Thick complexity,** as post-normal problems may have multiple legitimate but internally incoherent descriptions and because humans change the world by knowing it.

Because global sustainability challenges are seen as especially difficult to contain, thick complexity approaches are of particular interest to this report. The concept of wicked problems, developed originally in the field of urban planning (Rittel and Webber, 1973), is one example of thick complexity that has gained traction in sustainability studies as a realistic description of governance problems. A main feature of wicked problems — extended in the concept of super-wicked problems (Box 2.3) — is that there is no consensus on how to frame the problem and what counts as a solution. Moreover, more knowledge about the problem does not necessarily translate into knowledge about how to solve it.

Box 2.3

Wicked and super-wicked problems

Ten features of wicked problems (from Rittel and Webber, 1973):

1. There is no definitive formulation of a wicked problem.
2. Wicked problems have no stopping rule.
3. Solutions to wicked problems are not true-or-false, but good-or-bad.
4. There is no immediate and no ultimate test of a solution to a wicked problem.
5. Every solution to a wicked problem is a 'one-shot operation'; because there is no opportunity to learn by trial-and-error, every attempt counts significantly.
6. Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan.
7. Every wicked problem is essentially unique.
8. Every wicked problem can be considered to be a symptom of another problem.
9. The existence of a discrepancy representing a wicked problem can be explained in numerous ways. The choice of explanation determines the nature of the problem's resolution.
10. The planner has no right to be wrong.

Four additional features of super-wicked problems (Lazarus, 2009; Levin et al., 2012):

- Time is running out. The longer it takes to address the problem, the harder it will be to do so.
- No central authority. The absence of an existing institutional framework of government with the ability to develop, implement and maintain the laws necessary to address a problem of climate change's tremendous spatial and temporal scope.
- Those seeking to solve the problem are also causing it and are also those with the least immediate incentive to act within that necessary shorter timeframe.
- Policies irrationally discount the future.

Post-normal science

The concept of post-normal science (PNS) was originally developed in relation to the analysis of the science-policy interface on issues of environmental and technological risk (Funtowicz and Ravetz, 1985, 1993). This concept includes not only a definition of the problem, but also the practice and understanding of science and governance. The term 'post-normal' refers to Thomas Kuhn's characterisation of normal science as puzzle-solving science, where putting pieces together will eventually lead to a final answer (within its paradigm) (Kuhn, 1962). However in reality, the knowledge base does not always 'stabilise' and uncertainties are not always reduced. In fact, in some cases uncertainties continue to exist over time or even increase in tandem with political controversy. Such 'post-normal' conditions are often marked by: (1) uncertain facts, (2) values in dispute, (3) high stakes and (4) the perception that decisions are urgent (Funtowicz and Ravetz, 1993). These four features are linked intrinsically.

In post-normal conditions, controversies fail to be resolved by appealing to normal science or technical expertise per se. This is because there is no clear-cut separation between facts and values (e.g. cultural, moral) under such circumstances, as broadly recognised in the fields of history, philosophy and sociology of science. The relevance and meaning of facts are instead only judged in processes that are value-based, like

in policy making (Kuhn, 1962; Ravetz, 1971). Therefore, facts depend on how the issue is defined and how system boundaries are drawn, which again depends on the value-system of the observer. As an example, in situations where groups hold different claims that are each seen as legitimate, acknowledging the interactions between technical and political dimensions of the issue is the best approach.

While governmental discourse has been slow to incorporate such understandings, advances are being made (Scharfbillig et al., 2021; Strand, 2022; DEFRA, 2021). In the context of environmental conflicts and biodiversity issues, values and how they are expressed is receiving increasing attention (Funtowicz and Ravetz, 1994b; IPBES, 2022; Martinez-Alier, 2003; Unai et al., 2017).

Insights and principles provided by frameworks like wicked problems and post-normal science correspond well with the contemporary experience of polycrisis, turbulent times and a general lack of satisfactory progress towards sustainability. While acknowledging the legitimacy and value of all presented frameworks, this report places emphasis on post-normal science and its insights on sustainability governance under conditions of high uncertainty and complexity.

2.3 Uncertainty and action: insights from post-normal science

Because of the gravity related to sustainability challenges like the 'triple planetary crisis', the sense of urgency is one of the most defining features of such problems. In scientific terms, urgency means that there is no time to wait for full scientific certainty or even for more information to be produced. From a post-normal perspective, acting on systemic and complex challenges cannot be dependent on waiting for better knowledge. Instead, seeking ways to act and make decisions within uncertainty, complexity and controversy are the norms of environmental governance — acknowledging that urgency may create tensions with the soundness and legitimacy of the decisions (see Chapters 3 and 5).

To understand the level of uncertainty connected to a problem, there are many typologies available to help characterise and analyse the available knowledge for sustainability challenges (Bevan, 2022). Knight (2014) distinguishes between risk, (strict) uncertainty and ignorance. Strict uncertainty can be defined as the incapacity to rigorously and credibly quantify probabilities or likelihoods of specific events. Ignorance denotes the lack of full knowledge of the outcome. The presence of ignorance may be known, suspected or unknown to the decision-maker (so-called 'unknown unknowns'). Moreover, in principle, causal systems are open. System boundaries can be challenged and the framing of the decision problem changed according to the observer and their values. This phenomenon is called indeterminacy (Wynne, 1992).

Different conceptual understandings of uncertainty favour different governance regimes. Framing uncertainty as risk, defined as a quantifiable probability of harm, means that the logical response is to try and reduce it. If uncertainty cannot be reduced (at least not in the timeframe of the decision), one might need to move beyond uncertainty reduction as a response and search for responses that can help the system thrive in the context of uncertainty and complexity. For this reason, definitions of uncertainty and responses are better understood together, as reviewed in Table 2.3. Situations described in the table are not mutually exclusive, nor do they exist objectively. In any real situation, there will be elements of risk, uncertainty and ignorance. Their characterisation will be relative to the system definition, which again depends on the problem framing.

Table 2.3 A selection of types of partial knowledge

Situation	State of knowledge	Examples of governance approaches
Risk	'Known' impacts and 'known' probabilities	Risk management
Uncertainty	'Known' impacts and 'unknown' probabilities	Precautionary approaches that do not require certainty or risk to act
Ignorance	'Unknown' impacts and therefore 'unknown' probabilities — 'unknown unknowns'	Anticipatory and adaptive approaches that try to manage ignorance, reduce vulnerability and enhance resilience
Ambiguity	'Known probabilities' but 'unknown impacts' as one cannot predict which of the possible impacts will be realised and how it will unfold	Extending the peer-community and working deliberatively within imperfections; precaution; disaster preparedness
Indeterminacy	Impacts are unknown and their identification depends strongly on the choice of system boundaries because cause-effect relations are open-ended	In general, governance in complexity approaches (see Chapter 3)

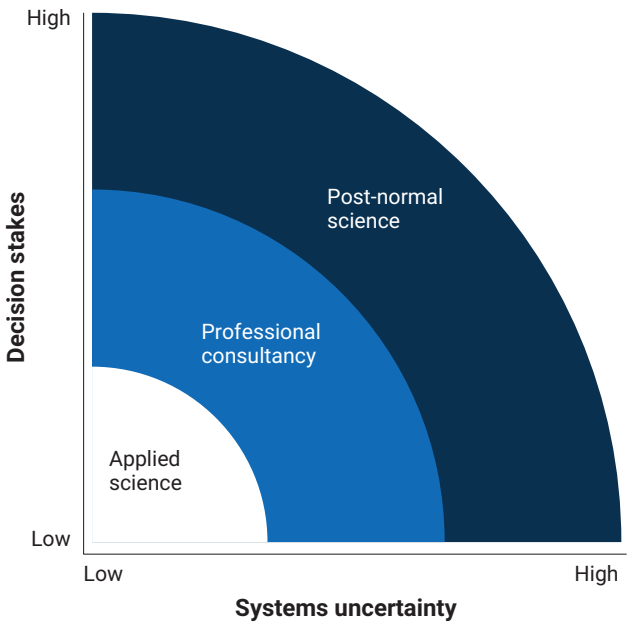
Sources: Source: EEA's compilation based on the work of Douguet et al., 2009; EEA, 2001; Stirling, 2017; Wynne, 1992.

A state of strict uncertainty, ignorance or indeterminacy would mean that rigorous, quantitative risk assessments and risk-cost-benefit analyses are invalid or impossible (EEA, 2001). Such situations should be addressed through deliberation within imperfection rather than forced quantification.

Post-normal science provides a number of recommendations for how to resolve persisting controversies, focusing on uncertainty management and the extension of peer communities (Funtowicz and Ravetz, 1993). Post-normal approaches have been tested extensively since the 2000s (Silva and Teixeira, 2011; Turnpenny et al., 2011; Buschke et al., 2019).

In the post-normal science framework (see Figure 2.1), both uncertainties and the stakes of various decisions can vary from low to high. Each level generates different challenges both for science and the science-policy interface. As uncertainty and/or decision stakes increase, it becomes less clear which type of expert should be consulted and solution be pursued, as each solution will have a different trade-off. In this context, different experts could be called on and a variety of problem framings should be considered.

Figure 2.1 The post-normal science diagram



Source: Funtowicz and Ravetz, 1993.

At very high levels of uncertainty (e.g. in case of ignorance, ambiguity and indeterminacy), even the definition of expertise becomes problematic. Problem definitions will differ, so the effects of different courses of action are never fully understood. Definitions and suggestions for solutions will therefore always be problematic and the use of scientific expertise becomes political in itself. This has been well-documented (Dupont et al., 2023). Because complex challenges involve multiple and interconnected natural, technical, social, economic and political domains — and relate to many dimensions, scales and domains — governing these challenges will inevitably produce winners and losers, trade-offs and compromises.

In this context, the way challenges are understood cannot be seen as independent of how they are managed or governed. To respond adequately, the post-normal science literature suggests extending the peer communities. This requires opening up the processes of knowledge production beyond science to include different types of knowledge, ranging from practical, to tacit, to local and indigenous. This also includes the knowledge of actors that are ultimately affected by the decisions made. This proposition has fundamental implications for the governance of sustainability challenges, as illustrated in the following chapters.

3 What form of governance to choose for sustainability?

Key messages

- Normative frameworks for environmental and sustainability governance are emerging. Most of them coincide on the need for change to the socio-economic system but differ on the theories they use.
- While the call for transformative change is clear from environmental sciences, systemic and complex challenges highlight questions around the ability to govern the socio-economic system and tensions between substantive and procedural values in good governance.
- To tackle sustainability challenges, focusing on both substantive and procedural dimensions (the what and the how) are necessary. Dealing with systemic and complex challenges requires a shift away from 'solutions', meaning the action to be taken, towards 'resolutions', focusing more on process. The latter includes drawing on the agency and creative resources of citizens and civil society.

This Chapter presents an overview of sustainability governance frameworks and presents key issues when governing sustainability challenges, building on the understanding of sustainability issues as systemic and complex problems (see Chapter 2). It highlights tensions between substantive and procedural goals and principles as cause for new approaches to governance.

3.1 Normative frameworks of sustainability governance

Against the backdrop of multiple environmental and social challenges and insufficient progress towards sustainability, there is a clear need to reflect on current practices and policies. This reflection raises several questions: should the current socio-economic system be made more resilient to crises or should production and consumption practices be made more sustainable? If sustainability requires systemic change and the phasing out of unsustainable practices, how should the inherent trade-offs be handled?

On a more philosophical level, debate is growing around the definition of sustainability and the values that should guide sustainability governance. Sustainability of what? For whom? For how long? These questions will define what is an intrinsically normative debate about how to respond to environmental challenges.

The question of how to understand and manage environmental and societal challenges has risen in prominence since the mid-2010s (EEA, 2015b) and led to a growing field of emerging normative frameworks for sustainability governance. Table 3.1 summarises the main perspectives on how governance models could change and how these shifts could take place. The literature on sustainability transitions has been the basis of several EEA and Eionet publications (Eionet, 2016; EEA, 2017, 2019a, 2021c),

which draw directly on emerging research on academic sustainability transitions and transformations. Different perspectives are based on disparate theories of change. Some see the key to a more sustainable future in technological change and innovation; to others it lies in the reconfiguration of the relationship between society and the environment; others think it requires in changes to the economic system; and some favour procedural aspects related to the justice system.

Table 3.1 Transition and transformation theory clusters

Transition and transformation theory clusters	Core ideas and concepts	Characterisation of key challenges	Theory of change	Practical examples
Sociotechnical transitions	Sociotechnical systems include technologies, infrastructure, regulations, norms and discourses. Multi-level perspective (Raven et al., 2010): interactions between innovation niches, regimes and landscapes.	Systemic challenges that are interdependent with (Western) lifestyles, technologies, infrastructure and cultures.	Top-down stimulation by governments as well as horizontal coordination between sectors. Transition governance emphasises phasing out unsustainable practices; diffusion and upscaling of (technological) innovations; incremental improvements at the niche level; and radical system change at the regime level.	Sustainability transitions (Kemp et al., 2007; Loorbach and Rotmans, 2010; Raven et al., 2010)
Socio-ecological transformations	Social metabolism. Socio-ecological systems as complex, adaptive and resilient systems. Alternative development trajectories and pathways.	Misalignment between biophysical and social processes. Humanity has become the major driver of global environmental change ('the Anthropocene').	Fundamental re-orientation or transformation of society and economy beyond mere 'technological fixes'.	Degrowth (D'Alisa et al., 2015; Escobar, 2015)
Socio-economic perspectives	Production and consumption patterns as drivers of the economic system. Fundamental role of values and worldviews in enabling or hindering systemic transformation.	Materialism and consumerism as drivers of sustainability challenges. This includes unsustainable resource use and lifestyles.	Changes in economic paradigms can shift values, mindsets and lifestyles. Socio-economic perspectives emphasise the role of market forces in driving the diffusion of new technologies.	Circular economy (Stahel, 2016)
Action-oriented perspectives	Governance of the commons, polycentricity, practice theory.	Challenge of allowing for self-management of ecosystems in diverse and dynamic landscapes, taking into account context-specificity and community needs.	Community-based civic society led bottom-up transformation. Initiatives may be replicated (scaling out); they may be institutionalised at higher levels or influence policy (scaling up); or they may become more deeply embedded in social norms and values (scaling deep) (Moore et al., 2015).	Adaptive governance of the commons (Folke, 2007)
Just transitions	Distributional and procedural justice, environmental justice, recognitional justice.	Consequences of sustainability transitions on marginalised actors and minorities: how vulnerable groups are impacted differently by sustainability transitions.	Empowering and giving voice to indigenous peoples, social movements led by socioeconomically disadvantaged and marginalised communities, acknowledging that fights for human rights and environment are often inseparable.	Social movements for environmental justice (Martinez-Alier, 2023)

Normative discussions of governance and sustainability are mainly connected to two elements: the gravity of crises, in association with the scale and pace of the change needed to address them, and the governability of the transformation towards sustainability.

The extent to which socio-economic regimes need to change to be sustainable relates to the question of change itself. Can sustainability be achieved through incremental changes like efficiency improvements, redirecting consumption to sustainable goods, green energy and fair trade, fiscal incentives and taxes that promote corporate social responsibility? Or is fundamental change required, meaning radically different societies and economies?

The theoretical framework of sustainability transitions combines the incremental and fundamental change perspective, claiming that systemic change starts in 'innovation niches' that can be scaled up and, as they accumulate, lead to a larger change at the system level (Geels and Schot, 2007). Others warn against the dangers of 'regulatory capture' from the way transitions are sometimes described and envisioned within this framework. Stirling (2014, p. 84) states that 'novel 'transitions' may readily end up concealing what are in actuality deeper realignments with existing structures. In other words, the realised forms of 'transformation' may be more discursive and superficial than material and substantive.'

The EEA (2017, p. 6) has previously called for Europe to 'go beyond incremental improvements in environmental performance. Instead, it must find ways to achieve fundamental transitions or transformations in core systems' and that 'fundamental' signifies profound changes of 'institutions, practices, technologies, policies, lifestyles and thinking'.

Within the sustainability transitions framework, the call for deep change demands rethinking and remaking society:

> According to these new perspectives, transitions are non-linear, society-wide processes, with a central role for bottom-up processes of innovation, experimentation, learning and networking. Change occurs through interdependent adjustments in technologies, business models, behaviours, rules, values and so on, producing non-linear and highly unpredictable results. Public policies and institutions are part of the regime structures, implying that they too need to be transformed (EEA, 2019, p. 8).

Discussions around the gravity of systemic and interconnected crises mainly come from framings in literature on climate change, where environmental crises are understood as global and urgent issues that constitute an existential threat. Here, the concept of 'tipping points' signals that conditions for (human) life may be compromised. There is a growing literature on the notion of collapse, based both on historical analysis and awareness that societies have collapsed before (Tainter, 1990; Lenton et al., 2023; Centeno et al., 2023) and doing forward-looking assessments that explore how to respond to collapse (Diamond, 2011).

The framing of environmental challenges as existential risks invites several reflections about the need for *inner* transformation related to consciousness, mindsets, values, worldviews, beliefs, spirituality and human–nature connectedness (Woiwode et al., 2021), as well as the interdependence of individuals, collectives and systems (Ives et al., 2023). Changes in mindset are seen as fundamental to turn vicious cycles into virtuous cycles, which spill from inner understandings to policy and decision making (Wamsler and Bristow, 2022; Oliver et al., 2022).

Secondly, the literature on socio-ecological transformations raises questions around the extent to which transformations are governable. The question of directionality becomes a key issue, as there is 'no clear vision of the make-up of the resulting society' (Haberl et al., 2011, p. 11).

The question of transition governability is prominent in the sustainability transitions literature. This acknowledges complexity and the fact that transitions cannot be deliberately planned but still can be managed by nurturing the right kinds of innovation. Governance is framed as 'coordination', 'alignment of visions' or 'convergence' (Geels and Schot, 2007, p. 402).

Approaches like integrated assessment modelling similarly represent a narrow view of governance, premised on the idea that governance is hierarchical and operating in a system that is essentially stable. Here the role of governments is to define targets, set rules of how they are to be achieved and create incentives through regulating markets and other social sectors.

Proponents of transformation and broader transition theories instead favour approaches of network governance (EEA, 2017) and call for change within the institutions responsible. The EEA (EEA, 2017, p. 27) states that 'tackling complexity and achieving transitions will depend in part on overcoming silos and enabling information to flow freely across government and across scales. It will also require the development of adaptive governance frameworks that operate via iterative cycles of planning, implementing, monitoring and learning.'

3.2 Emerging governance challenges and tensions

In this report, governance is understood as a broad societal phenomenon. This differentiates from that of government, which is often described by governmental agendas and the ecosystem of surrounding actors and institutions, as reflected above. The definition of governance proposed by the Commission on Global Governance (CGG, 1995) is the starting point:

> Governance is the sum of the many ways individuals and institutions, public and private, manage their common affairs. It is a continuing process through which conflicting or diverse interests may be accommodated and co-operative action may be taken. It includes formal institutions and regimes empowered to enforce compliance, as well as informal arrangements that people and institutions either have agreed to or perceive to be in their interest. (CGG, 1995, p. 2).

Governance as 'the sum of the many ways individuals and institutions manage their common affairs' includes market interactions and most activity in civil society, including community life and political debate. In governance literature, a distinction is frequently made between: (1) governmental (hierarchical/vertical) action by intervention logics and means of formal rules, regulation, taxation, laws and standards; (2) market governance and (3) network (horizontal) governance by informal social systems (Meuleman, 2020).

An overview of environmental and sustainability governance in the EU is offered in Box 3.1.

Box 3.1

Environmental (and sustainability) governance within the EU

A sophisticated system of governance exists within the governmental institutions of the EU. This includes institutional structures, processes and mechanisms for decision- and policymaking. It also incorporates the broad regulatory framework encompassing all the legislation, treaties, case law and international agreements that the EU has adopted and developed since its inception — the EU *acquis* — which dovetails for all EU policy areas.

The foundation of the EU's approach to governing the environment (and later sustainability) is laid out in the Treaty on the Functioning of the European Union, which together with the Treaty on European Union form the basis of the EU constitution and EU law. In its consolidated version the Treaty specifies that EU policy on the environment shall contribute to:

- preserving, protecting and improving the quality of the environment;
- protecting human health;
- prudent and rational utilisation of natural resources; and
- promoting measures at international level to deal with regional or worldwide environmental problems and in particular combating climate change.

It indicates that EU policy on the environment shall aim at a high level of protection on the basis that 'the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay'.

In the context of the EU policy and law-making cycle, the Better Regulation agenda defines a set of initiatives and principles geared towards improving the quality of the EU legislative process (EC, 2024a). While applicable to processes across various policy areas, its key principles are clearly relevant for environmental policymaking: it stresses the importance of evidence-based policymaking and therefore encourages the use of scientific evidence, data and impact assessments in policymaking. In addition, the Better Regulation Package — through the REFIT programme — intends to simplify EU legislation by reducing administrative burdens, encouraging compliance. These measures aim to improve the efficiency of regulatory frameworks. They also promote transparency and accountability, the conduct of both ex-ante and ex-post evaluations and the involvement of citizens, businesses and stakeholders in decision- and policymaking processes throughout the entire policy lifecycle. The principles of proportionality and subsidiarity guide the EU in its endeavour to ensure policies are implemented and laws are complied with.

Overall, the EU's approach to environmental and sustainability governance includes a great number of policies and laws on 'water, nature, air and waste', commitment to the UN Sustainable Development Goals, and crosscutting (e.g. sustainable finance) and high-level initiatives (e.g. greening of the European Semester). These are continuously developed in tandem with governance mechanisms by improving the whole policy cycle from the process of planning and proposing laws to implementation, monitoring compliance and — where necessary — legal enforcement.

Public participation is envisaged across the policy cycle by means of thematic (e.g. the Water Framework Directive) and cross-cutting legislation (e.g. Environmental Impact Assessment (EIA) Directive (EU, 2014) and the Strategic Environmental Assessment (SEA) Directive (EU, 2001)), as well as through initiatives like the 'Have Your Say' portal. Together they constitute key opportunities for vertical and horizontal knowledge integration, as they allow for local, regional and lay knowledge to be included in policymaking.

Recently, citizen engagement and participation in policy- and decision making on sustainability matters has received renewed attention (see e.g. the Conference on the Future of Europe), especially on questions around the governance of sustainability transitions and on the modalities and goals of public participation (EEA, 2023c).

In this context, multi-level governance models, 'intended as models of governance which may embrace international, supranational, cross-border, national and subnational (regional, intermediate and local) levels of governance, delivered with participation of the people, civil society, and other organisations and stakeholders' (Dunoff, 2021), have grown in prominence. The Urban Agenda for the EU is a very relevant example (EC, 2021a). It presents itself as an 'umbrella' for all urban policy initiatives, helping to strengthen urban policy at all levels, from city to Member State to the EU level. It also provides a place to integrate multiple EU programmes and initiatives addressing sustainable urban development, strengthening the importance of the local level within the EU environmental governance framework.

3.2.1 Substantive goals versus procedural principles

The Commission's *White Paper on European Governance* (EC, 2001) defines governance as 'rules, processes and behaviour that affect the way in which powers are exercised at European level, particularly as regards openness, participation, accountability, effectiveness and coherence'. The EU white paper therefore defines good governance largely in terms of procedural principles.

This aligns with the common view in political philosophy that a decision should be judged on the procedure of arriving at the decision — the process of resolution and handling of trade-offs — rather than the resulting outcome, because the outcome will always be influenced by elements outside the decision maker's control.

In the area of environmental, climate and sustainability policy advice, expertise has traditionally been dominated by natural science disciplines. Viewed through the natural scientists' lens of data and measurement, the appropriateness of a decision would typically be evaluated in substantive terms, asking if the outcome has achieved a pre-defined goal. As described in Chapter 2, views on what are good or desirable goals can always be disputed in post normal conditions characterised by complexity. The corollary is that purely substantial goals would be challenged.

Tensions around what determines a good decision are magnified when dealing with the complex and systemic character of sustainability challenges. Scientific uncertainty, indeterminacy, ambiguity and framing plurality means that conventional evaluation instruments like model predictions, cost-benefit-analyses or risk assessments are increasingly unsuitable for evaluating decisions. As a result, public decision-makers may fail to receive sufficient public endorsement to go forward with policy and implementation. Otherwise the implementation may become contested and reversed in the political process. This tension is helpful to better understand the insufficient progress towards sustainability: the result of trying to balance substantive goals (outcome) and procedural principles (process) is neither sufficient as judged by scientific advice nor legitimate as rendered by the political process.

3.2.2 Challenges to legitimacy and transformation

In democratic modern states, the division of labour between public administration and democratic institutions is fundamental and the people are seen as the only legitimate source of political power. Accordingly, decisions in public administration must be informed by the best available science as well as value choices that have been determined through democratic processes.

This tension becomes critical when insights of sustainability transitions are translated into policy recommendations, as done with the ten policy messages distilled in the report *Sustainability transitions: policy and practice* (EEA, 2019a):

1. Promote experimentation with diverse forms of sustainability innovation and build transformative coalitions;

2. Stimulate the diffusion of green niche innovations;

3. Support the reconfiguration of whole systems, phase out existing technologies and alleviate negative consequences;

4. Leverage and strengthen the role of cities in sustainability transitions;

5. Reorient financial flows towards sustainable and transformative innovations;

6. Promote clear direction for change through ambitious visions, targets and missions;

7. Align policies between different domains to improve policy coherence for transitions;

8. Promote coherence of actions across EU, national, regional and local governance levels;

9. Monitor risks and unintended consequences and adjust pathways as necessary;

10. Develop knowledge and skills for transitions governance and practice.

As reflected in the above, uncertainty and complexity are often reduced to technical problems that can be solved through innovation, coherence and new skills (Kovacic and Benini, 2022). Kovacic and Benini (2022) point to three tensions and related 'balancing acts' when bridging academic research and policy.

The first tension lies in the issue of governability, which is impacted by the complexity and gravity of contemporary societal challenges, as explained in Chapter 2 of this report. The acknowledgment that governability is limited must be balanced against the legitimacy of governing institutions. A second tension is related to the social contract of agencies and other organisations in the science-society interface, as well as their relationship both to policy and the public. On the one hand, the legal mandate of such organisations may be to provide evidence for policymaking and thus 'speak truth to power' (Waterton and Wynne, 2004). On the other hand, expert advice and governmental decision-making could become contested because major sustainability challenges display the characteristics of post-normal conditions. In these cases, stakes are high, facts are uncertain, values are in dispute and decisions are urgent (Funtowicz and Ravetz, 1993). In such conditions, the legitimacy of public administration becomes destabilised and unclear. Dealing with complex environmental challenges instead calls for the inclusion of a more diverse set of actors and different ways of knowing by involving an 'extended peer community' (Funtowicz and Ravetz, 1993).

The third and related tension concerns issues where uncertainty and complexity prevail. Here a balance needs to be found, between answering questions related to pressing policy- or decision-making and raising new questions — or at least ensuring that they have the space in which to be raised. In the context of such uncertainty, it becomes crucial to expand the range of possible inputs to debates around policy to include narratives, future visions among others as well as to create spaces for reflexivity (Strand et al., 2018).

For instance, in the case of climate change, de facto governance responses can either be close to no action or deem climate less important than other issues. Seemingly, this might even be the result of open, fair, transparent, participatory and accountable processes. One unsolved problem for democracies, however, is that the representation of future generations' concerns (and those of non-human life) are not included.

Solutions that are neither fair nor just, or processes that are not open, participatory and accountable, are not only problematic in terms of good governance and ethical grounds but are also unlikely to succeed as they will fail to mobilise agency in civil society. Views within the sustainability transitions literature argue that transformative change will need to be deep and involve the creative resources and agencies of citizens and civil society.

Following the principles of the EU White Paper on Governance, the quality of governance lies not so much in the targets it sets, the missions it defines or the innovation niches it chooses to support and nurture, but in the principles it adheres to while living through complexity and uncertainty.

To solve our most pressing issues, it might be crucial to shift focus merely from the 'what' to also include the 'how' of governance, as reflected in the EU white paper — even when urgency might suggest otherwise. Experiences conveyed in sustainability transitions literature suggest that focusing on *both* substantive and procedural dimensions (the what and the how) are necessary. To respond to this need, Chapter 4 presents the approach and concept of 'governance in complexity'.

4 Moving towards 'governance in complexity'

Key messages

- The report explores the concept of 'governance in complexity'. It is defined as the attempt to govern a system while being aware that it cannot be perfectly known or controlled, and actors of governance are themselves part of or interconnected with the system.
- Key principles of governance in complexity include experimentation, systems thinking, participation, precaution, anticipation and care.
- Governance in complexity should be cultivated as a mindset defined in terms of the level of awareness by its practitioners, not as a set of procedures or tools.

Based on the evolving understanding of sustainability challenges and sustainability governance (Chapters 2 and 3), this report arrives at the concept of governance in complexity. This approach to governance was developed as a response to the specific complex nature of sustainability challenges. This Chapter offers a first attempt at a definition of governance in complexity, alongside a set of suggested principles. Both are developed from academic literature and refined by real-life examples illustrations and actual governance of sustainability practices (see Annex 2).

4.1 What is 'governance in complexity'?

The definition of governance in complexity is less important than its practice and what follows should not be understood as a blueprint. To understand what could be gained from this approach, it is perhaps best to consider it in contrast to the existing — or what it is *not*. As will become evident, this does not imply that conventional approaches are not needed.

Most characteristically, governance *in* complexity is different from governance *of* complexity. This aligns with a view of governance as a broader societal phenomenon, as presented in Chapter 3, relating to more than the ecosystem actors and institutions that surround government. Traditionally, public decision-makers tend to somehow see themselves as outside and 'independent of the system that is being governed' (Rip, 2006). As argued in previous chapters, such simplifications are inadequate for challenges that are systemic and complex and could help explain the lack of progress on sustainability issues. Therefore, a reflexive mindset is at the core of the working definition brought in this report, which should be tested and improved through experimentation and learning:

> Governance in complexity is the attempt to govern a system, while being aware that (a) the system cannot be perfectly known or controlled and (b) actors of governance are themselves part of or interconnected with the system.

As the framings of problems and challenges are dependent on a complex set of political, cultural and moral values and knowledge claims (Wynne, 1992), so too are the practices of governing them. In any given case, the governance approach to some challenge would implicitly or explicitly amount to considering it as either specific, diffuse, systemic and/or complex, always with the risk of failure. To reflect on and discuss choices of descriptions and framings, it might be helpful to distinguish between two attitudes towards knowledge and governance: adaptive and assertive.

These opposing postures can be thought of along the lines of the Chinese pair of concepts yin and yang (Table 4.1). These correspond respectively to the notions of thick and thin complexity (Strand, 2002) (see also Section 2.2).

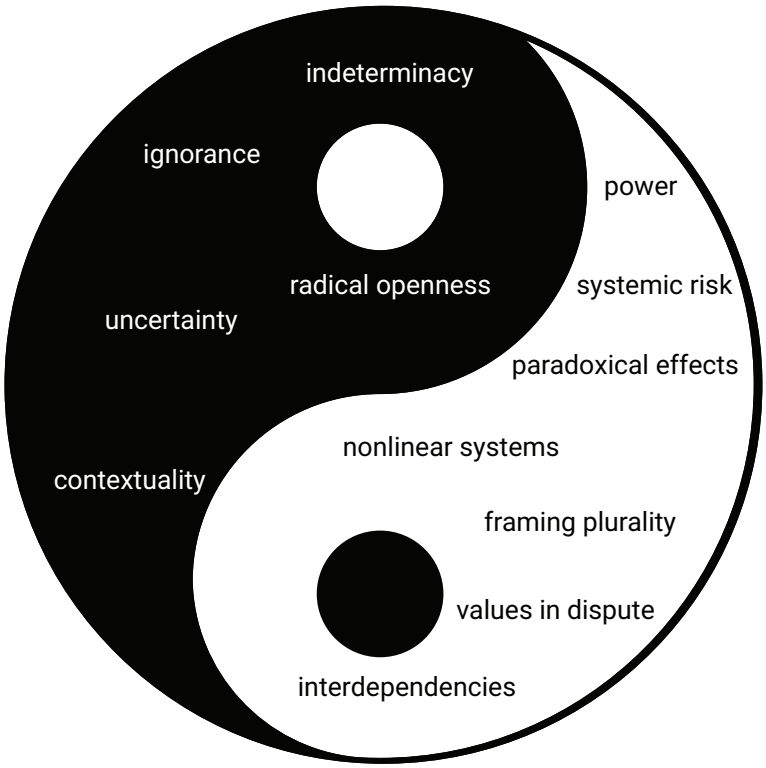
Table 4.1 'Assertive' and 'adaptive' thinking in knowledge and governance for sustainability

Aspect and focus	Knowing (and not-knowing)	Acting
Assertive	**It is ...** (nonlinear, complex adaptive systems, with feedback loops, multilevel, with path dependencies, lock-ins, rebound effects...)	**It ought to work to ... / We should go towards ...** (achieve policy coherence, aim for systemic solutions)
Adaptive	**It is more than ...** (linear, nonlinear, complex adaptive systems...) **It is un-**certain and -predictable, **in-**deterministic and -determinate	**It may be not enough to ... / We should go beyond ...** (we should aim for deep and radical change, transform, experiment, develop new and unknown social practices)

When considering systemic and complex challenges, the characterisation of their features can be ordered from an adaptive to an assertive pole, corresponding to yin and yang respectively. Assertiveness takes the form of having a high degree of belief in the characterisations of the system(s) (Figure 4.1). Claims of nonlinearity, interdependencies and systemic risks are in this sense more assertive, while claims or suspicions of ignorance and indeterminacy are closer to an adaptive and receptive pole.

Most essential — and just as with yin and yang — we will always need a combination or balance between these two attitudes. The awareness of uncertainty and complexity — and the search for societal transformations which are necessarily unknown — must be coupled and balanced with assertive and directive thinking in knowledge and governance to be translated into action. Governance in complexity is about progressing within such inevitable tensions and imperfections.

Figure 4.1 **Descriptors of systemic and complex challenges, ordered in a fish-shaped yin-yang taiji map**



Source: EEA.

The assertive yang posture provides positive, affirmative characterisations and knowledge claims, actions and governance approaches: the world is a huge, complex adaptive system with multiple, interrelated drivers of change. If we improve our scientific understanding of this system, there is – *there ought to be* – a way of governing it that surely is prone to imprecision and error but that gets the job done of improving sustainability. In its focus on knowing, it is optimistic. In its focus on acting, it is solutionist. It values agency, strength and instrumental rationality and asks for 'solutions' and knowledge that is 'actionable'. It imposes its own goals on what is being governed, using force to create impact (Haraway, 2016).

The adaptive, intuitive and receptive yin posture attends to uncertainties and what cannot be known, including knowledge that the world is too complex to be represented in models. Accordingly, it will not act as if the absence of evidence of harm equates to evidence of absence of harm. Some adaptive yin concepts for descriptions may sound affirmative but their meaning is to say: 'it is more than...'. This is sometimes revealed by negative prefixes such as in *un*certain and *in*deterministic. With some concepts, it is less obvious. Other concepts from the yin domain, like emergence, chaos, tipping points and free will, all describe that something else and something more than what we have imagined and prepared for may happen.

As for action, adaptive yin concepts point beyond business-as-usual, towards radical change, deep transformation, institutional change, public participation and new social practices. These are all concepts that call for something new and unknown. A yin action resembles the way water creates caves and shapes valleys: finding its way through obstacles rather than eliminating them, while leaving the unmistakable mark of its work.

This type of action departs from the dominant policy discourse, such as calls to boost innovation. Such calls are often requests for something already well known, namely products and services that may have novel details but with similar economic and social functions to the old.

The assertive aspect assumes much from non-systemic linear thinking, while the adaptive aspect is radically different. The latter has been traditionally associated with less prestige or symbolic and institutional power. More assertive ways of knowing and acting have dominated institutional discourse.

Governance in complexity is a matter of trying to put both aspects into action: the adaptive and intuitive as well as the assertive and affirmative. This requires experimentation, humility and respect for the magnitude of the challenge.

4.2 Principles of governance in complexity

Characterising the principles and features that fit into the mindset of governance in complexity can help clarify governance approaches to sustainability issues. In any particular case of real-world governance, however, features will interact, mutually stimulate each other, and even exist in slight tension. It is therefore important to note that governance would not be better if it satisfies more of the principles presented below rather than few. However, such principles are helpful to understand choices made in governance approaches, such as the current EU-level policies of crisis presented in Chapter 5.

The selection of the six principles presented in this Section is built on academic literature of normative frameworks for sustainability governance. It was refined through a co-creation process at the EEA (see Figure 4.2) and informed through key features from a broad range of examples of sustainability governance across multiple levels in Europe and beyond (Annex 2 and Figure 4.4).

The EEA held a workshop with governance experts in June 2023, in which participants explored characteristics of governance in the context of complexity and uncertainty, sharing the associations presented in Figure 4.2.

Figure 4.2 **Wordcloud: what do you associate with governance in complexity?**

Source: Answers provided by 20 experts on sustainability governance during a EEA webinar in July 2023.

4.2.1 Experimentation as a transversal principle

Experimentation means to learn by trial and error, therefore accepting that error is a necessary and legitimate part of the process. It also means allowing and boosting creativity (Wolfe, 2020). American scholars have underlined the long-standing role of experimentation in EU governance (Sabel and Zeitlin, 2010). For example, the European Commission's Joint Research Centre (JRC) SciArt (science and art) project explicitly expresses that in order to make progress, one cannot be afraid to fail.

From the perspective of governance in complexity, experimentation can be seen as a fundamental principle. In systemic and complex challenges, there is no blueprint or control. Accordingly, governance in complexity is a largely uncharted terrain and approaches must be invented, improved, and tested by trial and error. To some extent all reviewed good cases of governance in complexity display experimentation (see Annex 2).

To accept failure and error as key elements along the path to sustainability is in itself part of experimentation and a practice of humility. This contrasts with the expectation of win-win solutions that might conceal trade-offs and contestation. Creativity can be seen as the essence of the adaptive approach. In the European context, experimentation is most noticeable in initiatives to increase participation and less visible in technocratically-inclined public administration. Experimentation could in this sense consist of gathering new actors together to work towards a local common goal, such as is evident in the example of climate streets in Finland. It could be trying out institutional innovations at the national level, for instance in national citizen assemblies in Ireland and Austria. Or it could mean forms of tinkering to gradually introduce new elements of governance at the EU level, such as with the Conference on the Future of Europe and the Commission's Competence Centre on Participatory and Deliberative Democracy.

The Catalan strategy for smart specialisation RISCAT2030 is a particularly comprehensive case of experimentation. It sets out to implement third generation innovation policy frameworks to transform its research and innovation ecosystem towards sustainability. Finally, experimentation may also address political culture itself, as in the Mindfulness Initiative that originated in the UK. Its advocates argue that progression towards sustainability requires a cultivation of compassion and emotional intelligence in public and political discourse.

4.2.2 Systems thinking

Systems thinking is a set of cognitive approaches and strategies developed in what is often referred to as three or four 'waves' (Cabrera and Cabrera, 2019; Midgley and Rajagopalan, 2020). In the context of sustainability governance (Voulvoulis et al., 2022), systems thinking focuses on interactions between causal pathways in and across systems, feedbacks and other interdependences (Ackoff, 1994), as well as interlinkages between governance issues (Checkland, 1999). System sciences such as ecology or climate science and specialised fields of systems research (such as system dynamics or the study of complex adaptive systems) form part of the knowledge base. One example of systems thinking is seeking knowledge from different disciplines and domains to perform integrated environmental assessments. In this sense, systems thinking is already represented in the knowledge base of environmental and sustainability governance and through established principles of nexus governance, for example, predominantly in the shape of thin complexity approaches (see Section 2.2).

Governance is a systemic endeavour. One implementation of systems thinking is to seek interactions and collaborations across levels and scales ('multilevel', 'adaptive' and 'polycentric' governance). An example is the Catalan smart specialisation strategy (RISCAT2030) smart specialisation strategy, which attempted to make governance processes contribute to self-organised institutional change, so that institutions could better adapt to challenges. Similarly, frameworks such as meta- and trans-governance form part of systems thinking (Meuleman, 2013, 2020).

Systems thinking can be theoretical as well as practical and applied to both biophysical and socioecological systems, as well as systems of governance. Among recent initiatives, the Commission's strategic foresight reports explicitly implement systems thinking to imagine and develop transition pathways. Systems thinking can be demanding, however. For example, designated programmes to educate and train public servants in systems theory and practice have been launched in both in the UK and Ecuador.

4.2.3 Participation

As presented in Chapter 3, the value and importance of public participation in European policymaking and government is clearly established in the Commission's *White Paper on Governance* (EC, 2001). This recognition was most recently confirmed in the Commission's recommendation on promoting engagement and effective participation (EC, 2023b). Fundamentally, the right to access to information and to be able to participate in public decision-making is a basic democratic right. With respect to environmental matters, this right was established by the Aarhus Convention in 1998. Thousands of experiences with public participation are found across the globe (OECD, 2023).

In the context of governance in complexity, however, the interest in participation goes beyond this fundamental aspect and sees participation as an essential condition for achieving deep and transformative change. As presented in Section 3.2, a key

feature of governance in complexity is to move from the quest for 'solutions' (what to do) to 'resolutions' (focusing on the process of deciding what to do). This calls for an extended peer community (Funtowicz and Ravetz, 1993). A plurality of actors with different needs, concerns, perspectives, and sources and forms of knowledge and values are actively sought and included in the governance process. This is exemplified in a number of the cases in Annex 2, including the Austrian Klimarat and the Conference on the Future of Europe. Their participation improves the chances that resolutions, even if imperfect, are transparent and just. However, the success of participatory processes and fora depend on their path of uptake being clear and transparent, such as in the case of the Irish Citizens' Assembly. The Knowledge Network on Climate Assemblies has systematised lessons from a number of such experiences (Smith, 2023).

Active forms of participation such as co-design and co-creation are encouraged and developed, which can lead to new local sustainable practices. Participation leads to multiple ways of knowing and sources of knowledge (such as local knowledge, lay knowledge, practical knowledge, tacit knowledge) which can hold significant value and should not be dismissed as non-scientific. Such knowledge sources can be instrumental to technical outcomes, as in the reviewed case of the UNDP Accelerator Labs, as well as to social innovation, such as with the instrument of shared agendas (RISCAT 2030).

4.2.4 Precaution

In general, precaution means giving attention to uncertain potential for causing harm. The Rio Declaration of Environment and Development and the Treaty on the Functioning of the European Union both give legal status to the precautionary approach and the precautionary principle in environmental governance (EU, 2020). However, the application of precaution in courts and in public decision-making remains unsettled. This is partly due to tensions with other legal principles such as proportionality and with the political objective of fast technological innovation (EP, 2016; Röttger-Wirtz, 2020; De Smedt and Vos, 2022).

As presented in Chapter 2, risk and uncertainty are fundamentally different expressions of imperfect knowledge. The balance of the yin-yang adaptive and assertive postures in governance in complexity would perhaps call for stronger and broader versions of the precautionary principle (Drivdal and van der Sluijs, 2021). This is better aligned with the understanding of precaution proposed by the EEA:

> The precautionary principle provides justification for public policy and other actions in situations of scientific complexity, uncertainty and ignorance, where there may be a need to act in order to avoid, or reduce, potentially serious or irreversible threats to health and/or the environment, using an appropriate strength of scientific evidence, and taking into account the pros and cons of action and inaction and their distribution (EEA, 2013, p. 649).

Post-normal science offers practical knowledge tools to inform the use of positive versions of the precautionary principle. Such tools can be used to perform comprehensive uncertainty assessments to distinguish between a range of different types of uncertainty. However, governance instruments to support positive versions of the precautionary principle are few. One rare example is the Norwegian Gene Technology Act, which places the burden of proof on innovators to ensure safety, sustainability and ethical acceptability of the release of genetically modified organisms.

4.2.5 Anticipation

To anticipate is 'to take before' or to look forward, imagine possible, desirable or undesirable future developments and act in ways that take such developments into account. On the most fundamental level, all living organisms can be seen as anticipatory systems (Rosen, 1985). All biological organisms have the ability to act in the present on the basis of a (cognitive or other) model of the future. However in the context of transformative change for sustainability, the concept of anticipation is linked to the literature on governance of new and emerging technologies. Here the concept of anticipation is contrasted with prediction (Vervoort and Gupta, 2018). Anticipatory governance (of emerging technologies) has been defined as 'a broad-based capacity extended through society that can act on a variety of inputs to manage emerging knowledge-based technologies while such management is still possible' (Guston, 2014).

The contrast between anticipation and prediction is based on the recognition of imperfect knowledge. Firstly, the presence of uncertainty and ignorance implies that predictions of the future have limited value. A model used to predict the future might be wrong. Taking anticipated developments into account is not a question of *getting the future right*, but to include expectations about the future in present behaviour. Attention is given to potential long-term effects of action, bearing in mind that prediction may be impossible or implausible. For example, the United Nations Development Programme (UNDP) carried out 'futures impact assessments' with questions such as: 'could this policy restrict choice or opportunity for the target population in the future?' (UNDP, 2022).

Secondly, the pervasive presence of indeterminacy implies that looking forward is not an objective activity that is independent of the operator. Choices of how to frame future outlooks, scenarios, forecasts and predictions are loaded with social, political and ethical values (Selin, 2011; Muiderman et al., 2022). In fact, imagining desirable (or undesirable) social and technological futures is a highly political element of the governance system that, depending on the societal sector in question, may play a significant role in public decision-making (Jasanoff and Kim, 2015). The term 'foresight' is often used in a more general way than anticipation. In future studies and futurology, foresight typically signifies an approach. Sometimes, 'foresight' means an interest in possible long-term futures, for instance by use of scenario approaches (Kuosa, 2011; Voros, 2017). Foresight and anticipation activities in sustainability governance vary according to recognition of uncertainty and indeterminacy (Muiderman et al., 2022). As a result, scenario and foresight exercises risk becoming essentially futile attempts of prediction and governance *of* complexity. Several of the cases in Annex 2 illustrate how strategies of reflexivity and participation can be practised to mitigate this risk. In the Commission's strategic foresight reports and EEA-Eionet's Imaginaries for a Sustainable Europe in 2050, expert practitioners of anticipation acknowledged that future-making is never a neutral activity but a way to exert value choices. In other cases, the risk was mitigated by the very design, including the participation of a diversity of actors with different interests, concerns and values. The inclusion of strategic foresight as one of the tools of the Commission's Better Regulation toolbox illustrates the importance of foresight in improving policy design and ensuring that short-term actions are consistent with long-term objectives (EC, 2024).

Finally, in Annex 2, two of the cases chosen to illustrate the six principles of governance in complexity have interesting anticipatory features. In spite of their differences, the Norwegian Gene Technology Act and the Catalan smart specialisation strategy (RISCAT2030) both display a combination of reflexivity and participation, as they devise institutional procedures that orchestrate a diversity of values in their inputs.

4.2.6 Care

While care is an everyday word, in the context of ethics and political science, it is often connected to Gilligan's (1982) research on the differences between gender roles and expectations with respect to moral development. This difference can be summarised as follows: young males are socialised into general and impersonal ethics of justice, while young females are socialised into a relational, interpersonal ethics of care. Within feminist and post-colonial scholarship on ethics of care, it is often held that modern Western societies give preference to 'masculine' virtues as upholding impersonal, objective, universal standards and equivalently devalue personal relationships of care.

This trait of modern societies is also naturally reflected in European institutions of governance, both in their preference for standardised procedures and in their implicit view on scientific knowledge as objective and value-free (Strand, 2022). As presented in Section 3.2, sectoral governance frequently exists in the tension between the norm of impartiality and objectivity on one hand and the care for its particular sector on the other.

In the UK's Mindfulness Initiative, the emphasis on strengthening and cultivating care, compassion and general emotional intelligence in contemporary political culture is similar to Gilligan's perspectives on gender. Several scholars are engaged in how care perspectives could be better incorporated in institutional logics (The Care Collective, 2020).

The distinction between logics of choice and logics of care describes contrasting views on decision-making. This makes it an exercise in selecting from predefined decision options (choice) or attending to the issue at hand and those affected by it — rather than applying universal principles or standard procedures (care) (Mol, 2008). In this sense, care means continuing to attend to the issue at hand in the absence of a solution, also referred to as 'staying with the trouble' (Haraway, 2016).

In this report, care is among the principles that most directly responds to indeterminacy and the need to develop adaptive responses to systemic and complex challenges. While concepts such as indeterminacy may at first sound elusive, care is concrete. Typically, a care approach would not focus on making a plan, model or a set of standards but instead directs efforts towards doing something for humans, animals, plants, places and other elements that we care for. The UNDP Accelerator Labs is a clear case of this, pursuing clearly defined needs. The Catalan RISCAT2030 shows how such direct efforts can be constructed through collective agenda-setting.

Care is not neutral nor objective, as caring for something may imply caring less for something else (Puig de la Bellacasa, 2017). In the context of governance in complexity, the principle of care is accordingly also a matter of managing and possibly including a plurality of perspectives and stakeholders, dealing with multiple values and ways of valuating through participatory initiatives.

In Annex 2, the citizens' assemblies in Ireland and Austria and the Conference of the Future of Europe are examples that clearly illustrate that care is important in the framing of the issue for several reasons: firstly, framing is important for the identification and scope of policy options/action. Secondly, it instructs the choice of a knowledge base and the prospects of coordinated action and success. Thirdly, as stated above, framing itself depends on a complex set of knowledge claims as well as political, cultural and moral values (Wynne, 1992). Caring could imply the avoidance of reductionist approaches or recognising that different values are sometimes inherently contradictive. Among the cases reviewed in Annex 2, anti-reductionist approaches can be seen in the Ecuadorian example of adopting

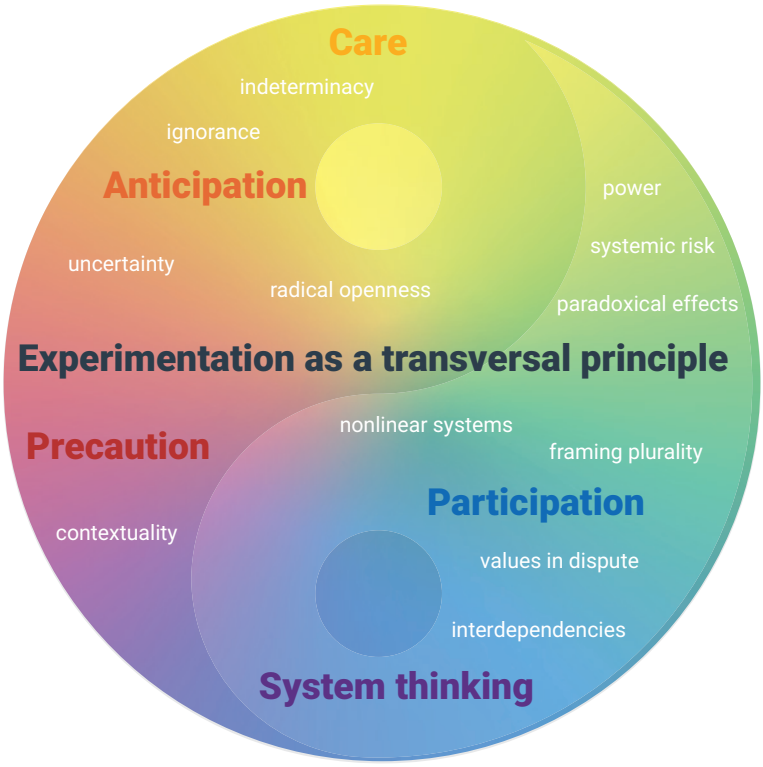
multi-scale integrated analysis in a political context of *Buen Vivir* (Good Living) as well as in the Norwegian Gene Technology Act.

Caring also means recognising that different groups are impacted differently from sustainability transitions. For instance, sustainability transitions also mean phasing out unsustainable practices and economic activities, which may cause 'transition pains' that need to be acknowledged as legitimate.

4.3 Governance in complexity practices

When looking at governance approaches to sustainability issues, the principles of governance in complexity explained above partially correspond to the characteristics of systemic and complex challenges (presented in Chapter 2). For example, uncertainty and ignorance correspond to precaution. Furthermore, plurality of values, perspectives and problem frames correspond to participation. This is illustrated by placing the principles within the yin-yang diagram for the descriptors, as presented in Figure 4.3.

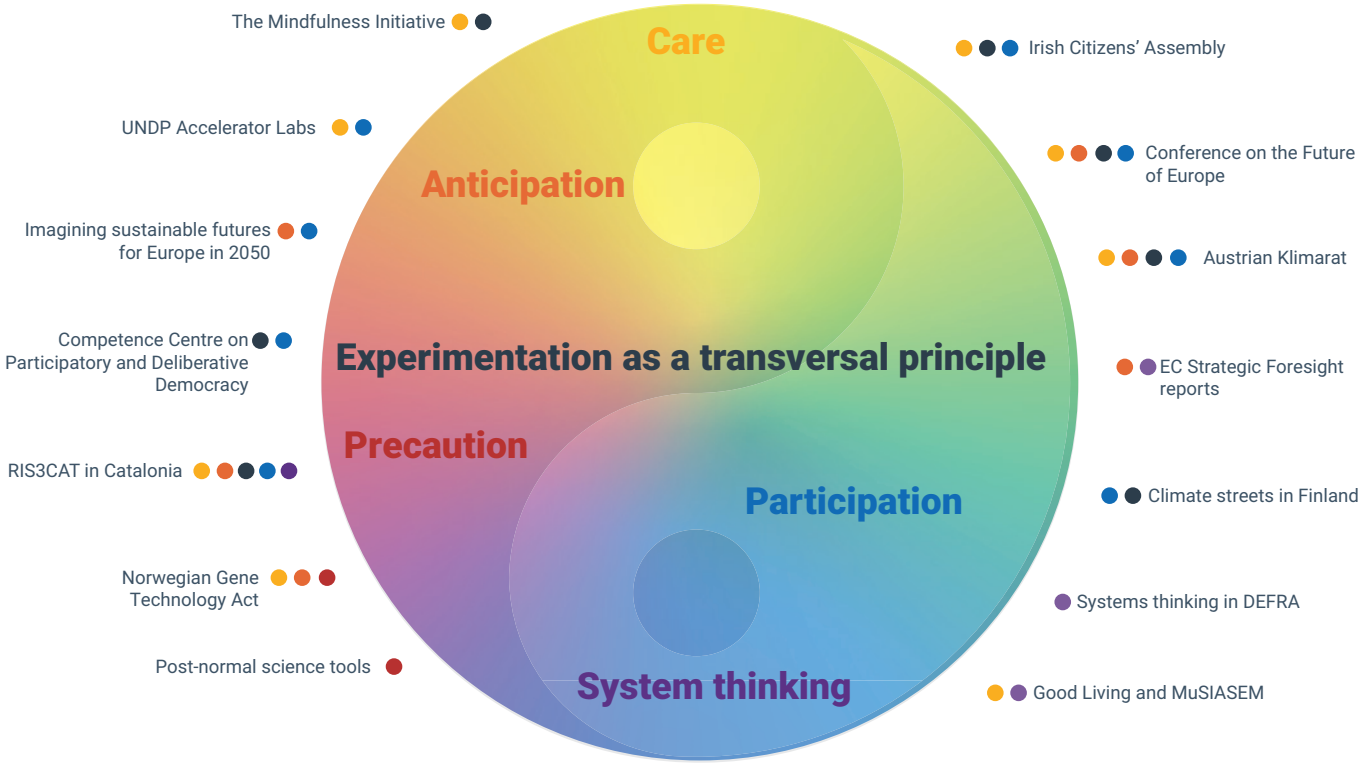
Figure 4.3 **An approximate correspondence between descriptors of systemic and complex challenges and principles of governance in complexity**



Source: EEA.

Similarly, examples of governance in complexity (Annex 2) can be placed in the same diagram in combination with these principles, illustrating their possible approximate domain by colour shades, as presented in Figure 4.4.

Figure 4.4 **The six principles of governance in complexity and a selection of practical examples (reviewed in Annex 2)**



Source: EEA.

For practitioners of sustainability governance, visualisations like the above can help improve understanding of principles from normative governance theory and the unique characteristics of complexity and uncertainty. They should not be seen as maps to instruct thinking or approaches. As is clear from its definition, governance in complexity is determined in terms of the level of awareness by its practitioners. It is a way of thinking or a mindset from which principles and practices follow. A minimal requirement for governance in complexity is to admit the possibility of failure and search for some combination of adaptation and assertiveness.

What constitutes good governance is a matter of details and context in each case. Governance in complexity does not reject other normative frameworks of sustainability governance, such as U Theory (Scharmer, 2018), meta- or trans-governance (Meuleman, 2020) or sustainability transitions, nor does it determine the validity or applicability of these frameworks.

This report explores real-life approaches to sustainability governance through the lens of governance in complexity, to illustrate and exemplify a governance in complexity mindset. Such explorations and analysis of examples are also necessary if we are to learn from past and current practices and approaches. In such situations, the six governance in complexity principles from sustainability governance can be especially useful. Similarly, the understanding of assertive and adaptive postures presented in this Chapter can help to better understand barriers to sustainability governance.

As presented in Chapter 3, the current mode of operation in institutions of governance corresponds to an assertive posture. Efforts to strengthen the adaptive posture would ensure more balance by demonstrating principles of experimentation, care, anticipation and precaution. This corresponds better to the characteristics of the issue at hand. It would align with the understanding of governance needs in Figure 4.2, as described by invited governance experts in connection with the making of this report.

5 Is sustainability governance changing in Europe? Insights from selected cases

Key messages

- Four selected cases (REPowerEU, COVID-19 responses, biodiversity loss and the Beyond GDP debate) are analysed to understand how current EU policy responses are adapting to the systemic and complex nature of challenges.
- In all cases, emerging elements of *de facto* governance in complexity are identified. The six principles (experimentation, systems thinking, participation, precaution, anticipation and care) were all present to varying degrees.
- From the perspective of governance in complexity, the four selected cases illustrate that public participation could be strengthened and a plurality of perspectives employed.

In this Chapter, five current approaches to complexity and crisis at the EU level are explored to highlight changes in governance that are already emerging.

5.1 Setting the scene

The current 'turbulent times' with their set of entangled systemic and complex challenges include many environmental crises such as biodiversity loss, soil degradation and climate change, which are closely interlinked with health, economic, social and political crises. This Chapter takes a closer look at four different crises and at the governance responses that have emerged to them in EU institutions. The aim of the examination is twofold. On the one hand, these crises are examples of the systemic and complex nature of the governance challenges related to the environment; on the other hand, the analysis of the four case studies shows that many of the principles of governance in complexity emerge spontaneously in the governance of and through the many crises. Therefore, discussing governance in complexity sheds light on some practices that may otherwise go unnoticed and become marginalised.

It should be noted that the declaration of a 'crisis', an 'emergency' and a call to 'urgent' action is itself an outcome of processes of governance. These processes may include many elements including scientific advice, political judgement and negotiation. The sense of urgency often associated with environmental crises and the call for 'immediate' action is not a neutral descriptor. Rather, it has in itself performative power (Lakoff, 2017) and tends to pose strains and tensions in the space for deliberative and participatory processes. There are different ways to read a crisis and, importantly, to govern in a situation of perceived crisis, including exacerbating crises by well-intended but hasted action. When there is little or no possibility of 'solving' or eliminating the crises, this highlights the need to act ethically through them.

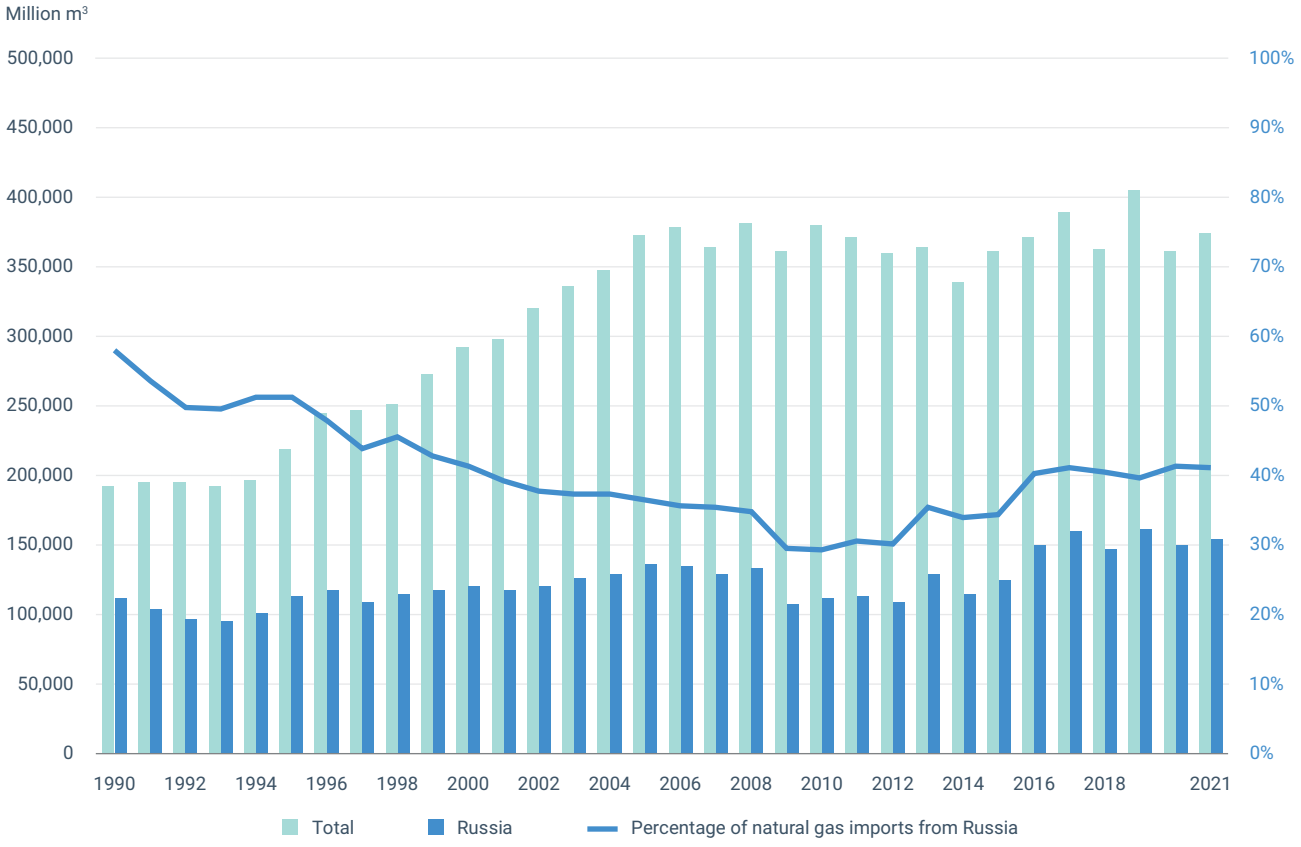
The four case studies are all examples of systemic and complex challenges. The energy crisis induced by the war in Ukraine highlights the interdependencies between geopolitical stability, energy security and energy transitions. The COVID-19 pandemic

started as a health emergency and developed important economic and environmental consequences. Biodiversity loss is a long-term process, which among its many negative consequences makes visible the fundamental dependence of socio-economic systems on natural ecosystems. Debates about the unsustainability of economic growth have emerged both from environmental movements and from concerns about the adverse social effects of unequal economic growth. They have materialised in efforts to move beyond GDP indicators and growth as the main driver of economic policy. This Chapter visits these four examples of governance processes in the EU policy context. It asks to what extent these examples show changes in governance practices that acknowledge systemic nature and complexity of the challenges they address. The analysis was guided by use of the diagnostic tool presented in Annex 1 to characterise the systemic and complex features of the selected cases. The resulting details of this are included in Annex 3. The six principles of governance in complexity introduced in Chapter 4 were used to inform the analysis of the cases. In what follows, the main points of the analysis are presented.

5.2 RePowerEU from the perspective of governance in complexity

Gas imports from Russia are critical to the EU, oscillating between 50% and 30% of total imports. Natural gas imports from Russia have been stable at 40% of total imports since 2016 (see Figure 5.1). Cuts in gas supply from Russia pose a serious threat to energy security in the EU.

Figure 5.1 Natural gas imports (million cubic metres) to the European Union (1990-2021)



Source: Eurostat, 2024b.

The REPowerEU plan was published in response to Russia's 'unprovoked and unjustified military aggression against Ukraine' (EC, 2022b) and the subsequent cuts in natural gas deliveries to the EU. The plan supports the transition towards 'affordable, secure and sustainable energy for Europe' and has four main pillars:

1. saving energy, through measures such as improvements in energy efficiency and behavioural change, with campaigns that encouraged lowering the thermostat for heating during the winter;

2. producing clean energy, whereby the gas crisis is turned into an opportunity to accelerate the transition towards renewable energy;

3. diversifying the energy supply of the EU by reducing reliance on Russian gas and importing gas from other countries, as well as increasing the types of energy carriers used to include liquified petroleum gas and hydrogen;

4. supporting investment plans by partially redirecting funds from the Recovery and Resilience Facility, the Common Agriculture Policy, the Cohesion Policy and Innovation Fund.

The following sections apply the diagnostic questions for systemic and complex challenges onto the challenge addressed by REPowerEU while identifying elements of governance in complexity.

5.2.1 How does REPowerEU address a systemic and complex challenge?

An energy system refers to the complex network of production, distribution and consumption of primary energy sources into multiple energy carriers. Primary energy sources include fossil fuels (coal, oil, natural gas), renewable resources (solar, wind, hydro, geothermal) and nuclear energy. Energy carriers transport energy or store it for later use. They can be divided into three main types: electricity, fuels (such as gasoline, diesel or biofuels) and heat. End uses refer to the final applications of energy carriers in various sectors such as residential, commercial, industrial and transportation.

This is where energy is ultimately consumed to perform specific tasks or provide services. Different energy carriers serve different purposes or end uses. Coordinating the interactions between energy sources, carriers and end uses is at the core of managing energy systems. The transition to cleaner and more sustainable energy systems involves integrating renewable sources across these interconnected components.

A systemic feature that is particularly challenging in the energy system is the presence of rich interconnections between the parts of the system. The dependence on natural gas has increased with the transition towards renewable energy sources (He et al., 2018). To produce electricity from intermittent energy sources such as solar radiation and wind power requires a cascading set of adaptations. Either demand adapts to the availability of electricity, both in regard to when things can be powered and to how much power there is; or, as has been the route so far, an excess capacity has to be built to guarantee a base load when electricity production from renewables is low.

Excess capacity ideally needs to come from a power plant that can be switched on and off on demand. Nuclear power plants take two or three days to be switched on or off and cannot compensate for the daily variation of solar radiation, for instance. This is why natural gas has become such a strategic resource in Europe: power plants that use gas to produce electricity can easily chip in to the energy supply when needed (Nunes and Brito, 2017; He et al., 2018). As stated in the EEA/ACER Report (2023), 'currently, peak generation gas plants provide much of the flexibility but with the clean

energy transition, other types of flexibility resources are needed'. The unintended consequence of managing such a richly interconnected energy system is that the transition towards renewable energies has made the European energy system more dependent on natural gas.

Both the International Energy Agency and Johnston et al. (2022) identified opportunities to reduce gas consumption in the EU. This includes switching to heat pumps for heating, improving energy efficiency and promoting behavioural change, such as lowering the thermostat. While these measures are sensible, they improve the system 'as is' and do not clearly take into account changing causal pathways. Fossil fuels contributed more than two thirds (69%) of heat production in 2020 (EEA, 2023a). Hence switching to heat (the energy carrier) does not necessarily contribute to the energy transition, unless heat from renewable energy sources is explicitly set as a target.

Complexity can be seen in the multiple framings that are at play. The dominant framing of the REPowerEU plan is the geopolitical framing. The plan is a direct response to the war in Ukraine and political tensions with Russia. Solutions include diversifying imports, both in the sense of importing from different countries and importing different energy carriers, such as liquefied petroleum gas (LPG), liquefied natural gas (LNG) and hydrogen. The trade-offs that may emerge from the diversification of imports are also framed in geopolitical terms, such as the creation of new import dependencies and tense relations with China.

Multiple legitimate framings exist in this debate, from the exacerbation of problems such as energy poverty to the immediate reaction to the shortage of Russian gas that led each Member State to turn to available safety nets like coal or nuclear power. As Kuzemko et al. (2022) argue, 'reframing energy as a geopolitical security concern has, in acute crisis, tended to obfuscate and/or downplay other energy policy goals,' especially those related to sustainability and equity (Kuzemko et al., 2022). The more technical framing of the energy transition challenge that considers lock-ins and the rich interconnectedness of the energy system has only recently been acknowledged (EEA, 2023h). Consequently, while increasing the penetration of intermittent renewable energy sources has led to higher demand for gas, the REPowerEU plan calls for an increased use of intermittent renewable energy sources as a means of phasing out natural gas. As in any systemic transformation, conflictive trade-offs may emerge during the transition towards renewable energy, including with regards to knock-on effects in the Global South (Kuzemko et al., 2022).

5.2.2 REPowerEU as governance in complexity

Several elements of governance in complexity can be recognised in REPowerEU. The plan supports policymaking based on anticipation and long-term thinking — aspects that were lacking in the energy policy realm. As Kuzemko et al. (2022) argue, 'despite various Russia-Ukraine gas transit disputes and Russia's invasion of the Crimea in 2014, the EU has maintained high levels of dependency on Russian natural resources.' In the REPowerEU plan, the energy crisis was interpreted not as an exceptional event, but as the first of a series of energy-related challenges that will play out in the future. The current crisis serves as a stepping stone to accelerate the transition to renewable energies, a necessarily long process. Systems thinking is also clearly part of the diagnosis of the problem: geopolitical crises have impacts on energy security, while future projections of the EU's energy security take into account the role of China in the demand for LPG. Systems thinking is also present in the solution proposed, which for the first time includes curbing energy consumption as a direct goal and not just as a desired effect of improved efficiency. This therefore takes a systemic view that goes beyond changes in primary energy sources and efficiency improvements. The Re Power EU plan targets multiple components of the energy system.

There is scope for improvement with regard to the application of the principle of precaution. In its political communication, the REPowerEU is presented as a win-win plan in which there are seemingly clear solutions to the problem of dependence on Russian gas and fossil fuels more in general. Upon closer inspection, it's clear there are contested framings about the role of coal, nuclear energy and LPG in the transition. Some trade-offs are communicated, such as the increasing demand for critical minerals for renewable energy and electricity storage technologies. The Critical Raw Materials Act and the Net-Zero Industry Act respond to the risks created by the energy transition by diversifying EU imports and scaling-up manufacturing of key net zero technologies within the EU (EC, 2023e, 2023f). Nonetheless, the Critical Raw Materials Act is presented as a reliable solution that will 'ensure EU access to a secure and sustainable supply of critical raw materials, enabling Europe to meet its 2030 climate and digital objectives'. Precaution may inspire a move away from the 'win-win' style of communication and create a more open dialogue about the need to accept imperfect solutions.

Recognising trade-offs and identifying who may be on the losing end of each trade-off is also important when applying the principle of care. The call to consider that 'all Member States are in this together, ready to share gas with their neighbours in case of need' rests on the principle of care. However, care in this narrative is almost dictated from the urgency posed by the geopolitical crisis. A complementary route may be to establish solidarity mechanisms that come into effect not only in case of crisis as is currently done (security in gas supply), but as an anticipatory exercise that embraces the idea of governance in complexity and builds resilience towards times that are permanently turbulent.

Finally, the principles of participation and experimentation are not as prominent in REPowerEU as governance. This is not surprising given a framing of the challenge as an urgent problem where policy cannot afford to fail (ZOE Institute for Future-fit Economies, 2023).

In summary, the systemic view of energy challenges invites systemic responses, as exemplified by the multiple angles from which energy governance is tackled. The REPowerEU plan foresees actions that span from consumption (saving energy) to diversifying supply, and finance and regulatory action such as fast-tracking renewable energy permitting. EU plans combine measures that are adaptive (lowering energy consumption through behavioural change) and more conservative (using technological advances to keep business running as usual). The diversity of measures can be seen as a step towards dealing with complexity. On the other hand, the idea of turning the conflict with Russia into an opportunity to accelerate the energy transition shows that the EU communicates its governance strategies through win-win ideas. However, acknowledging trade-offs and imperfect solutions — and hence the need to prepare for unforeseen shocks, turbulence and increasing crises despite temporary solutions — may improve the EU's resilience. Describing necessary energy transitions as troubled rather than seamless may improve anticipatory capacity and preparedness.

5.3 COVID-19 responses from the perspective of governance in complexity

The COVID-19 pandemic has been described as a crisis, a human tragedy, a great challenge, a wicked problem and even a unique opportunity. What it 'is' for a given individual or collective actor depends on the context, or what these actors intend to or must do. The nature of the challenge and the content and orientation of the governance response cannot be defined independently of each other. In the context of EU policy and governance, COVID-19 is an illustrative example of both systemic and complex challenges.

From the very beginning (early 2020), it was treated at least as a systemic challenge or indeed two systemic challenges on two different levels. The first level was the 'Coronavirus response', that is, the monitoring and response to the spread of the virus and the infectious disease it caused with a focus on the public health sectors. The second level was the socio-economic impact of the pandemic including the impacts of the coronavirus response itself.

5.3.1 COVID-19 as a systemic and complex challenge

Already in 2020 it was clear that COVID-19 posed an immediate threat of the infectious disease itself but also posed challenges to a number of other sectors, such as food systems, education, city infrastructure and security, among others (Lambert et al., 2020). These all experienced impacts from response measures to COVID-19. Framings of the challenge developed during the pandemic are presented in Table 5.1 and illustrated below.

Table 5.1 Two different categories of framings of the COVID-19 challenge

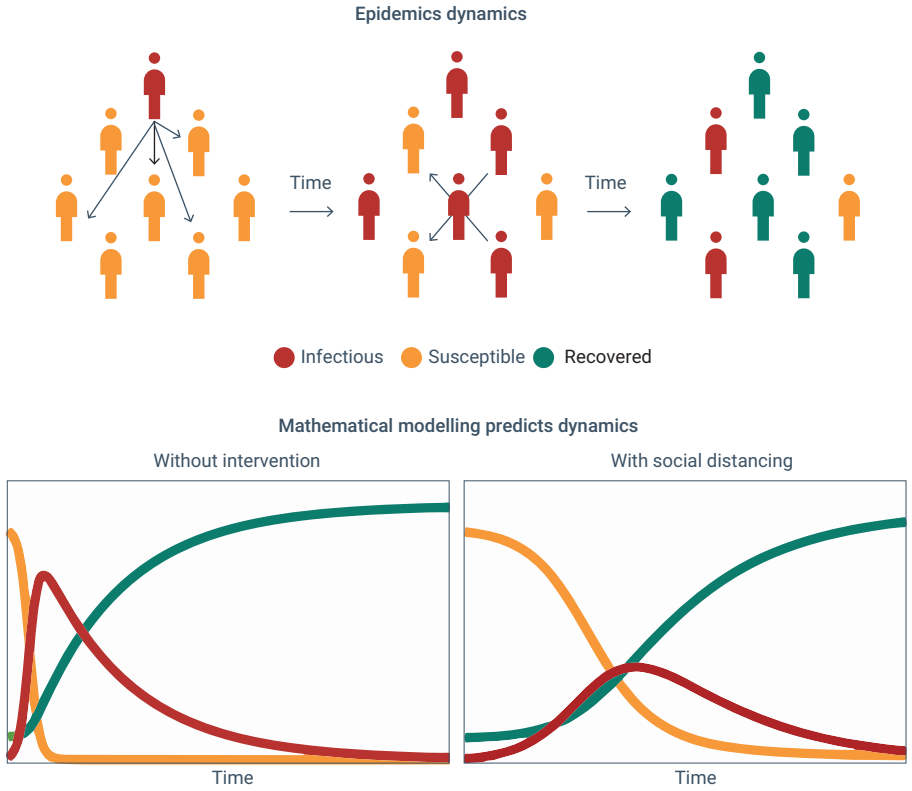
COVID-19 as multiple public health challenges	COVID-19 as a socio-economic challenge
First, COVID-19 posed an immediate threat of infectious disease, illness and death that called for an immediate coronavirus response. Subsequently, the public health challenge was reframed in many countries to the challenge of achieving a sufficient level of vaccination within the population. Finally, COVID-19 also posed a systemic and complex challenge because of the many uncertain linkages and trade-offs between COVID-19, COVID-19 measures and other health issues.	In the EU, COVID-19 was also treated as a socio-economic challenge from the start of the pandemic, taking into account the innumerable interlinkages between COVID-19, COVID-19 measures, and production and consumption systems across all economic sectors. Furthermore, the socio-economic challenge of crisis recovery was proactively connected to other policy goals, such as the green and digital transitions.

At the level of the coronavirus response, the threat of the virus was framed with elements both of a specific challenge and a systemic challenge. In its simplest definition, the system consisted of the populations of virus and hosts, respectively. The classic SIR model contains three variables that correspond to the human population in three states (susceptible, infected, resistant) (Kermack et al., 1997) (see Figure 5.2). It is given by a set of three first-order differential equations:

$$\frac{dS}{dt} = -\beta IS \; ; \; \frac{dI}{dt} = \beta IS - \gamma I \; ; \frac{dR}{dt} = \gamma I$$

The so-called basic reproductive number (R_0) is equal to the fraction β/γ. This system definition suggests typical responses that were seen in the COVID-19 pandemic as well as in previous outbreaks: either to quench the epidemic by changing behaviours to stop the propagation of the virus (decreasing β and thereby reduce the reproductive rate R_0); to strengthen the health services and let the virus run through the population so that it reaches the 'recovered' state; or to 'flatten the curve', which means letting the epidemic propagate but at an R_0 only slightly higher than 1 to avoid health services becoming overwhelmed, for instance by social distancing.

Figure 5.2 The SIR model



Source: Adapted from Xavier et al., 2022.

An epidemic remains a specific, non-systemic challenge only to the extent that this highly idealised model accounts well enough for real problems, choices and dilemmas. First, there was the uncertainty about the status of being recovered, how long the immunity would hold or if a second infection would be more dangerous (Altmann et al., 2020). Furthermore, from the history of epidemics it was also known that strong measures of social distancing and lockdowns may face declining compliance, which called for careful timing of the measures (Tognotti, 2013; Taylor, 2022). These uncertainties made the challenge complex in the sense that it was unclear to what extent one could trust the model. The evidence is mixed (Adams et al., 2023), but there are indications that European expertise succeeded in many instances in communicating the presence of uncertainty. This suggests model-based predictions should not be taken too literally and that such transparency was well received (Warren and Lofstedt, 2022; Wegwarth et al., 2020). Furthermore, the system displayed natural selection and evolution. Ever-new variants of the virus emerged and propagated through populations, with differing transmissibility and virulence (Markov et al., 2023).

Even when framed only as a public health challenge, COVID-19 was also a complex challenge because the radical openness to other health problems was evident from the beginning, for example health loss due to unemployment caused by lockdowns (Zala et al., 2020). Notably there were trade-offs between the need for social distancing and lockdowns to reduce propagation on one hand and the need for health services and other critical services to continue to operate on the other (Norheim et al., 2021).

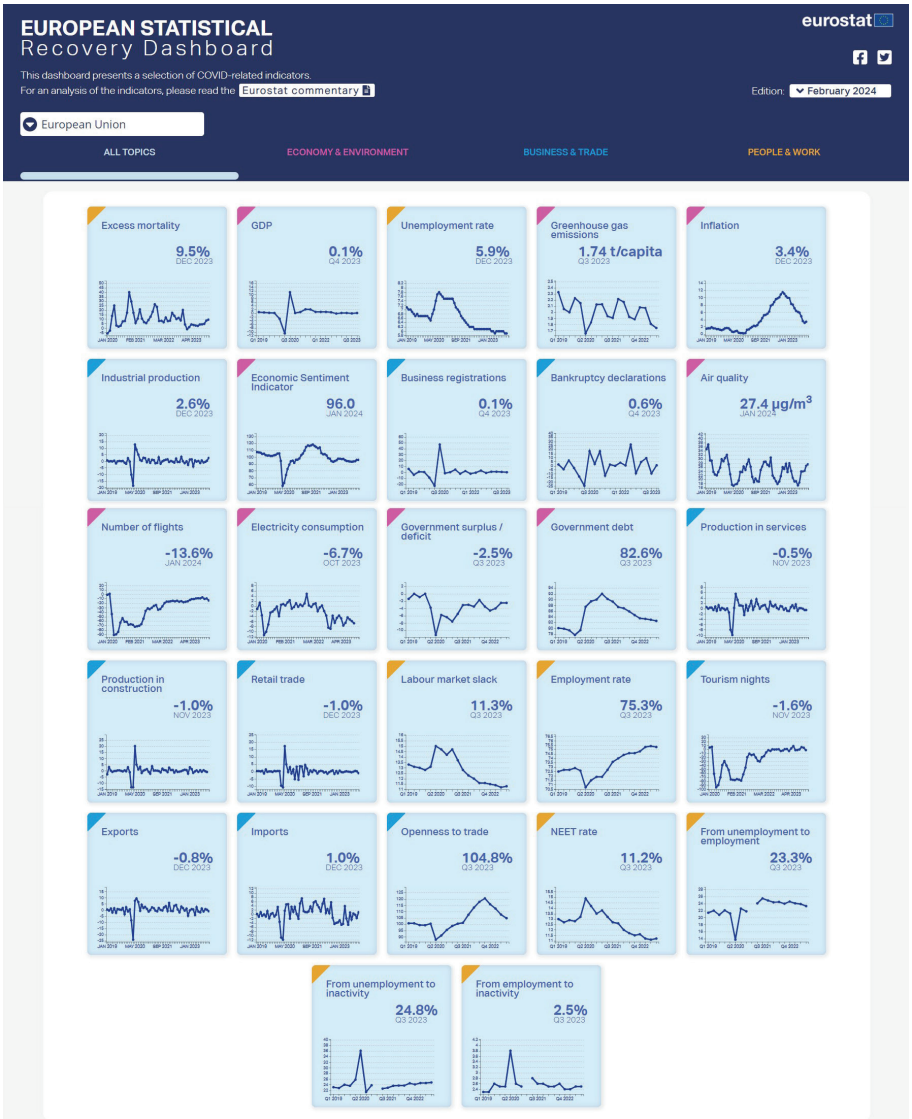
Emergencies like the COVID-19 pandemic 'amplify pre-existing conditions' (Jasanoff et al., 2021). This means that crises tend to reinforce already existing economic disparities and distrust, yet can also reinforce pre-existing solidarity where this was already strong.

In the EU context, as in general in the Global North, the uncertainty and complexity of the host-pathogen interactions was amplified by the uncertainty and complexity of the capacity of health services, as well as acceptability and compliance with restrictive social measures. Such uncertainties were managed by introducing vaccines and vaccination programmes. First, the vaccination programmes offered a medical technology as vaccination reduced the severity and mortality of the disease for vaccinated individuals (ECDC, 2023). Secondly, the vaccination programmes offered a political technology in the sense that they offered a way out of the pandemic state of emergency (Bahl et al., 2021). The existence of the vaccination programmes implied that citizens and civil society could expect a relief in the restrictive measures and return to normality, which may have contributed to high compliance and political stability.

The complex challenge was domesticated and governed again as more of a specific challenge in 2021. This time, the main focus was not the propagation and reproductive number of the epidemic or the number of COVID-19 mortalities, but a focus on vaccination compliance (Boëlle and Valdano, 2023). Indeed, excess mortality statistics even within the EU varied a lot in the course of the pandemic and between countries, both in amplitude and sign. In the presence of this complexity, the vaccination programmes and the question of compliance made the challenge governable again. As the pandemic faded out, this work was continued in the HERA incubator, the EU-initiated bio-defence preparedness plan against new COVID-19 variants (EC, 2021b). This normalised research processes, health technology development and ordinary operation of the public health sectors.

From the start of the COVID-19 pandemic, the EU treated the direct responses to it and its socio-economic impacts as a systemic challenge. By 8 April 2020, the Commission had already communicated its 'Team Europe' approach to the European Parliament and the European Council (EC, 2020). Team Europe consisted of a collaboration between the EU and Member States (including implementing agencies and development banks at the state level and the European Investment Bank and the European Bank for Reconstruction and Development) to coordinate action to mitigate the socio-economic impacts (as well as COVID-19 emergency responses) (Burni et al., 2022). With the challenge defined as the threat of societal and economic collapse due to direct and indirect consequences of the pandemic, the systemic perspective included a number of societal sectors and aspects, including the health sector, the economic sector, the transport sector and so on. Eurostat's COVID-19 dashboard is illustrative (see Figure 5.3).

Figure 5.3 Screenshot from Eurostat's COVID-19 dashboard



Source: Eurostat, 2023.

Indeed, the challenge is more complex than systemic because there is no closure to the definition of the system: all policies were COVID-19 policies and they could target any sector. Mitigation and recovery from COVID-19 transformed from crisis management into a frame of opportunities and development policy through the installation of the temporary budget instrument NextGenerationEU (EC, 2023c).

Thus, COVID-19 recovery was identified with other policy goals that existed prior to the pandemic, such as making Europe 'greener' and 'more digital'. This instrument was coordinated with the EU's long-term budget for 2021-2027 and can be seen as indication of a change in European governance towards governing in complexity in two ways: first, it represents novelty and experimentation in that it is unprecedented and that it is a step in-between emergency measures and what was considered normalcy, in terms of the normal budget procedures. Secondly, it represents system thinking in that interdependencies are acknowledged and even framed as opportunities.

NextGenerationEU, originally a COVID-19 recovery plan, thus became a policy instrument directed towards the ambitions of the EU's Green Deal and the digital transition (Maucorps et al., 2023) — indeed with the explicit slogans 'Make it Green' and 'Make it Digital', among others (see https://next-generation-eu.europa.eu).

5.3.2 COVID-19 responses as governance in complexity

To summarise, the COVID-19 pandemic shows many if not all of the features of systemic and complex challenges: nonlinearity and paradoxical effects, uncertainty, framing plurality and not the least indeterminacy. While it is too early in 2024 to write a history of how COVID-19 was governed and how it contributed to change governance systems, a multitude of governance elements can be noted, including those that are characteristic of governance in complexity.

Precaution was critical during the first phase of lockdowns and social measures. Indeed, the early response can be considered a paradigmatic case of the application of the precautionary principle in that lack of scientific certainty was not used as a reason to postpone COVID-19 measures. Anticipation can be noted as a main principle of the EU's governance of the socioeconomic impacts of COVID-19 by the formation of Team Europe and the development of the recovery policies.

On a more general level, the COVID-19 crisis in 2020 gave force to already ongoing developments introducing resilience as 'a new compass for EU policies', as described in the *2020 Strategic Foresight Report* (EC, 2020b; JRC et al., 2017).

Care and experimentation can be observed in the unusual, indeed unprecedented, amount of attention given to COVID-19 and its impact, to the extent that new types of social measures, new types of regulations and new forms of budgeting were developed. European COVID-19 governance is in that sense a strong example of continuous adaptation and experimentation. Again, while it is too early to make historical conclusions, one can see COVID-19 as a case of how the distinction between 'crisis' and 'normalcy' is becoming blurred in governance. This is so not only because COVID-19 develops from an acute emergency to an endemic viral disease but also because the extraordinary, acute economic measures are being consolidated into longer-term economic policies that help redirect the EU towards additional policy goals (such as sustainability and the digital transition).

In Chapter 3, governance in complexity was defined as the attempt to govern a system, while being aware that: (1) the system cannot be perfectly known or controlled and (2) oneself is part of or interconnected with the system. In this minimal sense, EU governance of COVID-19 can be seen as governance in complexity. Scientists and policymakers were also considerably open in expressing the lack of certainty and control.

One may speculate that a considerable part of the citizenry appreciated this openness and that this was part of the explanation for a high degree of compliance with often painful measures. The unsolved question is how to foster and find the space for participation, in particular public participation, in the styles of governance that developed with COVID-19. Indeed, throughout the pandemic, there was ample use of centralised power and a focus on national and international harmonisation of policies that resulted in a hegemony of problem framings. The framings changed over time — notably from 'flattening the curve' to vaccination as a political technology — but at any given time, governments enforced their dominance at the expense of fostering a multitude of perspectives and extending the peer communities. This came at the possible expense of the quality of the system thinking, anticipation and care exerted (Jasanoff, 2003). Indeed, differing views among citizens were at times criticised and sanctioned for being irresponsible (Bardosh et al., 2022).

There could be room for improvement in acknowledging the uncertainties that emerge from using different and non-equivalent framings of issues, about questions of vulnerability that derive from how different groups are affected by the distribution of risks and consequences and about alternative modes of learning that are needed when expert knowledge that is supposed to guide policies becomes a moving target itself. Collective experimentation in this sense is not to be confused with large-scale experiments in which societies serve as guinea pigs but as an extension of the scientific-inspired mode of learning by trial and error. Here, society is involved so as to ensure that the consequences of errors are fairly distributed and transparently managed.

While the pandemic can be regarded as a showcase for our society's potential for collective action when faced with an emergency (EEA, 2022a), the way, shape and form of these actions — i.e. governance interventions — varied greatly and their outcomes are yet to be fully understood. This is especially important in light of potential future crises (or crises that will be acknowledged as such only in the future).

COVID-19 has been referred to as a 'dress-rehearsal' for the challenges to come (Guterres, 2020). A picture is already emerging of how different governance responses were grounded in local contexts, collectively shared perceptions of global and national pasts and desired futures and ideas about the relation between science, (bio-)technology, politics and society. A global group of experts led by Harvard, Cornell and Arizona State University produced a comparative analysis of various (mostly) national governance responses to the epidemic (Jasanoff et al., 2021).

This report points to a number of common approaches to governance of interest to the topic of governance in complexity. Among other points, the study shows that 'playbooks' grounded in previous crises-response did not function well in dealing with a global pandemic. There is a need for collective experimentation and constant adaptation.

5.4 Responses to nature degradation and biodiversity loss from the perspective of governance in complexity

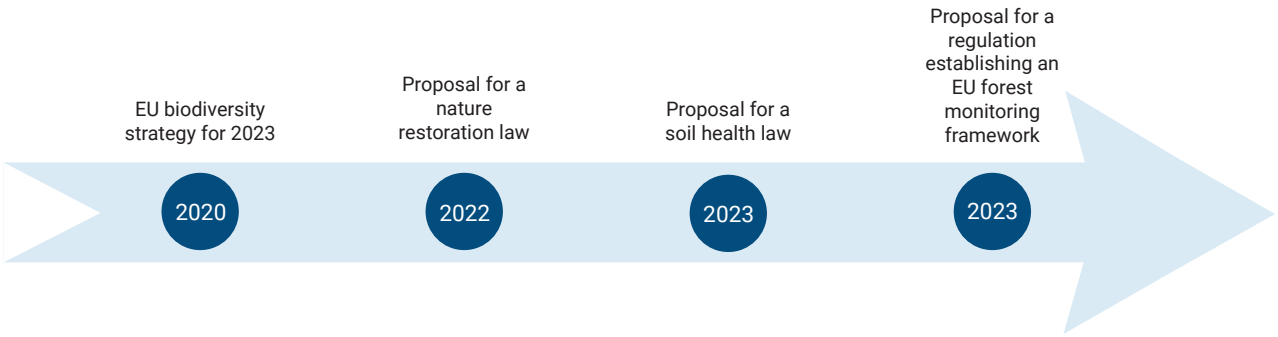
Biodiversity has been steadily declining over several decades but only recently has it been recognised as a crisis (UNEP, 2021). The decline in pollinators, for instance, has triggered the alarm and made visible how agriculture — and hence food security for humans — is dependent on pollinator health. The biodiversity crisis has thus greatly contributed to mainstreaming the understanding of socio-economic systems as embedded in and dependent on natural ecosystems, with calls for overcoming the conceptual separation between culture and nature.

In the EU, the view that we humans are part of nature is becoming part of policy responses, as stated in the EU Biodiversity Strategy for 2030 (EP, 2021a). This case study thus illustrates very clearly the complexity linked to framing and the governance responses that aim to include multiple framings. Governance in complexity can be here understood as the effort to stay open to multiple framings and to challenge existing framings.

In the context of EU policy, eight environment action programmes (EAPs) setting out multiannual goals and an extensive body of environmental laws (or *acquis*) have been adopted by the EU since 1973. Conservation and restoration are currently the subject of renewed attention of EU policy. Starting with the EU Biodiversity Strategy in 2020, a series of new proposals have been set forward, which foreground the importance of biodiversity, nature restoration and soil health (see Figure 5.4).

The EU Biodiversity Strategy for 2030 states that 'at least EUR 20 billion a year should be unlocked for spending on nature' (EC, 2020a, p. 17) and that positive results are expected if that target can be reached. Likewise, the legal requirement for large-scale nature restoration set by the proposed EU Nature Restoration Law could lead to important, positive results. Furthermore, it should be noted that ecological thinking has also permeated other policy areas, such as the Farm to Fork Strategy of the European Green Deal (EP, 2021b). While these developments are encouraging, the situation is very serious and challenging: Europe is currently nowhere near its own goals for protecting, conserving, restoring and maintaining nature, despite its advanced legislation on the matter (EEA, 2019b). Moreover, the emergence of backlash against environmental policies is fuelling environmental deregulation and the rollback of legislation and policies proposed under the European Green Deal.

Figure 5.4 **Timeline of laws and regulations proposed under the EU Biodiversity Strategy for 2030**



Source: EC, 2024b.

5.4.1 Biodiversity loss as a systemic and complex challenge

Ecosystems are systems by definition and are often described in terms of emerging properties, multiple causality, feedback processes and non-linearity. The interconnections between biodiversity loss and climate change are well recognised. The understanding of biodiversity loss as a socio-ecological challenge is sharpening, as the interconnections between the health of non-human species and the health of humans are made visible through the pollinator crisis and the rising emergence of zoonotic diseases.

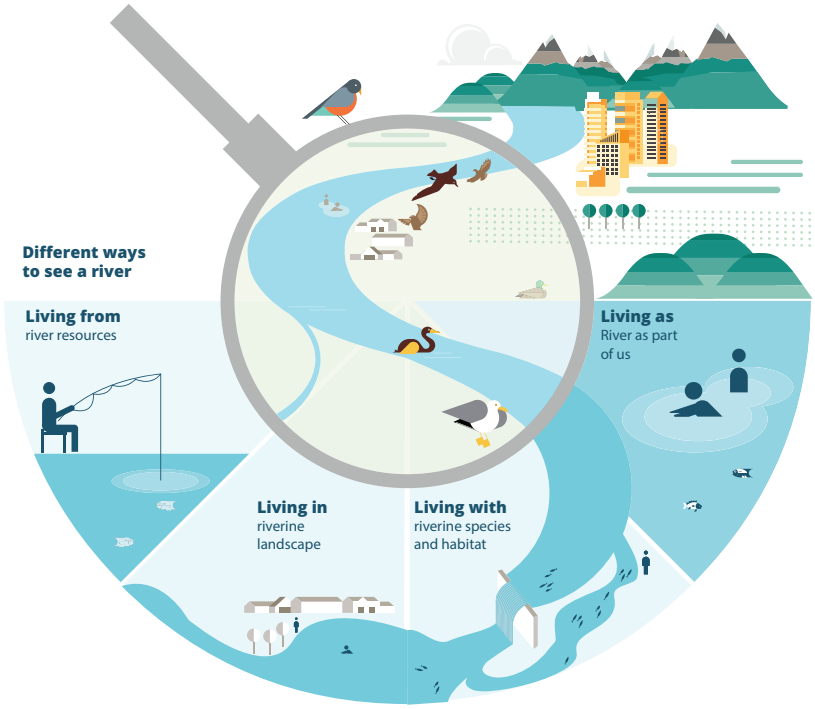
The interdependence between species and organisms has been the source of quite different understandings of evolution. Evolutionary biology developed from the concept of survival of the fittest and a fine-grained scale of analysis — namely that of gene mutations — and is understood as disconnected from the environment as changes in genes are held to be serendipitous. Contemporary biology conceptualises evolution as a multi-species process, in which species live in symbiosis, closely interdependent on each other, and evolve in symbiosis (Margulis, 1971; Margulis and Sagan, 2000). Evolution is thus recast in relational terms from a systems perspective. Similarly, biodiversity loss can be understood by counting the number of species that are going extinct or indirectly by studying the health of ecosystems (Lomas and Giampietro, 2017). The concept of biodiversity is not uncontroversial. Considering invasive species, for example, some may welcome non-native species as increasing biodiversity while others may worry about how alien species may alter the host ecosystem.

Framing is perhaps the most crucial matter in understanding biodiversity as a complex challenge and in thinking of governance approaches that may halt biodiversity loss. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) has been trying to shift away from a problem framing and promote a more values-based framing. The assessment published in 2022 (IPBES, 2022) notes that both people and societies have a number of different ways of framing human-nature relationships.

In the words of the IPBES, the excessive reliance on the life frame of living **from** nature has been the main culprit behind the massive degradation of ecosystems and biodiversity loss (IPBES, 2022). This needs to change. There must be a better balance with other frames, such as living **in**, **with** and **as** nature, in assessing and evaluating actions and in driving policies (EEA, 2023g).

Figure 5.5 reproduces IPBES' example of the different ways to see and relate to a river. People can perceive themselves as living from nature (i.e. where the river is valued for the natural resources and ecosystem services it provides); living in the landscape formed by the river and living with the other species that inhabit the riverine landscape; or living as nature (i.e. where the river is perceived as sacred and a part of themselves).

Figure 5.5 **Different ways to see a river**



Source: EEA, 2023g; adapted from IPBES, 2022.

5.4.2 Biodiversity Strategy for 2030 as governance in complexity

The response of the EU to the biodiversity crisis includes a broad range of measures, directives and strategies, such as the Birds Directive (the oldest piece of EU legislation on the environment adopted in 1979), the Habitats Directive from 1992 and the Natura 2000 network of protected areas (Langlet and Mahmoudi, 2016). Here, we focus on the Biodiversity Strategy for 2030 (EP, 2021a). The Strategy provides continuity to previously existing policy efforts and acts as a catalyst for new actions, such as the Soil Health Law (EC, 2023h). It may be worth noting that although the EU has a long history of nature conservation efforts backed by legislation, biodiversity loss, pollution and environmental degradation continue to be in a state of crisis. According to a recent EEA briefing, 81% of protected habitats, 39% of protected birds and 63% of other protected species are in a poor or bad state (EEA, 2023d). The ongoing crisis speaks both to the difficulty of the challenge and to the fact that in some cases, action is not taken until tipping points are reached, as in the case of the pollinator collapse.

The Biodiversity Strategy for 2030 is a good example of care, firstly because it creates a space to reflect about what the EU should care for — and the risks of omitting biodiversity, forests and soils from the list. Secondly, among measures taken under the auspices of the strategy is the adoption of the Soil Health Law, which mainstreams the concept of soil health and expands the notion of health to non-human entities. Similarly, the publication of values-assessment by the IPBES illustrates how the debate about what to value and care for is central to biodiversity governance, within and beyond the EU.

Participation is a natural consequence of increasing the number of entities for which governance should care. In the case of the Biodiversity Strategy for 2030, participation so far has been limited to a 'public consultation' held from January to April 2021 by means of an online questionnaire. By contrast, in the case of IPBES, participation of experts and country representatives from the Global South has been central to the decision to undertake a values assessment. This has been an effort to resist the reductionism of dominant framings of biodiversity as a resource to be used and of interdependencies with the embedding ecosystem and services provided by nature.

Systems thinking is still underdeveloped regarding governance measures. Some measures of the Biodiversity Strategy for 2030 perpetuate the 'us versus nature' separation and set targets for natural areas to be protected on land and sea. While the conservation of natural areas is important, it may run the risk of creating areas in which the environment is cared for and areas in which less care is needed. Other measures strive for a more relational understanding of humans in nature and set goals such as organic farming, which reduces harmful impacts on ecosystems. Organic farming is not a panacea: it is mentioned here as an example of an approach that considers the impacts of human activity on nature.

5.5 Responses to unsustainable economic growth from the perspective of governance in complexity

The negative implications of economic growth have been widely acknowledged by debates about the 'Anthropocene', with an emphasis on human-made climate change. The 'Limits to growth' report (Meadows et al., 1972) brought to the public debate the idea that limitless economic growth is not possible on a finite planet. It anticipated the long-term environmental crisis that would ensue from the depletion of natural resources and the unchecked emission of greenhouse gases into the atmosphere. The need for economic growth has been defended on the grounds that economic growth is strongly correlated with wellbeing and development. The social benefits of economic growth, however, have been questioned, too. Piketty (2014) has shown that economic growth is generally correlated with growing inequality. Piketty's findings point to the failure of the classic idea of neoliberal economic thinking that economic growth is like 'a tide that raises all boats' and even if growth does not correct inequalities, it improves the wellbeing of all.

The association of economic growth with wellbeing is reflected in the indicators used to set policy targets and monitor progress. GDP is the dominant indicator worldwide and the reference against which policies are measured and discussed. GDP does not specify where economic growth comes from (whether from a resource-intensive and high polluting sector) and does not measure the depletion of natural resources and pollution (EP et al., 2023a). As indicators exert a strong influence on policy targets, the critique of the negative environmental effects and questionable social benefits of economic growth has seen a surge of efforts to move 'beyond GDP' (Costanza et al., 2014; Fioramonti et al., 2022).

The case can be made that the 'beyond GDP' and the beyond-growth debates are both a response to: (1) a long-term and on-going crisis related to the sustainable use of scarce natural resources and to excessive pollutants and (2) a related crisis of governance, which stems from the criticism of the dominance of one single metric (Kaufmann, Raphael et al., 2023).

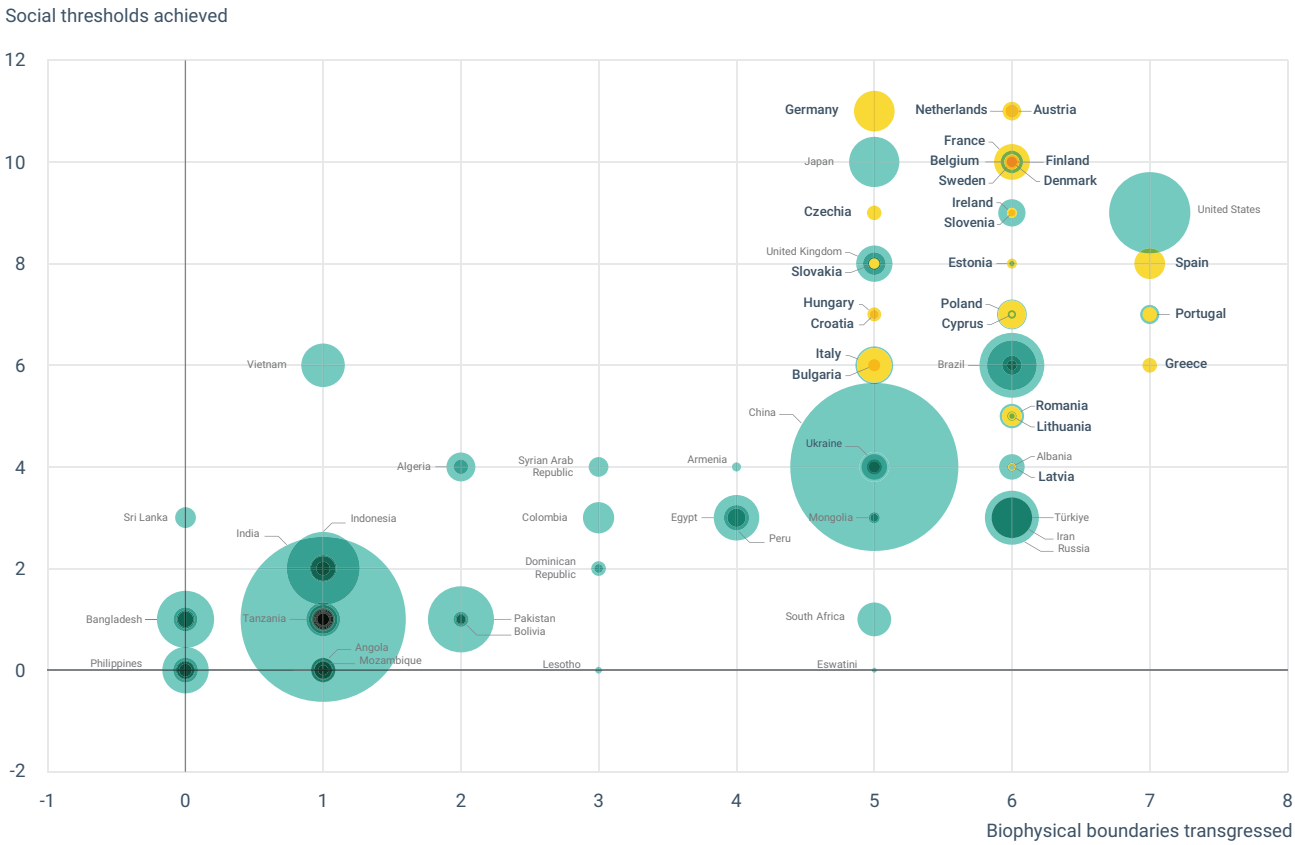
In the European context, initiatives that engage with the call to move beyond GDP include the 'Beyond GDP Conference' organised by the Club of Rome, the European Commission, the European Parliament, the OECD and the WWF in 2007; the public debate entitled 'Beyond GDP: Measuring people's well-being and societies' progress

organised in 2019 by the European Economic and Social Committee in collaboration with the OECD; and the 'Beyond Growth' conference organised at the European Parliament in May 2023.

Calls to go beyond GDP have been operationalised, for instance, through the Commission on the Measurement of Economic Performance and Social Progress (also known as the Stiglitz Commission), created by then-French president Nicolas Sarkozy in 2008. Other recent policy-relevant documents include the 2022 briefing *This is the moment to go beyond GDP* published by WWF, the Wellbeing Economy Alliance (WEAll) and the European Environmental Bureau (WWF et al., 2022), along with the report *Mainstreaming wellbeing and sustainability in policymaking: technical and governance levers out of the institutional GDP lock-in*, published in 2023 by the ZOE institute (Kaufmann, Raphael et al., 2023).

The challenge is that despite decades of academic debates and policy responses to unsustainable economic growth, no country in the world has managed to achieve the social thresholds of meeting the needs of its citizens without transgressing biophysical boundaries (see Figure 5.6).

Figure 5.6 **Number of social thresholds achieved versus number of biophysical boundaries transgressed for different countries (scaled by population)**



Notes: Only countries with data for all 7 biophysical indicators and at least 10 of the 11 social indicators are shown (=109). EU Member States are represented in yellow.

Source: Adapted from O'Neill et al., 2018.

The Global Resources Outlook 2024 published by the International Resource Panel (IRP) of the UN Environment Programme reports that 'Chile, Argentina, Costa Rica and Ecuador achieved a high inequality-adjusted life expectancy (more than 70 years) and education (more than 10 years) while keeping climate impacts *comparably* low' (our emphasis, UNEP, 2024, p. 64). Nevertheless, the upper left quadrant of high social threshold and low environmental impact remains empty.

While 'beyond GDP' and post-growth critiques share some elements, notably the preoccupation with the negative environmental impact of economic growth and the resulting social inequality, their prescriptions are quite different. Efforts to move 'beyond GDP' often call for additional indicators and/or composite indicators that include GDP. For instance, the Human Development Index developed by the UN is a composite indicator of development and is based on GDP per capita (as a proxy of living standards), life expectancy (as a proxy for health) and years of schooling (as a proxy of education). Post-growth critiques, on the other hand, question the very need for economic growth.

5.5.1 How does the 'beyond GDP' debate address a systemic and complex challenge?

The call to move beyond GDP — endorsed by international organisations such as the UN (UNEP, 2024) and the Commission — and the more niche call for post-growth societies by some corners of academia (D'Alisa et al., 2015; Hickel, 2021) can be interpreted as a response to the 'triple planetary crisis' of climate change, pollution and biodiversity loss created by unsustainable economic growth. It may too have been spurred by the legitimacy crisis of a governance system that struggles to change its means of governing and whose response to the triple planetary crisis has had, at best, mixed results.

Both the 'beyond GDP' and beyond-growth debates address a double lock-in. On the biophysical side, prevailing economic models are heavily dependent on resource consumption which, in turn, is responsible for a large share of environmental pressure. Whether or not this can be is a matter of heated controversy (EEA, 2021b; EEA, 2021). While some have proposed optimistic scenarios in which future economic growth and resource demand are decoupled (UNEP, 2024), it is contested whether an economic model based on green growth could deliver on global climate mitigation targets and reverse biodiversity loss (Parrique et al., 2019; Hickel and Kallis, 2020; Wiedmann et al., 2020). The lack of absolute decoupling between economic growth and resource consumption observed in the EU and globally, combined with the recognition that achieving a 100% circular economy is impossible (EEA, 2021b), raises fundamental questions about the viability of green growth. Current estimates suggest the EU's material footprint remained stable between 2010 and 2022 (EEA, 2023f), pointing to a relative decoupling from economic growth. Changing these dynamics would require a major reconfiguration of systems of production and consumption and of the broader socio-economic model.

On the governance side, there is a lock-in regarding the path dependency generated by the GDP indicator and the associated dominance of the economic logic in policymaking. Many beyond-GDP metrics have already been developed and used; for example, the SDG indicators and the EU Resilience Dashboards. There is a challenge in their lack of prominence, as alternative metrics are not part of the 'overarching top level narrative'. The financial crisis of 2008 and the economic crisis that followed in the eurozone triggered a reckoning with legitimacy in EU institutions, which culminated in the exit of the United Kingdom from the EU.

The criticism of GDP and the call for a more systemic view create a situation of irreducible pluralism, which makes explicit that decisions about what to measure and how are fundamentally value-laden and post-normal. Divergences about 'how' to measure economic progress can be seen in the juxtaposition of GDP and net savings, which emphasises how GDP does not distinguish between assets and debt. Proposals such as the happiness index and the ecological footprint (which measures the land use equivalent of the natural resources used by a country, a person or a product) open the debate about what to measure. In all cases, there are important controversies about the quality of the indicators being proposed. Standardised and widely-adopted indicators such as GDP, along with more recent indicators such as the ecological footprint, rest on questionable assumptions (Giampietro and Saltelli, 2014).

They also face critical data gaps and are the result of negotiations about what to measure and how, rather than objective representations of a reality 'out there'. Controversies also exist regarding the desirability of using metrics and reducing policy debates to what can be quantified, especially when discussing intrinsic and non-marketable values such as the value of nature. Some authors argue that it is problematic to quantify the worth of a songbird (Funtowicz and Ravetz, 1994b), that quantification leads to a reduction of different languages of valuation (Martinez-Alier, 2009), and that monetary valuation commodifies environmental resources (Corbera, 2012) and leads to the highly controversial governance model by which resource scarcity is managed through market mechanisms.

In broader terms, beyond the challenges of measurement, there are discussions about the desirability of economic growth. In the background paper prepared for their 'Beyond Growth' conference in 2023, the European Parliament explains that economic growth does not alleviate inequality and that GDP growth may be driven by undesirable events, such as war or responses to natural disaster (EP et al., 2023a). The reflection on the drivers of economic growth opens fundamental questions about what progress is and the need to consider types of growth beyond merely economic (EEA, 2021b).

5.5.2 Beyond GDP as governance in complexity

We discuss the extent to which responses to unsustainable growth patterns present elements of governance in complexity by focusing on the 'beyond GDP' indicators. This is mainly due to the fact that there are no EU-level, post-growth policies at the time of writing this report.

Attempts to move beyond GDP are clearly a case of experimentation with different metrics and the use of different indicators for governance, which can lead to setting alternative policy targets. In most cases, experimentation happens at the level of indicators and conferences about the need to go 'beyond GDP', but in a few cases, there are examples of experimentation in governing institutions. For example, Bhutan produces a yearly Gross National Happiness index. At the EU level, the debate is still taking place in conferences. The Stiglitz commission is one of the few cases in the EU in which 'beyond GDP' ideas have moved past the conference and debate stage and onto a scoping of possible indicators. Experimentation could be taken further: one could think, for example, of public policies aiming at improving the happiness of a country's population instead of aiming for a GDP growth rate of 7%, as set by Agenda 2030 (UN, 2015). If post-growth policies were put in place, those would be an experimentation with regard to previous policies. Experimentation does entail the risk of failure. However, non-experimental policies that do not adapt to the changing global economic, geopolitical and environmental context are also set for failure.

The 'beyond GDP' and post-growth debates are debates about which values governments, institutions and statistical agencies should care about. The critique of GDP as insufficient to measure wellbeing, happiness and sustainability points to the need to care for humans and nature. The debate operationalises the long-held understanding within studies of science that indicators are not just neutral tools that inform policymaking, but also carry agency and determine what policymakers see and focus on. Similarly, the suggestion to move beyond economic growth hails from the observation that economic growth does not benefit all those that should be cared for.

Some argue that the participation principle is weakly mobilised. The Conference for the Future of Europe, a citizen-led series of debates, included the beyond GDP debate. The OECD report 'Beyond GDP' mentions the importance of citizen engagement in developing indicator frameworks (Stiglitz et al., 2018). Participation is seen as relevant, yet it remains a marginal exercise.

The debate about what to measure takes indicator production outside of the exclusive realm of statistical agencies and turns it into a public and political debate. On the other hand, the 'beyond GDP' debate has been dominated by experts, such as Joseph Stiglitz and Amartya Sen in the French case, along with hegemonic international institutions, including the OECD, the Club of Rome, and the European Economic and Social Committee.

One issue is that the 'beyond GDP' debate tends to suggest alternative indicators that focus on issues that are often equally one-dimensional (e.g. focusing on net savings), or aim at aggregating multiple dimensions under one single composite indicator (e.g. ecological footprint and happiness index). In most cases, alternative proposals produce equally flat indicators which provide binary information. From a systems thinking perspective, an alternative approach would be to use indicators which can visualise trade-offs and synergies. Examples of this exercise are the EU Voluntary Review on progress in the implementation of the 2030 Agenda (EC, 2023b), which presents an analysis of synergies and trade-offs for each Sustainable Development Goal, and the UN Our Common Agenda's beyond-GDP initiative (UN-DESA 2022).

The analysis of trade-offs steps away from the idea of solutions, moves beyond the focus on targets and acknowledges that all actions have both positive and negative consequences. Measuring trade-offs in addition to 'progress' is a way to embrace the mindset of governance in complexity and uncertainty. The lack of system thinking entailed by the reliance on a single indicator, be it mono- or multi-dimensional, also reduces the anticipatory capacity. Nonetheless, the strategic foresight reports published by the JRC can be seen as an example of systemic and anticipatory thinking. The 2023 report (Matti et al., 2023) specifically discusses the 'possible and necessary changes in European social and economic systems' needed to transition towards a sustainable economic model.

5.6 What picture emerges for Europe? Between governance of complexity and governance in complexity

Across the four selected cases, the analysis revealed the presence of some elements of governance in complexity. Chapter 3 discerned a set of six principles of governance in complexity, which to varying degrees could be identified in the cases. In what follows, general observations for each principle are made:

- Experimentation can be taken up by necessity or design. The COVID-19 case illustrates a situation in which experimentation was a necessity because of the lack of predefined responses to a global pandemic. In the case of 'beyond GDP' debates, experimentation is part of the efforts to go beyond the growth imperative and the

use of GDP metrics. In the context of governance in complexity, experimentation is an alternative to the predict-and-control mindset that may accompany hierarchical governance. All policies could be seen as a case of experimentation in as far as policies need to be reviewed, adjusted and adapted. In general terms, embracing this principle could mean increasing the periodicity with which EU policies are reviewed. The recent reviews of energy and biodiversity policies are a promising step towards fostering reflexivity.

- Systems thinking is increasingly present across EU policymaking. The interconnected nature of the multiple crises we face is increasingly recognised and there are efforts to break governmental 'silos' and coordinate policy action. In the cases analysed, systems thinking can be observed in the association of energy policy with geopolitical considerations, of public health with economic and social considerations, and of economic growth with environmental and equity considerations. The uptake of systems thinking is an important step forward, not least because it enables a deeper dive into the reflections that this report raises.

- Anticipation exists in the analysed responses in varying degrees. Perhaps the clearest case is with REPowerEU, in which the response to the gas supply crisis goes beyond the solution of the immediate problem and looks at the energy transition the EU aims to support in the coming decades. At the same time, this is a principle that can be strengthened across the board, as policy is often forced to respond to emergencies, while long-term thinking is not always valued and resourced. Efforts to embed strategic foresight into EU policy-making are definitely an important step also for anticipatory thinking.

- Precaution is perhaps more visible in the COVID-19 responses, especially with regards to measures that aimed at containing the spread of the virus early-on in the onset of the pandemic.

- Participation is the principle least identified in the analysis. None of the selected cases showed strong elements of participation as a part of governance in complexity.

- Elements of care were identified in all four cases, though not always fully reflecting the mindset of governance in complexity, which calls for recognising the inevitability of trade-offs. The policy discourse of 'win-win solutions' represents a possible lock-in and barrier for transformative change in this sense: it may appear necessary for political legitimacy while at the same time being a barrier to proper care.

Governance in complexity requires a difficult balancing act. An emphasis on uncertainty and complexity may be misleadingly considered an excuse for postponing or abstaining from action. Claims of uncertainty have been made strategically — and still are — to obfuscate environmental issues and counteract legitimate action (Oreskes and Conway, 2011). On the other hand, action considering challenges as specific or diffuse increasingly fails because of actual, real-world complexity.

The call for governance in complexity is hence not one of passivity or acting less, but acting *differently,* and learning by trial and removal of error. One may speculate whether some degree of urgency or perception of crisis is needed or at least conducive to the willingness to move out of the comfort zone and develop new governance strategies, as was seen both in the REPowerEU and COVID-19 cases.

In the latter case, it was noted how 'playbooks' grounded in previous crises response did not function well in dealing with a global pandemic. There was a need for collective experimentation and constant adaptation. One way of doing this is through practicing governance as (collective) experimentation. This means allowing for epistemic pluralism and knowing through difference, by means of transparent public debate about which perspectives are included in the decision-making process. Ideally a plurality of actors is given opportunity to make their needs, concerns and perspectives matter. In that way, different sources and forms of knowledge as well as values are actively integrated into the governance process.

Overall, the picture that emerges is that governance in complexity approaches are evolving in Europe as a direct result of turbulent times. Since systemic and complex challenges call for experimentation and learning by trial and removal of error, it seems natural that such adaptations to traditional governance approaches are piece-meal, partial and imperfect. Elements of emerging institutional change can be identified, like the budget mechanism of NextGenerationEU, but are otherwise rare. To the same effect, most practical examples of governance in complexity chosen to inspire in Chapter 4 came from the local and regional level. The questions of how to scale-up the application of sustainability governance to the national and EU level is therefore presented in Chapter 6.

6 Enabling governance in complexity: the science-policy interface

'You have learnt something. That always feels at first as if you had lost something.'

George Bernard Shaw, *Major Barbara*

Key messages

- Governance in complexity should be cultivated as a mindset, defined in terms of the level of awareness by its practitioners and not as a set of procedures or tools.
- At the individual level, governance in complexity can be cultivated by diversified training activities and widening roles and ways of interaction.
- At the organisational level, governance in complexity can be cultivated by allowing for double-loop learning, that is, learning that modifies goals as well as decision-making rules and procedures, and learning that allows and applies inconvenient or uncomfortable knowledge.
- At the institutional level, governance in complexity requires considering institutional barriers.
- Inevitably, calls for transformative change towards sustainability can conflict with interests, power structures, and the dominant discourses of economic growth and material wealth.

This Chapter looks more closely at the need for scaling up and enabling good governance of sustainability issues at the EU level, overcoming the barriers in conventional governance approaches identified in Chapter 3.

6.1 Enabling governance in complexity at the individual level

The principles of governance in complexity need to be adapted case-by-case, for which individual skills and competencies are required (JRC, 2022).

Without devaluing non-scientific ways of knowing, it should be recognised that governance in complexity (especially the adaptive attitude) is closely aligned with the scientific mindset as defined in classic philosophy of science. Specifically, it is a process of conjectures and refutations, a systematic approach to trial and the removal of error, and attention to the possibility of being wrong (Popper, 1963).

As shown throughout this report, the primary scientific knowledge base for governance in complexity belongs to the humanities and interpretative social science, including political science, governance studies, environmental social science and science-and-technology studies. The very definition of governance in complexity describes the internalisation of theoretical insights from governance studies (Rip, 2006). This knowledge base can and should be taught and disseminated. For example, there is extensive literature on the different roles and approaches that scientific experts may take when providing scientific advice into a policy process, including the roles of science arbiters, issue advocates, stealth issue advocates and knowledge brokers (Pielke, 2007; Phipps and Morton, 2013). The introduction of the mindset of governance in complexity into evidence-centred advisory ecosystems may require an expansion of this set of roles in a way that enables experts to exert reflexivity, modesty and humility and a willingness to engage in co-creation of knowledge (Strand and Cañellas-Boltà, 2006; Jasanoff, 2007; Duncan et al., 2020; Strand, 2022).

Additionally, each of the six principles involved in governance in complexity are informed by their own body of scientific knowledge. For example, good cases numbers three and four in Annex 2 showed how appropriate training can deliver systems thinking. Similarly, training in the tools and techniques of participation, uncertainty assessment, transdisciplinarity and co-creation, foresight and anticipation may be valuable practically and also conducive of the mindset of governance in complexity.

6.2 Enabling governance in complexity at an organisational level

Many normative governance frameworks for sustainability, change, uncertainty or complexity include in their theory of change (see Table 3.1) some prescription or proposed mechanism for learning at the organisational level. In this sense, they can in themselves be seen as de facto experimentation — as proposals that can and should be subjected to trial and learning by removal of error in a variety of contexts (Oliver et al., 2021).

For governmental organisations promoting or participating in sustainability governance, two robust lessons can be drawn from literature. First, enabling governance in complexity at the organisational level requires organisational cultures that promote and facilitate double-loop learning, which is learning that modifies goals as well as decision-making rules and procedures (Argyris and Schön, 1978).

Organisational cultures depend on both external factors as well as internal (including strategy, structure, communication, etc.) (Argyris, 2002; Dauber et al., 2012). Governmental organisations are typically heavily dependent on external factors on the institutional level (see Section 6.3). Several of the self-assessments or independent reviews of the good cases presented in Section 4.2 concluded that initiatives were successful at the local level but failed to be scaled up or to have lasting effect. One important enabler of governance in complexity is double-loop learning related to the uptake of uncomfortable knowledge (Giampietro and Funtowicz, 2020).

To illustrate, Toyota Production System emphasises elements of uncomfortable knowledge in their organisational culture, including encouraging workers to stop production process, make independent judgements, and point out problems and errors upwards in the organisational hierarchy (Liker, 2004). In this specific case, more of these examples would in themselves be positive, making uncomfortable knowledge more comfortable.

One should not expect that the mindset of governance in complexity can be successfully introduced in organisations unless there is a simultaneous commitment to develop organisational culture. Governmental organisations involved in environmental and sustainability governance experience tensions between acknowledging uncertainty and complexity, while presenting knowledge that is simple, self-consistent and manageable enough to fulfil their institutional mandate to act (or give advice) (Rayner, 2012).

6.3 Enabling governance in complexity at the institutional level

There is no consensus in social science on the exact definition of institutions and organisations. For this Chapter, we distinguish between organisations as groups of actors working towards a shared goal or purpose (e.g. a company, think tank or governmental agency) and institutions as a category that also includes structures, rules, regulations, norms and belief systems that inform and constrain behaviour and agency in individuals and collectives. Some governmental entities will by that definition count as both organisations and institutions.

As presented in Section 3.1, the call for transformative change runs counter to the dominant discourse in modern societies that give high value to materialist wealth and high levels of consumption and production. The notion that materialism, consumerism and excessive consumption among affluent groups and individuals are obstacles to sustainability has been promoted not only by the EEA but also NGOs, civil society organisations, and spiritual and religious leaders around the world. Similarly, emphases on experimentation, learning and the adaptive posture of governance in complexity stand in contrast to dominant institutional discourses, which reflect the assertive posture of prediction, control and 'win-win' solutions. Solutionism is a barrier against governance in complexity and against transformative change (Kovacic et al., 2019). However, history has repeatedly shown that hegemonic discourses may fracture and change abruptly if the historical conditions are right (Arendt, 1973; Foucault, 1994).

As first presented in Chapter 3, the EU, as in many governance systems, also has institutional barriers to governance in complexity related to the legitimacy of public decision-making. These barriers are well-characterised in the case of the precautionary principle, which stands in tension with the principle of proportionality (De Smedt and Vos, 2022). This tension is even inherent to versions of the precautionary principle that require that precautionary measures are cost-effective.

Governance in complexity and its various principles may also face tensions with norms of modern bureaucracies, including legal certainty, predictability and proportionality, as well as practices of cost-benefit analysis and other quantitative impact assessments. The ideas of transformative change towards sustainability and governance in complexity are based on a scientifically robust diagnosis of multiple environmental and social crises, and a systematic lack of progress. At the same time, governmental institutions were established in the context of the opposite assumption: that challenges are governable by business-as-usual. The first step towards transformative change is to acknowledge that business-as-usual may no longer be an option.

The Commission's *White Paper on Governance* (EC, 2001) was in that sense an early recognition of a crisis of legitimacy, reflected in its first paragraph: 'Today, political leaders throughout Europe are facing a real paradox. On the one hand, Europeans want them to find solutions to the major problems confronting our societies. On the other hand, people increasingly distrust institutions and politics or are simply not interested in them'.

More inclusion and public participation in environmental and sustainability governance is not just a means to widen the space for resolutions to sustainability challenges, but also an attempt to address the legitimacy crisis and revitalise democracy. However, the principle of participation is not practically nor politically simple to scale up. Changes in European governance described in Chapter 5 illustrate the tension between 'inclusiveness and effectiveness' (EEA, 2015a), which can challenge legitimacy.

The framing of political challenges as crises and emergencies has made it possible to turn to innovative and unusual governance measures, like the emergency laws as part of the coronavirus response, as well as budgetary mechanisms such as NextGenerationEU. As sustainability problems are likely to aggravate throughout the 21st century, part of the challenge of transformative change will be to avoid ecosystem collapse while also confronting a permanent state of exception in authoritarian or semi-authoritarian political regimes and so-called illiberal democracies (Agamben, 2005).

Governance in complexity provides resources for navigating such situations but its principles are not new. Participation and openness correspond with EU principles of good governance. The principles of precaution and care for the environment are already enshrined in European legislation, although work towards institutional change is needed to strengthen precaution. Experimentation, systems thinking and anticipation are all well-aligned with the enlightened scientific mindset which defined European identity and values.

Table 6.1 summarises lessons of governance in complexity at the individual, organisational and institutional level.

Table 6.1 Lessons at different levels of governance in complexity

Levels of governance	Description	Insights and learnings
Individual	Single actors (with agency) embedded in networks of social relations such as e.g. organisations and institutions.	Be aware and make use of different roles and repertoires of interaction within knowledge-intense organisations: science arbiters, issue advocates, knowledge brokers. These roles and repertoires need to be expanded to include reflexivity, modesty and humility. Training activities need to be diversified according to the six principles of governance in complexity: tools and techniques of participation, transdisciplinarity and co-creation, foresight and anticipation, and uncertainty assessment. Adopt a mindset of experimentation, anticipation and care.
Organisational	Groups of actors working towards a shared goal or purpose, governed by rules and procedures.	Enable organisational cultures that allow for double loop learning: learning that includes goals as well as decision-making rules and procedures. Double loop learning is a way for organisations — especially those involved in environmental or sustainability governance — to incorporate uncomfortable knowledge, i.e. knowledge that challenges an organisation's premises for operating.
Institutional	Structures, rules, regulations, norms and belief systems that inform and constrain the behaviour and agency of individual and collective actors.	Calls for transformative change towards sustainability run counter to the dominant discourse in modern societies. There are important institutional barriers to transformative change and governance in complexity, such as tensions between different principles of governance (e.g. precaution and proportionality). Promoting inclusion and public participation in environmental and sustainability governance accordingly is an attempt to revitalise democracy by introducing elements of direct participation.

6.4 Broader societal change: power and governmentality

The specific context of systemic and transformative change and its implications for legitimacy require a broader perspective on political power in modern societies than the one presented by conventional studies of governance. In modern states, citizens are governed through subtle social control in public institutions such as schools and hospitals. In contemporary societies, this 'governmentality' can also be the result of private actors that shape discourse, often commercial actors. The result is that citizens discipline themselves to be productive, abide by public health recommendations, be 'good consumers' and so on. The notion of 'flygskam' (flight shame), which emerged in Sweden, is a striking example of this kind of self-governance that replaces disciplinarian exercise of power with willing participation or pre-emptive obedience (Gössling, 2019). Self-governance is however ambiguous, as it can be seen as both constraining and empowering for citizens (Rose et al., 2009).

The close link between power and knowledge has led to the term 'power/knowledge' (Foucault, 2011). To illustrate, producers who understand consumer patterns and desires could exercise power through advertising and other means of influencing social and cultural norms and values, often in ways that are elusive. Because of its dynamic and intangible character, power/knowledge may be difficult to resist or protest.

Although eco-movements and ecological discourse have gained strength across many Western societies, the dominant discourse emphasises the connection between progress, growth, happiness and consumption (EEA, 2021b). In other words, the call for transformative change asks citizens to radically depart from our collective way of making sense of and acting in the world. Responsible citizens concerned with sustainability may choose to redirect consumerist values and buy 'fair', 'recyclable' and 'organic' products.

However, to engage with a more radical departure from being a good consumer, such as getting involved with subsistence agriculture or establishing networks to share and exchange goods outside of the market, runs against the dominant discourse — thereby creating cognitive dissonance. As a result, governmentality acts with initiatives like ecological modernisation and governance responses like policy coherence and the vision of a circular economy. Such measures affirm and stabilise the dominant discourse of growth and material wealth, and support the flow of power.

Naturally, novel ideas for governance that depart from Western and modern beliefs in mass consumption, capitalism, scientific control, technological innovation and so on are harder to establish. Initiatives like citizen assemblies, extended peer communities, simple living, degrowth, co-creation of knowledge with scientists and indigenous people, and futures impact assessments are all initiatives that logically follow from the various conceptual frameworks for systemic and complex challenges. However, they all run counter to dominant discourse of prediction and control. Without a mindset of governance in complexity that allows for more ways of knowing, such initiatives risk being simplified and considered irrational or inappropriate, reduced to small-scale experiments or oddities.

Acknowledging the power of discourse as power/knowledge or governmentality offers optimism, because it means that power flows and shifts together with discourse. Like there are tipping points in ecosystems, there might also be tipping points in social norms. To this effect, Chapter 7 includes some possible pointers on how perspectives could be widened.

7 Conclusion: from 'solving problems' to 'resolving challenges'

Key messages

- Systemic and complex challenges may not have perfect solutions or 'fixes'. In such situations, a more realistic option is to work towards resolve by broadening the knowledge base and gathering concerned parties to collectively find a practical way forward.
- Resolving implies a need to abandon false hopes for perfect solutions and 'win-win strategies', aiming instead for overlapping consensus and preparing for inevitable compromises and painful trade-offs.
- Progress towards sustainability appears unlikely unless sustainability advocates find ways of constructively engaging with those who resist. There must be a mindset of experimentation, trial and the removal of error.

Central to the argument in this report is the characterisation of systemic and complex challenges as having many possible framings. Such framings are crucial for the choice of policy and governance approaches, as well as for defining what knowledge base our chosen actions should be based on. As a result, with complex and systemic challenges, there are neither unique definitions nor solutions.

Therefore, a more suitable approach to sustainability challenges is to aim for resolution, bringing contested issues to the table, gathering differing parties and finding a practical way forward. To resolve implies abandoning false hopes of perfect solutions and 'win-win' strategies that conceal inevitable trade-offs, instead aiming for an overlapping consensus and a preparation for compromise. This way, the plurality of perspectives, values and ideas are not considered as obstacles to overcome, but rather as a fundamental and necessary condition and resource (Nature, 2022; King et al., 2023). When our current model of governance is faced with a context of urgency and multiple interrelated crisis as presented in this report, such resources might paradoxically be all the more demanding but necessary to include.

In the context of the science-technology-policy interface in Europe, the principles of governance in complexity presented in Chapter 3 are not new. The EU *White Paper on Good Governance* reflects many of the same intentions. Several practical examples have been implemented throughout the last decades. Chapter 5 demonstrates how a movement towards de facto governance in complexity is also currently visible in European policy. This is becoming increasingly evident in the discourse of the European Commission. For instance, the *Strategic Foresight Report 2023* (EC, 2023b) and its underpinning science for policy report (Matti et al., 2023) point to concepts and practices like systems thinking, anticipatory governance and capabilities, experimentation and innovation in policy as key opportunities for dealing with the evolving nature of the challenges.

More fundamentally, a renewed social contract, where democracy and democratic engagement at local, regional, national and international levels are strengthened, is seen as a precondition for advancing sustainability in Europe. Yet two possible explanations and barriers to scaling such approaches into the mainstream, demonstrated in Chapters 3 and 6, are the tensions within governance and the power of societal discourse that run counter to sustainability.

As presented throughout this report, framing problems and challenges is in itself a complex phenomenon that stretches far beyond the realm of environmental sciences. Dealing with sustainability challenges therefore requires a broadening of the knowledge base to also include social sciences and the humanities, such as literature, history and philosophy. In philosophy, the mindset of governance in complexity was succinctly described already in Laozi's *Tao Te Ching,* approximately 2500 years ago: 'Trying to control the world? I see that you won't succeed'.

In contrast, in our current situation, it is almost as if the strength of our evidence has paralysed action. It is our duty, Latour and Schultz (Latour and Schultz, 2022, p. 18) write, 'to diagnose the sources of this paralysis and to seek a new alignment between anxieties, collective action, ideals and the sense of history'.

If science is the art of the soluble and politics is the art of the possible (Medawar, 2021), control might be impossible but progress is not. There is much inspiration to draw from. If we look to cultures outside Europe throughout history, traditional societies have used adaptive governance strategies over millennia. Without our reliance on technological fixes and solutions, we are simply left to stay with the trouble (Haraway, 2016).

The complexity of sustainability challenges has been diagnosed before and sensitive solutions have been proposed and implemented. It is within this context that governance in complexity is emphasised as a mindset. In this mindset, many different perspectives are sought to collectively find resolution through experimentation, trial and the removal of error.

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Annex 1 Diagnostic tool for systemic and complex challenges

The following presents a diagnostic tool for identifying key features of systemic and complex challenges. These features are accompanied by a set of corresponding guidance questions. The list of descriptors should not be seen as a definition, in the sense that a challenge would have to fulfil all or a certain number of conditions to qualify as systemic or complex. Rather, the set is to be seen as a heuristic to be used by scientists, extended peer communities and scientific advisors to policy, for diagnostics and (at the science-policy interface) for deliberation, to clarify the perceived features of a given challenge. When stakes are high and values are in dispute, it is not infrequent that different actors (experts and stakeholders) hold different opinions about the features of a challenge. Diagnostic heuristics should accordingly not be seen as tools to enforce agreement by objectively determining such features. Rather, their purpose is to increase the conceptual precision into deliberative processes.

In governance challenges that appear as systemic, it may be possible to identify a system or a definite set of systems involved in the challenge. The two main features are the description and the definition of the system(s). Especially for challenges in which biophysical causal networks are important, system sciences may offer mature models of the system(s). Climate models, hydrological models and population ecology models are examples. In such cases, key features may be described by main model properties, such as the structure of causal networks (interdependencies, rebound effects etc) and the structure of the phase space (attractor patterns, instabilities, bifurcations and tipping points etc).

The system definition is the formal or informal model of the system. While there are multiple ways of characterising models, a main feature with respect to governance is the degree to which the model has been shown to be reliable and valid. Degrees of reliability and validity are relative to the use of the model and the error tolerance for that use. Furthermore, they may vary across phase space and parameter space and are sensitive to the properties of data sources. Methods of sensitivity analysis and sensitivity auditing can to some extent elicit such properties.

Moreover, models may be characterised in terms of radical openness and sources of contextuality (Chu, 2011; Chu et al., 2003). Radical openness is a consequence of the absence of natural boundaries of a system. More precisely, it is defined as the failure of the modelling process to draw systems boundaries that makes the system closed with respect to efficient causation. One may try to solve the problem by redrawing the boundaries and expanding the system. Typically however, this just introduces new interactions with the surroundings. Contextuality is the analogous problem that the entities within the system may have an indefinite number of properties and therefore interact in indefinite ways.

Table A1.1 Diagnostic guidance questions for systemic challenges

System description	**Systemic nature**	Is the challenge defined in terms of the presence or future danger of an undesirable state of a complex system?
	Interdependencies	Which are the known/important/relevant causal interdependencies in the system corresponding to the challenge framing?
	Attractor patterns	What is known about the phase space and the attractor patterns of the system? Are there lock-ins, instabilities, opportunities or risks of transitions?
	Causality	Are there upward and downward causal pathways across levels and scales? Is the system richly connected? Are there important nonlinearities? Are cascades of impacts expected?
	Paradoxical effects	Which paradoxical effects (such as rebound effects) are expected or suspected?
System definition	**Radical openness**	Did the system definition/modelling process arrive at closure with respect to system boundaries and if so, how?
	Sources of contextuality	Did the system definition/modelling process arrive at closure with respect to the set of relevant variables of its elements and if so, how?
	Validity and plausibility	How much should descriptions and models of the system be trusted?

Models of socio-ecological systems will as a rule experience radical openness or contextuality, as well as unclarity or doubt about the validity and reliability of the model. If so, the challenge is not only systemic but complex, in the sense that there is uncertainty, ambiguity and indeterminacy. The two main features in that respect are how the challenge is framed by different actors and the characterisation of the knowledge base and its uncertainties. The knowledge base and its degree of uncertainty is dependent on the framing of the challenge. Conversely, the framing may depend on the available knowledge base. Approaches from post-normal science can be used to characterise the knowledge base and its degrees and types of uncertainty. The guidance questions on framing plurality and stability may be thought of as questions that practitioners can reflect upon. However, they can also be pursued rigorously by social sciences such as sociology, political science and science and technology studies. Hence, a proper treatment of complex sustainability challenges requires an expansion of the knowledge base that includes social sciences.

Table A1.2 Diagnostic guidance questions for complex challenges

Descriptor	Example of guidance questions
Framing plurality	Are there alternative framings of the challenge? Who advocates them, and what are their matters of concern and care? Who advocates the main framing and with what matters of concern and care?
Framing stability	Is the main framing dominant, hegemonic, contested, in development, stable? Which types and sources of power are important in the framing process?
Uncertainty	What are the sources of technical, methodological and epistemological uncertainties in the knowledge considered relevant to the challenge? What is their significance? Is the knowledge contested? What is the knowledge pedigree?
Plurality of values	Are values in dispute? How do values contribute to the framing of the challenge and the definition of the system?
Stakes	Are stakes high, for whom and why?
Urgency	Is the challenge deemed urgent? By whom and why? What are the implications of deeming it urgent?
Indeterminacy	How would the system definition and the relevant knowledge body change with a reframing of the challenge?

Annex 2 Collection of good cases of governance in complexity

The following is an inventory of selected good examples of the mindset of governance in complexity and the six related principles highlighted in this report. As emphasised in Section 4.2, the examples are chosen to illustrate and inspire — many more could have been selected and the absence of a particular regional or EU-scale development does not imply that it is inferior to the chosen examples chosen.

Box A2.1

Good case of governance in complexity that illustrates: experimentation – participation

Commission's Community of Practice: Competence Centre on Participatory and Deliberative Democracy

The European Commission has taken a number of initiatives that could be understood as **experiments with different forms of governance** and thus as knowledge or governance responses to systemic and complex challenges. One of these initiatives are the so-called Communities of Practice (CoP). Within the ecology of the Commission and in particular its Joint Research Centres (JRC), a CoP is one of several approaches to knowledge management. Beyond the Commission, the CoP facilitates partnering with different organisations to address common challenges about a particular topic.

One of these CoPs focuses on citizen engagement and deliberative democracy. This is a collaborative project at the JRC which involves different units and policy DGs of the EC. It aims to map, build capacity, innovate, and implement citizen engagement at all stages of the EU policy cycle, from design through to implementation and evaluation. It is situated within attempts to develop and institutionally stabilise citizen engagement/public participation approaches within Commission policymaking mechanisms – this has been an ongoing process for at least two decades.

The aim of this project is to establish different forms of participation and citizen engagement as a so-called transversal activity' within the JRC. This means that the objective is to establish citizen engagement as a standard element in the process of producing knowledge and making decisions within EC activities.

In parallel to the negotiations surrounding the establishment of this particular Community of Practice, a new Competence Centre was launched in 2022: the Competence Centre on Participatory and Deliberative Democracy (CC DEMOS). The establishment of this CC is a further step in **institutionalising forms of experimenting** with different modes of governance. The CoP is now a part of this Centre.

The self-understanding of CC DEMOS is to support policymaking. It does so through a number of activities described on the website of the Competence Centre:

- enriching the EU knowledge base on participatory and deliberative practices;
- providing guidance for researchers and policymakers;
- building capacity on methodologies;
- developing dedicated public spaces for citizen engagement;
- experimenting with new methodologies.

To reach these objectives the centre organizes internal trainings, conferences, contributes their methodological know-how and experiences and engage in projects beyond the confines of the JRC.

In addition the JRC Makerspace is a physical space dedicated to 'tinkering' and allows JRC researchers to engage 'Makers', the DiY (Do it Yourself) community and citizens more broadly.

As with other Competence Centres of the JRC, this is seen mainly as an internal service for policymaking. However — and this is why it is a nice exemplar — by doing this work this Centre is showing that 'things could be otherwise', thus pointing to contingency and a plurality of approaches and understandings of governance responses.

Already the aim to make policies more robust is a challenge to ideas of robustness that focus exclusively on expertise and evidence as criteria of robust advice. In addition to validity as a criterion for the evidence policies are imagined to be informed by, 'social robustness' becomes increasingly important as a principle in developing policies.

Also, as briefly mentioned above, there is an explicit focus on **small scale experimentation and 'tinkering'**. This is an explicit reference to Knorr Cetina's 'Tinkering towards success' from 1979 – one of the first lab studies and theories of scientific practice and thus a call to focus on the practices of doing democracy: the mechanisms ruling the progress of research are more adequately described as successful 'tinkering' rather than as hypothesis testing or cumulative verification (Knorr, 1979).

There are still several challenges to this kind of work towards governance in complexity, which include institutionally stabilised rationales, repertoires and habitual ways of doing things There are deeply entrenched roles and modes of interaction that define what can be imagined as being possible in engagement settings, i.e. what Jasanoff (2003) calls 'institutionalised habits of thought' in her call for relying more on technologies of humility.

The work of this Competence Centre deliberately stresses the need for novel modes of governance such as different forms of public participation and citizen engagement. This often leads to critiques of hegemonic discourses. It employs co-creation methodologies and is based in post-normal science maxims, most notably the integration of 'extended peer communities'. The set-up of the Competence Centre as well as the negotiations that led to it together with a range of parallel activities can be seen as a broader experiment with new social, institutional and in some instances also personal practices.

Box A2.2

Good case of governance in complexity that illustrates: experimentation – participation

Climate Streets in Finland

Within a mindset of experimental climate governance, there are various examples of attempts to make urban neighbourhoods climate-neutral at a very local scale, in fact, street by street. Such examples obviously illustrate the principles of experimentation and participation but also systems thinking insofar as the underlying model is that of multi-level governance (Grönholm, 2022).

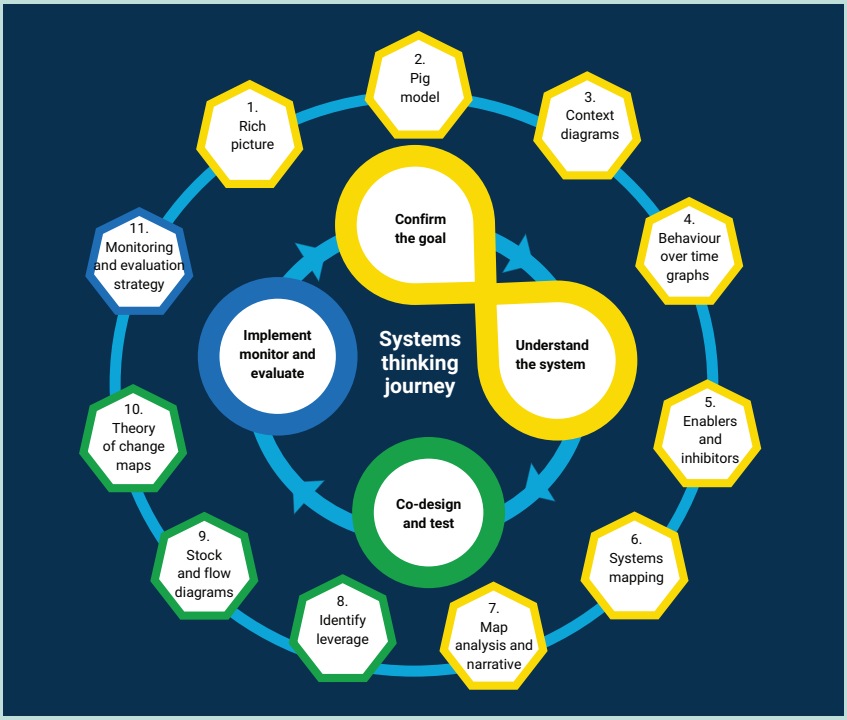
One such example is the the Ilmastokatu/Climate Street Project that aimed to transform into climate neutrality the streets Iso Roobertinkatu in Helsinki and Tikkuraitti and Asematie in Vantaa (Finland), which was funded by the European Regional Development Fund (2014-2020). In all, 52 experimental initiatives were developed, both for climate mitigation and adaptation. The experiments included a wide variety of business, civil society organisations and citizens, and the content of the experiments addressed all parts of daily life, including food, mobility, housing, physical exercise and so on. The project was evaluated as a success in the sense that it produced a number of new local practices and raised knowledge and awareness of climate change (Juhola et al., 2020). However, the evaluation also showed a resemblance to other, similar initiatives in that it was difficult to document that the project led to systemic change.

Box A2.3

Good case of governance in complexity that illustrates: systems thinking

Integration of systems thinking into the UK's Department of Environment, Food and Rural Affairs (DEFRA)

In 2019, the United Kingdom's Department of Environment, Food and Rural Affairs (DEFRA) launched a systems research programme to inform DEFRA policymaking. One of the outputs of this programme is a suite of guidance documents, toolkits and training resources for civil servants to encourage and facilitate 'systems thinking journeys' (DEFRA, 2021).



Source: UK Government Office for Science, 2022 (UK Open Government License).

The programme has developed a standardised systems approach for application in DEFRA and across UK government, taking a broad systems approach that includes aspects of framing and the concept of wicked problems (Rittel and Webber, 1973). It concludes: 'systems approaches do not always provide hard answers but can be invaluable in exploring issues and asking 'what if?'. In systems, the journey is as important as the destination. Approaches should be people-centred, co-designed and co-owned with participants' (DEFRA, 2021). In parallel, the Systems Thinking Interest Group has been created as a network that counted more than 300 UK government officials as members in 2020 (Jones, 2020).

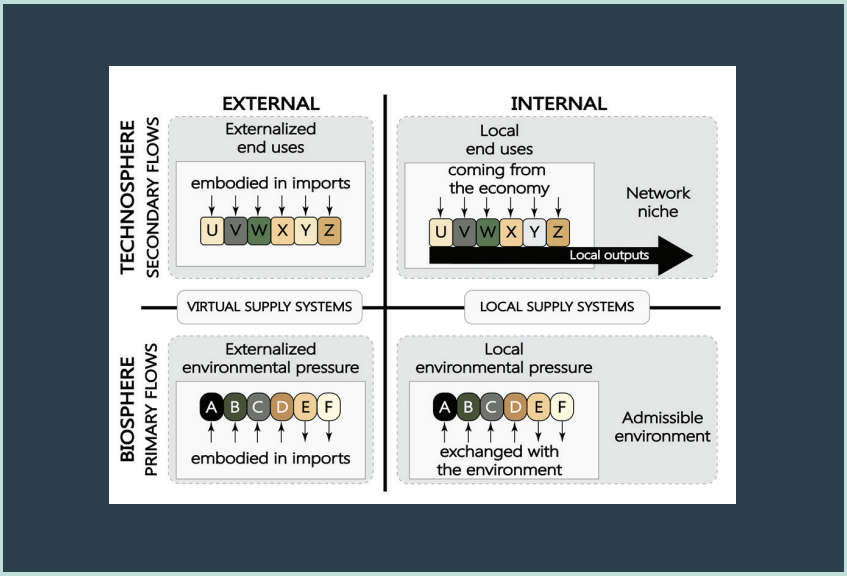
Box A2.4

Good case of governance in complexity that illustrates: systems thinking – care

Good Living and multi-scale integrated analysis of societal and ecosystem metabolism (MuSIASEM)

In 2008, the Ecuadorian government introduced the concept of Good Living in its constitution and has been publishing four-year National Plans of Good Living (*Plan Nacional del Buen Vivir*) ever since. The concept of 'Good Living' is a translation of the Quechua concept of Sumak Kawsay, which refers to a way of life that allows for happiness and for the permanence of cultural and environmental diversity. Its principles are harmony, equity, equality and solidarity. The institutionalisation of Good Living is a notable example of **care**, enacted through the attempt to integrate cultural pluralism in the constitution by giving voice to indigenous worldviews.

The third version of the National Plan of Good Living, in vigour during 2013-2017, stressed that Good Living is not something that can be improvised but needs preparedness. To this purpose, from 28 April–16 May 2014, the Ecuadorian Secretariat for Planning and Development (SENPLADES) sent a team of sixteen experts to Barcelona to take part in an intensive training course in Multi-scale Integrated Analysis of Societal and Ecosystem Metabolism (MuSIASEM). The two-week course was aimed at strengthening human and institutional capacities in designing and evaluating future development scenarios within the context of the Ecuador's National Plan for Good Living. MuSIASEM is an integrated assessment methodology that has system thinking at its heart: it integrates societal and ecosystem metabolism and is based on a multi-scale relational representation of the system that serves to describe complexity.



Source: MuSIASEM.

This example shows an attempt to institutionalise system thinking by training policy officers and technicians, rather than relying on external experts and on policy briefs that necessarily reduce the complexity of the issues being governed through the exercise of distilling clear messages for governance. Moreover, the MuSIASEM accounting framework makes it possible to identify the trade-offs of different courses of action and is thus best suited to support deliberative processes than to identify solutions to complex challenges.

Box A2.5

Good case of governance in complexity that illustrates: experimentation – participation – care

Irish Constitutional Convention and subsequent Citizens' Assemblies

The Irish Citizens' Assembly is among the model cases of participation and much has already been written about it (see e.g. OECD, 2020). It is an independent body with a government-appointed chair, consists of 100 randomly selected citizens who deliberate on pressing societal issues and provides reports and recommendations to the Houses of the Oireachtas (the Irish parliament). The Assembly convened for the first time between 2016 to 2018 to deliberate on five legal and policy issues:

- the 8th amendment of the constitution on abortion;
- ageing populations;
- referendum processes;
- fixed-term parliaments;
- climate change.

The recommendations of the Assembly were submitted to parliament for further debate. Following the recommendations, the Irish government organized a referendum an amending the 8th amendment on abortion. Furthermore, a climate emergency was declared. The Citizen's Assembly has since convened on other occasions to deliberate on the issues of gender equality (2020-2021) and biodiversity loss (2022). In addition, the Dublin Citizens' Assembly was established in 2022.

The establishment of the Irish Citizens' Assembly was preceded by the initiative 'We the Citizens' in 2009 and the Irish Constitutional Convention, which ran from 2013 to 2014 and consisted of 66 randomly selected citizens, 33 politicians and an independent chair. This Convention led to a referendum on marriage equality, which passed with a majority of 62.1%.

The rationale for establishing such a permanent deliberative body was to give citizens more say in government decisions and to create a culture of political participation of all members of Irish society. This is reflected in the principles of the Assembly: openness, fairness, equality of voice, efficiency, respect and collegiality.

The Irish Citizens' Assembly is special as it is an independent and permanent deliberative body. Because of this status and the continued support of the Irish Parliament, there is a consequentiality to the recommendations of the Assembly that is often missing in other examples. There is a clear path from the deliberations of the Citizens' Assembly to recommendations and decisions to be made. In addition to being a good illustration for the principles of participation and experimentation, it is also a fitting exemplar for the principle of care. The integration of different perspectives and the possibility to address the framing of issues through deliberation clearly speaks to an ethics of care.

Box A2.6

Good case of governance in complexity that illustrates: experimentation – participation – anticipation – care

The Austrian 'Klimarat'

Was a national climate assembly organized in 2022. It was commissioned by the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology, on behalf of the Austrian Parliament in response to a citizens' initiative (Volksbegehren) on climate protection.

The Klimarat consisted of around 80 participants selected by a two-stage civic-lottery. The citizens deliberated over a period six weekends between January and June 2022, supported by a scientific board consisting of 15 scientists from different disciplines. Importantly, also a stakeholder advisory board was involved. This board involved members from the social partnerships, such as the Chamber of Commerce, labour unions, and NGOs.

The aim of this assembly was to propose measures to reach climate neutrality in Austria by 2040. The following broad questions were guiding the discussions of this assembly: How do we want to move? Where do we get our energy from? How do we need to feed ourselves to protect the planet? Finding answers to these questions meant to develop ways of ensuring a climate-healthy future (*klimagesunde Zukunft*). The questions were worked on along five themes: mobility; housing; energy; production and consumption food and land use. Two transversal issues were also developed in the discussions: global responsibility and social justice.

The assembly delivered its report, which entailed 93 recommendations, in July of 2022. There are no formal mechanisms for a response in place beyond a commitment of the Minister at the start of the process.

This example shows how modes of governance that build on experimentation and participation can develop out of more mainstream tools of representative democracy — a Volksbegehren in this case. This climate assembly also represents a form of anticipation, as one of its core aims was to work towards more 'climate-healthy futures'.

Box A2.7

Good case of governance in complexity that illustrates: experimentation – participation – anticipation – care

Conference on the Future of Europe

The Conference on the Future of Europe was a series of debates between April 2021 and May 2022 organized as a joint undertaking of the European Parliament, the European Council and the Commission together with the EU's member states. It was organized in the form of different citizens' panels on national and European level involving randomly selected citizens. Recommendations from the citizens' panels were discussed by the conference plenary. Conclusions were presented to the Executive Board. The Conference ended when the report on the final outcome of the Conference was presented to the joint presidency. The slogan for the conference was 'The future is in your hands'.

One of the key elements of the Conference on the Future of Europe were four European citizens' panels involving 800 randomly selected citizens. These panels were organised by theme:

- stronger economy, social justice, jobs, education, culture, sport, digital transformation;
- EU democracy, values, rights, rule of law, security;
- climate change, environment, health;
- EU in the world, migration.

This example shows how citizen assemblies can be organized on a supra-national level and can be embedded within policymaking processes on a European level. It is an example for experimentation and participation but in its future-orientation importantly also for anticipation and care.

Box A2.8

Good case of governance in complexity that illustrates: precaution – anticipation – care

The Norwegian Gene Technology Act

Act of 2 April 1993, No 38 Relating to the Production and Use of Genetically Modified Organisms etc., hereafter referred to as 'the Norwegian Gene Technology Act', is a case of precaution in the strong and broad sense (Genteknologiloven, 1993). A legally non-binding translation into English by the Norwegian government is found here.

In its preamble (Article 1), the Norwegian Gene Technology Act states its purpose as 'to ensure that the production and use of GMOs and the production of cloned animals take place in an ethically justifiable and socially acceptable manner, in accordance with the principle of sustainable development and without adverse effects on health and the environment.' The strong version of precaution is formulated in Article 10: 'The deliberate release of genetically modified organisms may only be approved when there is no risk of adverse effects on health or the environment.' However, sustainability governance in the shapes of anticipation and transformative change is also present, as Article 10 continues: 'In deciding whether or not to grant an application, considerable weight shall also be given to whether the deliberate release will be of benefit to society and is likely to promote sustainable development.' While Norway complies with European Union directives within the field of biotechnology and GMOs, the Norwegian practice adds a strong element of precaution, sustainability and ethics (Hvoslef-Eide, 2012) which has led to several rejections of release of GMOs that have been approved in other European countries (Myhr et al., 2020).

To develop the knowledge base on risks and uncertainties while contributing to safer use of biotechnologies, GenØk, the Norwegian Centre for Biosafety, was founded in 1998 as a publicly funded, non-commercial foundation. Furthermore, an extensive apparatus of guidelines for environmental impact assessment and ethics self-assessment has been put in place by Norwegian authorities to operationalize Article 10 of the Gene Technology Act. The guidelines for ethics self-assessment includes checklists of questions that the applicant should consider, including:

Section III. The precautionary principle:

- Is there a reasonable degree of doubt about existing risk assessments, and is there a danger that the risk may be higher than these assessments indicate?
- Is there a reasonable degree of doubt about existing probability assessments, and is there a danger that the probability of adverse effects is higher than these assessments indicate?
- Is there a reasonable degree of doubt about existing impact assessments and is there a danger of even more serious effects on health and the environment than these assessments indicate?
- Is there a reasonable degree of doubt about possible serious cumulative effects on health or the environment?
- Is there a reasonable degree of doubt as to whether proposed mitigating measures and instruments will function as intended?

The guidelines state the following: 'If the answer to one or more of these questions is yes, this indicates that the application can be refused with reference to the precautionary principle'. The ethics guidelines also include a checklist for sustainability, then not construed as just as environmental impact assessment, but more broadly about the future envisaged by the technology, in terms of biodiversity, ecosystem functioning, energy and natural resource use, emissions, basic human needs, distribution between generations and distribution between rich and poor countries.

The Norwegian Gene Technology Act has been contested throughout its existence. The Norwegian government is currently preparing its revision. The Norwegian Biotechnology Advisory Board, which is a permanent independent institution appointed by the Norwegian government, recommended in 2023 a significant 'softening' of the regulations, in the sense of lowering the regulatory threshold for release of GMOs.

Box A2.9

Good case of governance in complexity that illustrates: precaution

Post-Normal Science Tools for Precautionary Uncertainty Assessment

Within the field of post-normal science, techniques and tools have been developed for qualitative and quantitative uncertainty assessments beyond the tools of statistics. Funtowicz and Ravetz (1990) created NUSAP, a notational system to describe and deliberate on technical, methodological and epistemological uncertainties. NUSAP stands for numeral, unit, spread, assessment and pedigree. Pedigree means information about the origin and production of the information being assessed, as well as its anticipated use, typically expressed by the use of matrixes or spider diagrams (van der Sluijs et al., 2005).

NUSAP has so far been used more by academic researchers at the science-policy interface than by policymakers and civil service. One example of a research-driven but collaborative endeavour is the NUSAP workshop used to assess uncertainties in the UK energy systems model ESME (Energy Systems Modelling Environment) (Pye et al., 2018).

The Netherlands Environmental Assessment Agency (PBL and its predecessor RIVM/MNP) put NUSAP and similar uncertainty assessment techniques developed from post-normal science already into use in 2003 (Petersen et al., 2011), following a public controversy around the use of simulation models in environmental assessments. In 2013, PBL published its second version of the uncertainty assessment guide (Petersen et al., 2013), which includes elements of participation as well as the use of an uncertainty matrix, see illustration below:

UNCERTAINTY MATRIX		Level of uncertainty (from 'knowing for certain' (deterministic knowledge) to 'not even knowing what you do not know' (total ignorance))			Nature of uncertainty		Qualification of knowledge base (backing)			Value-ladenness of choices		
Location ↓		Statistical uncertainty (range+ chance)	Scenario uncertainty (range indicated as 'what-if' option)	Recognised ignorance	Knowledge-related uncertainty	Variability-related uncertainty	Weak –	Fair 0	Strong +	Small –	Medium 0	Large +
Context	Assumptions on system boundaries and ecological, technological, economic, social and political context											
Expert judgement	Narrative; storyline; advice											
Model: Model structure	Relations											
Model: Technical model	Software and hardware implementation											
Model: Model parameters												
Model: Model inputs	Input data; driving forces; input scenarios											
Data (in a general sense)	Measurements; monitoring; surveys											
Outputs	Indicators; statements											

The use of post-normal uncertainty assessment techniques is endorsed by the organisation and has to some extent found their way into practical use. Petersen et al. (2011) pointed out barriers and challenges but concluded that 'we can conclude that an openness to other styles of work than the technocratic model has become visible in PBL's practice.'

Box A2.10

Good case of governance in complexity that illustrates: systems thinking – anticipation

Strategic Foresight reports

Starting in 2020 and in the wake of the COVID-19 pandemic, the European Commission launched a series of annual strategic foresight reports on the following themes:

- Charting the course towards a more resilient Europe (2020);
- The EU's capacity and freedom to act (2021);
- Twinning the green and digital transitions in the new geopolitical context (2022);

The series 'seeks to embed foresight into European Union policy-making' (https://commission.europa.eu/strategy-and-policy/strategic-planning/strategic-foresight_en#strategic-foresight-reports) and aim at a change in institutional culture and policy-making practices. Strategic foresight builds on systems thinking and collective intelligence, with the double aim to 'better develop possible transition pathways' and 'prepare the EU to withstand shocks'. The reports depart from the 'win-win' narrative that permeates many EC policy documents and acknowledge a broad range of solutions as well as challenges and trade-offs.

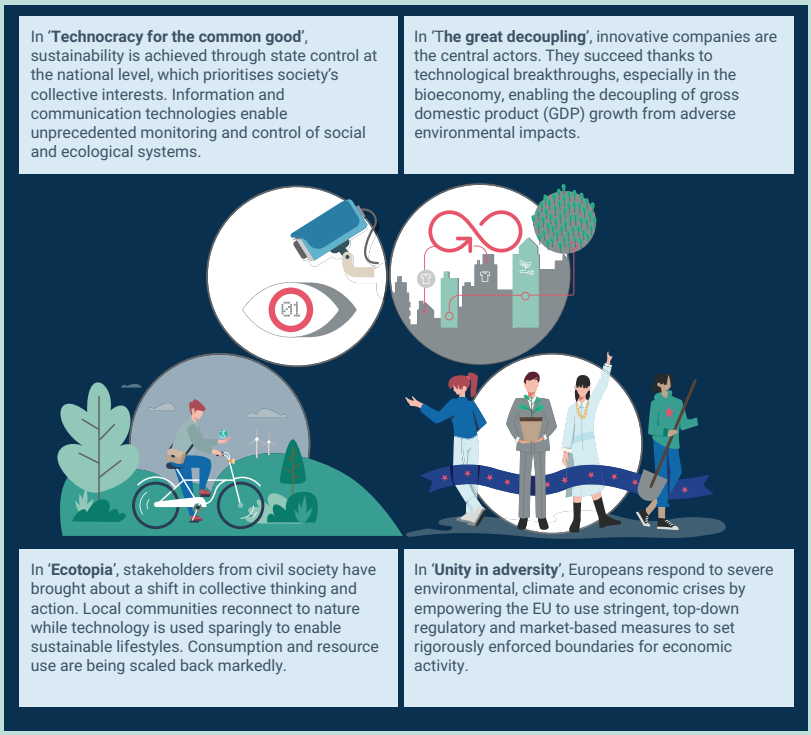
The Strategic Foresight reports create an avenue through which risks and uncertainties may be discussed in-depth. The 2022 Strategic Foresight Report, for instance, focuses on the tensions between the green and the digital transitions – these are at the heart of the European Green Deal. The 2022 report warns that the digital and green transitions can reinforce each other but can also clash. Tensions include, to name a few, the issue of the growing energy demand of data centres and cryptocurrencies; possible rebound effects by which improvements in energy efficiency make technologies cheaper to use and more accessible leading to greater energy consumption in the long term; the risk of increased dependence on imports of critical materials such as lithium and cobalt, which are scarce and may create new geopolitical tensions; and the increased production of e-waste as new technologies require the replacement of old equipment (EC, 2022a). Policy documents such as the European Green Deal set the framework for the policies that will be designed in the following 10 years. They are written in a promissory tone, which sets the ambitions of the EU and produces a future vision that, among other functions, legitimises the EU project. The Strategic Foresight reports are thus very unique in their approach and focus. Rather than producing future visions, the reports take an anticipatory approach and assess the challenges that the EU may face in the future to improve preparedness.

Box A2.11

Good case of governance in complexity that illustrates: participation – anticipation

Imagining sustainable futures for Europe in 2050

The following text is an abbreviated version of the EEA online report *Imagining sustainable futures for Europe in 2050* (2022): In 2020, the foresight group within the EEA's country network (Eionet) initiated 'Scenarios for a sustainable Europe in 2050'. This co-creation project, developed and implemented jointly with the EEA, aimed to produce a set of imaginaries offering engaging, plausible and clearly contrasting images of what a sustainable Europe could look like in 2050. The project primarily focused on creating imaginaries for desirable European futures, considering them separately from global developments that could influence the transition to a sustainable Europe. While this separation of European and global futures is artificial, it makes it possible to assess the viability and resilience of the different European imaginaries in varying external conditions (e.g. global shocks or trends) that are largely outside Europe's control. The imaginaries were developed through a participatory workshop process, involving EEA staff, experts from the Eionet Group on Foresight, and external stakeholders. The project employed the methodology of 'key factor' and consistency-based scenario construction. The overall result of this process was a set of four distinct imaginaries that capture some of today's most prominent discourses on sustainability and explore their implications. In doing so, they highlight different approaches, strategies and measures to achieve sustainable development. The main features of the four imaginaries are summarised in the illustration below:



It is certain that none of the imaginaries will be fully realised. In the best case, the future may combine elements from the different imaginaries. Yet they can provide a valuable tool to inspire thinking about future pathways for innovation, policy, finance and society-wide participation that can drive the fundamental transformations needed in Europe and worldwide. For example, in 2022, the EEA began to use the imaginaries to support more detailed analysis of sustainable futures for Europe's key production-consumption systems (i.e. food, energy, mobility and built environment), which will feed into the 2025 edition of EEA's flagship report '*The European environment — state and outlook*'.

Source: EEA, 2022b.

Box A2.12

Good case of governance in complexity that illustrates:
experimentation – systems thinking – participation – anticipation – care

RIS3CAT 2030 and transformative innovation policy: promoting sustainable and inclusive development pathways in Catalonia

As part of EU's cohesion policy, regions are expected to develop their own strategies for smart specialisation (S3). S3 strategies are expected to develop further the competitive strengths of regions to develop innovation capacity and strengthen economic sectors of the regions. Regional S3 plans, so-called RIS3 plans, can be supported by the European Regional Development Fund.

The regional S3 plans of Catalonia (RIS3CAT) adopted the conceptual framework of third generation innovation policy (Schot and Steinmueller, 2018), which focuses on how to overcome transformation failures in the research and innovation ecosystem. Several characteristics of governance in complexity can be found in RIS3CAT: experimentation, system thinking, anticipation, participation and care. Central to the approach is the recognition of a plurality of values and framings and careful consideration of framing processes. An important element of RIS3CAT is its ability to fund local and regional initiatives for transformative change. While funding organisations must choose between different proposals and applicants, RIS3CAT is characterised by logics of care in the sense that its approach is to nurture existing, concrete, intentions and initiatives created by local and regional actors rather than formulated substantive goals by a hierarchical process. In its most recent strategy, the RIS3CAT 2030, the Generalitat de Catalunya emphasises that they support social innovation 'in its broadest sense'.

The following description of the instrument of 'shared agendas' is an excerpt of the CC-0 licensed paper *RIS3CAT Shared Agendas as platforms for synergies* (Generalitat de Catalunya, 2023), with permission from the authors:

RIS3CAT 2030 revolves around the notion of Shared Agendas. Shared Agendas are initiatives established via participatory governance models to articulate collective action towards **common challenges**. Shared Agendas are conceptually inspired by the literature and practice of Transformative Innovation Policy, as well as by Systems Thinking. The Catalan government offers methodological guidance and support for stakeholders to develop Shared Agendas and, through RIS3CAT 2030, supports the transformative initiatives emerging from them.

In a nutshell, the first step for a Shared Agenda is to devise a shared **vision** of the future aligned with the SDGs; secondly, it must arrive at a **shared diagnosis** of the problems and limitations of the current socio-technical system; this second step allows the Shared Agenda to identify **opportunities and solutions** emerging from the transformation being pursued. These opportunities and solutions are then articulated by identifying initiatives that offer potential solutions to the common challenges through intersectoral collaboration and the generation of knowledge between diverse actors. Such solutions require the participation of all actors affected by the challenge, regardless of their traditional engagement in research and innovation activities. In other words, in Shared Agendas, it is not sufficient to involve only the research, business and public sector; citizens and civil society are critical in shaping both the visions and the path to achieve them.

Shared Agendas aim to identify the solutions and initiatives that have the most potential to produce positive changes in the local system, with the aspiration of replicating them on a larger scale, beyond their territory or sector. Indeed, the Shared Agenda of Lleida, Pyrenees and Aran, which is explored in this document, seeks to become a benchmark in the field of bioeconomy in Southern Europe.

Needless to say, within this context, consensus-building processes are very slow and require a lot of work and many meetings, as well as a **participatory governance structure**. Within this context, conflict is not avoided, rather, it is recognised and managed using participatory approaches to navigate the expectations from the diverse stakeholders. This is done through the definition and implementation of

a governance model that is accepted by all the actors involved in order to translate the vision and potential transformative actions into actual initiatives. By default, this governance system is dynamic, flexible and participatory and has the necessary mechanisms in place to allow all actors to have their say at all times.

Typically, the governance is structured around:

- the strategic committee;
- the technical office;
- stakeholders' task forces.

At the early stages of development, the strategic committee is composed of the actors who promote the shared agenda. As the agenda grows, the committee's roles and functions, as well as its structure and composition, must be defined. The committee provides the strategic direction and leads efforts to involve and align the actors in the territory towards the shared future vision.

The technical office facilitates and promotes the active participation of the actors. In other words, its function is to guarantee the participatory governance model. For this reason, this role must be assumed by a respected, neutral and trusted body in the area. The functions of the technical office include, but are not limited to:

- guiding and coordinating efforts and actions aimed at achieving the shared future vision;
- supporting the actions framed in the agenda;
- defining and managing the evaluation system focused on learning and adaptation;
- working toward strengthening the commitment and responsibility of local actors;
- lobbying political agendas;
- fundraising;
- communication.

It is the technical office that practically facilitates the dialogue among stakeholders, taking responsibility for the complementarities and synergies between the various elements of the ecosystem by anticipating the needs of the Shared Agenda and being on the lookout for funding, resources, and investors. To this end, the office must also be an effective communicator. On the one hand, it must effectively pitch the shared vision to funding agencies, foundations, and investors in general, as this is key to gaining external support. On the other, it must also know how to tell the story to keep up the momentum and engage further stakeholders.

As the diverse actors in the Agenda seek solutions from different perspectives, these actors are organised into smaller, more focused task forces according to their different lines of work, expertise and skills. For actors to interact and develop the Shared Agenda as a whole, it is necessary to have physical spaces for co-creation and experimentation, where ideas can be shared, explored, developed and tested. (Generalitat de Catalunya, 2023, pp. 7-8)

The Generalitat has published a set of interviews with individual actors who have worked within the Shared Agendas. One of the questions was as follows: 'shared agendas understand forced consensus as an obstacle to progress. This clashes with the current vision held by society, by which the need to move forward with initiatives relies on forging overall agreement. How is this apparent contradiction resolved?'

One informant answered:

Big agreements on paper are all well and good. However, depending on the type of agenda, they can end up obstructing the process. If you wait to have full consensus before taking action, you'll be late. The Lleida agenda has a strong institutional component. The promoting group includes the Diputació de Lleida, the Paeria de Lleida, the Government of Catalonia, the two Chambers of Commerce in the region, and the University of Lleida. Are we all there? No. But we had to start moving, given the strategic importance of the challenge. Gradually, other actors have joined. Depending on the type of challenge and actors involved, you may need more or less courage when seeking minimal consensus.

Box A2.13

Good case of governance in complexity that illustrates: experimentation – care

The Mindfulness Initiative

The Mindfulness Initiative is an NGO and advocacy group that promotes and supports the deployment of contemplative practice within society in general and within public policy in particular, with the aim to shift political culture towards wiser, less polarised and more compassionate decision-making. Based in the UK since 2013, its actions have gradually spread to other countries and into international collaborations. Its report *Reconnection – meeting the climate crisis inside out* (Bristow et al., 2022) lays out arguments and evidence in favour of contemplative practices such as mindfulness as an approach to wiser climate governance. This view has considerable support, e.g., within the field of ecological economics (see e.g. Ericson et al., 2014; Wamsler and Brink, 2018).

The arguments presented in favour of mindfulness align closely with arguments in favour of ethics and logics of care. Mindfulness and contemplative practice may strengthen the ability to observe and internalise the sustainability challenges and 'stay with the trouble' rather than escaping into denial, fatalism or cognitive dissonance. It may strengthen one's compassion and emotional intelligence, a prerequisite for care. Furthermore, it may lead to 'wiser wanting' of personal growth rather than material consumption (EEA, 2021b). Indeed, Occidental advocacy for mindfulness and contemplative practice can be seen to share the Oriental philosophical roots of deep ecology and simple living (EEA, 2023g). The Mindfulness Initiative is an interesting case in that instead of organisational reform, its actions directly target the individual and cultural enablers of the shift in mindset that governance in complexity would constitute.

Box A2.14

Good case of governance in complexity that illustrates: participation – anticipation – care

UNDP Accelerator Labs

The UNDP Accelerator Labs is a social innovation network created in 2019 to facilitate communication and learning across 91 accelerator labs in 115 countries, mainly in the Global South, and with the global innovation system. The network supports local, grassroot innovation to tackle wicked sustainability challenges, with an ethos of seeing citizens and communities as knowledge holders and experts on their own challenges. While this case as every other case portrayed in this report, could be seen as an example of experimentation – each Lab indeed employs a dedicated Head of Experimentation – the principles of participation, anticipation and care are particularly prominent, as explained below in the words of Alberto Cottica at UNDP:

- **Participation** and **Care**. All Accelerator Labs employ a 'Head of Solution Mapping'. These are people who have some kind of ethnographic expertise. The idea is to build a deep listening muscle; and indeed, the Labs turn out to be very good at empathy, which enhances the quality of the participatory processes they set up. For example, the Labs study and support (by providing digital tools) forms of 'folk' community saving to avoid relying on professional financial operators, who in the Global South may have high or even predatory interest rates of 50%.
- **Anticipation**. UNDP's Executive Office, which hosts the Labs, also hosts a Strategy and Futures Team. This team works mostly by collecting 'signals' of possible future trends by UNDP staff members who volunteer for the task. More than half of these 'signal scanners' work at the Accelerator Labs; indeed the third role common to all Labs is called Head of Exploration. This attention to weak signals is built into the Labs (Alberto Cottica, 2024, direct correspondence).

A striking feature of the UNDP Accelerator Labs is their approach to the challenge of scaling up. A challenge for any set of local innovation initiatives is that of isolation and fragmentation. Rather than trying to scale up local, place-based solutions into universal tools or technologies, the UNDP has taken a network approach that focuses on flow of knowledge and learning across local innovation ecosystems:

Perhaps one of the most difficult aspects of executing a network-of-ecosystems approach is learning from local solutions, generalising them, and then (where appropriate) relocalising them for other geographies. This process of innovating from the edges can be complicated because even if two locations face the same problem, local geography, culture, regulations, and other norms may limit the ability to implement the same solution in both places. Therefore, from the lessons learned one can conclude in general terms that the satellites must be in close touch with both the local stakeholders (to understand their demands and needs) and the parent organisation (to understand the limitations of existing solutions and technologies) (Altman and Nagle, 2020, p. 29).

Annex 3 Diagnostics on cases studies of short-term and long-term crises

Chapter 5 presents analyses of a set of four short-term and long-term crisis in European governance. Each analysis was supported by the diagnostic tool presented in Annex 1. For reference purposes, Annex 3 shows how the tool was used in the analyses, featuring the questions that were applied and a summary of the answers.

Table A3.1 Examples of diagnostic guidance questions for the systemic nature of the challenge addressed by REPowerEU

System description		
Systemic nature	Is the challenge defined in terms of the presence or future danger of an undesirable state of a complex system?	Yes, danger derived from the war in Ukraine and from Russia's cuts natural gas supply to the EU.
Interdependencies	Which are the known/ important/relevant causal interdependencies in the system corresponding to the challenge framing?	Interdependencies are clear: 'The human tragedy caused by Russia's invasion of Ukraine shocked the world and upended the lives of millions of Ukrainians. The human costs of war are immeasurable and grow with each passing day. In the wake of the first shock, also other impacts started emerging. The threat to Europe's steady and affordable supply of energy is one of them' (EEA, 2023e).
Attractor patterns	What is known about the phase space and the attractor patterns of the system? Are there lock-ins, instabilities, opportunities or risks of transitions?	Lock-ins in the energy system are well-known and acknowledged, both with regard to: (1) the lock-ins inherited from the past which have resulted in the current dependence on fossil fuels, on an electric grid that requires a stable electricity supply and is ill-equipped to integrate intermittent energy sources such as solar radiation and wind, on transport infrastructure that relies on hard to decarbonise sectors such as aviation and waterborne; (2) the lock-ins that current choices will create for the future. 'Europe needs to react quickly but also in the right direction to avoid lock-ins on solutions that are not compatible with what we want to hand over to future generations' (EEA, 2023e).
Causality	Is the system richly connected?	The double challenge of reducing dependence on gas and transitioning towards renewable energies, as envisioned by the REPowerEU plan, faces rich interconnections.
Paradoxical effects	Which paradoxical effects (such as rebound effects) are expected or suspected?	Measures such as improved efficiency are notoriously subject to rebound effects. The Jevons paradox was formulated by looking at increases in energy consumption following increases in efficiency, based on the observation that improvements in the efficiency of coal-powered steam engines made it possible for a wide variety of industries to adopt such technology. The risk of a rebound effect in energy consumption is acknowledged in EU policy and is tackled by promoting behavioural change and aiming for the reduction of energy consumption.
System definition		
Radical open-ness	Did the system definition/ modelling process arrive at closure with respect to system boundaries, and how?	The boundaries of the 'energy system' are hard to define, because energy is used for transport, in buildings, industry, construction, agriculture. Energy may be considered transversal to most environmental and economic policies.
Sources of contextuality	Did the system definition/ modelling process arrive at closure with respect to the set of relevant variables of its elements, and how?	Modelling the energy system involves dealing with non-equivalent metrics for primary energy sources and for energy carriers. Different types of primary energy sources are measured with different units (Joules, tonnes, m/s), creating conversion challenges. Different transformation processes heighten the complexity of accounting exercises.

Table A3.2 Examples of diagnostic guidance questions for the complex nature of the challenge addressed by REPowerEU

Framing plurality	Are there alternative framings of the challenge? Who advocates them, and what are their matters of concern and care? Who advocates the main framing, and with what matters of concern and care?	Framing plurality can be observed regarding nuclear energy, for instance, which some countries have phased out or are phasing out, while other countries are promoting both at home and abroad. Nuclear power plants could play a critical role as base-load providers of electricity to help stabilise the electric grid in the transition towards renewable energy.
Framing stability	Is the main framing dominant, hegemonic, contested, in development, stable? Which types and sources of power are important in the framing process?	The framing of the gas crisis as an EU-level challenge is an emerging framing that the EC strongly advocates for: 'while it is true that some Member States historically imported more Russian gas than others, the consequences of possible disruptions would be jointly suffered by all. This is why it is imperative that all Member States are in this together, ready to share gas with their neighbours in case of need.'
Uncertain-ty	What are the sources of technical, methodological and epistemological uncertainties in the knowledge considered relevant to the challenge, and what is their significance? Is the knowledge contested? What is the knowledge pedigree?	Uncertainties are ubiquitous. In the present predicament, with Europe still relying heavily on gas for heating, there is high uncertainty with respect to winters, as exemplified by the publication 'Natural gas supply-demand balance of the European Union in 2023. How to prepare for winter 2023/24' by the International Energy Agency (2023). Warm weather and reduced demand of Liquefied Petroleum Gas from China created a relief in the winter 2022-23, but the situation is highly unstable. The transition to renewable energies is also fraught with uncertainties, as greater reliance on intermittent renewable energies will require greater storage capacity (EPRS, 2023). 'Reaching our clean energy goals will require increasing amounts of various raw materials, e.g. a 3500% increase in the use of lithium, a key component for electric mobility. Chile currently holds 40% of lithium deposits, while China hosts 45% of its refining facilities worldwide' (EC, 2022a). The energy transition is thus also vulnerable to geopolitical changes.
Plurality of values	Are values in dispute? How do values contribute to the framing of the challenge and the definition of the system?	At the wake of the crisis, energy security was given priority over sustainability principles, leading to a supposedly temporary return rather than giving preference to clean energy sources and rolling out nuclear energy.
Stakes	Are stakes high, for whom and why?	New challenges have emerged with the energy crisis derived from the war in Ukraine, such as talk of energy poverty within the EU. According to Eurostat, the annual inflation rate for energy in the EU was 27% in January 2022, with price increases of 67% in Belgium and 58% in the Netherlands.
Urgency	Is the challenge deemed urgent? By whom and why? What are the implications of deeming it urgent?	Urgency is at the core of the REPowerEU plan, which responds to 'the urgency to address the lack of reliability of Russian energy supplies'. Given the sense of urgency with which the situation was handled, as illustrated by the call for 'rapid' action, there was no time for new technologies to be developed, leading to a return to coal and nuclear energy.

Table A3.3 Examples of diagnostic guidance questions for the systemic nature of COVID-19 as a public health challenge

System description		
Systemic nature	Is the challenge defined in terms of the presence or future danger of an undesirable state of a complex system?	As a pandemic, the COVID-19 was classified as a public health emergency that threatened not only individual health and lives but also the disruption of health services.
Causality	Are there upward and downward causal pathways across levels and scales? Is the system richly connected? Are there important nonlinearities? Are cascades of impacts expected?	Disruption and collapse of hospital services and other public health services was one of the important cascades of impacts considered during the pandemic.
Paradoxical effects	Which paradoxical effects (such as rebound effects) are expected or suspected?	In both main framings – the SIR model and the vaccination programmes – there are rebound effects to be governed. From the SIR model, the more extensive measures of social distancing and lockdowns are more effective in 'flattening the curve' but are also known historically to lead to lower compliance in the long run (Taylor, 2022). Vaccines may contribute to direct virus evolution towards vaccine resistance; however, the importance of such paradoxical effects is contested (Lobinska et al., 2022).
System definition		
Radical open-ness	Did the system definition/modelling process arrive at closure with respect to system boundaries? If so, how?	COVID-19 as a public health issue was in 2020-2022 mainly defined as health loss and death directly caused by the COVID-19 disease itself, and to a much less extent health loss and death caused by COVID-19 measures such as lockdowns.
Sources of contextuality	Did the system definition/ modelling process arrive at closure with respect to the set of relevant variables of its elements? If so, how?	One example of contextuality in the COVID-19 case is statistics of COVID-19 related mortality. It is not straightforward to define clinically what constitutes a death caused by COVID-19, especially in the presence of high age and comorbidities. Accordingly, closure emerged around the concept of overall excess mortality rates (Juul et al., 2022). Such rates avoid biases due to clinical definitions but introduce error especially in the short term, since excess mortality in frail population groups one year tends to be a negative driver of mortality in a neighbouring year.

Table A3.4 Examples of diagnostic guidance questions for the complex nature of COVID-19 as a public health challenge

Framing plurality	Are there alternative framings of the challenge? Who advocates them, and what are their matters of concern and care? Who advocates the main framing, and with what matters of concern and care?	The framing developed over time in 2020 and 2021, from the SIR model and the idea of 'flattening the curve' to the re-framing of COVID-19 as governable by vaccination.
Framing stability	Is the main framing dominant, hegemonic, contested, in development, stable? Which types and sources of power are important in the framing process?	Because COVID-19 was declared as an emergency, power could be and was centralized to a large extent. Alternative perspectives and framings were to less extent a part of the public decision-making process and were more relegated to the margins and framed as irresponsible or uninformed protests (Bardosh et al., 2022).
Urgency	Is the challenge deemed urgent? By whom and why? What are the implications of deeming it urgent?	COVID-19 was declared a public health emergency of international concern by the WHO in 2020, implying the highest level of alarm (WHO). The implications of the emergency were legion, including the use of emergency powers and laws across Europe and in most parts of the world.
Indeterminacy	How would the system definition and the relevant knowledge body change with a reframing of the challenge?	The relevant knowledge body is highly dependent on the definition of the main parameters – health loss and deaths directly caused COVID-19; short-term (annual) excess deaths; or long-term health loss and mortality caused by COVID-19 and the measures for its management.

Table A3.5 Examples of diagnostic guidance questions for the systemic nature of the biodiversity loss challenge

System description		
Systemic nature	Is the challenge defined in terms of the presence or future danger of an undesirable state of a complex system?	'Biodiversity loss and ecosystem collapse are one of the biggest threats facing humanity in the next decade. They also threaten the foundations of our economy and the costs of inaction are high and are anticipated to increase' (EC, 2020a).
Interdependencies	Which are the known/ important/relevant causal interdependencies in the system corresponding to the challenge framing?	'The pandemic is raising awareness of the links between our own health and the health of ecosystem.' (EC, 2020a).
Attractor patterns	What is known about the phase space and the attractor patterns of the system? Are there lock-ins, instabilities, opportunities or risks of transitions?	Biodiversity collapse and the idea of a tipping point are invoked.
Causality	Are there upward and downward causal pathways across levels and scales? Is the system richly connected? Are there important nonlinearities? Are cascades of impacts expected?	Biological systems are richly interconnected at multiple levels: 'humans' can be seen as a rich ecosystem made of multiple co-evolving microbes; Margulis argued that species co-evolve in close symbiosis; according to the Gaia hypothesis the planet as a whole can be seen as behaving like an organism due to the interdependencies between all species and ecosystems.
System definition		
Radical open-ness	Did the system definition/ modelling process arrive at closure with respect to system boundaries? If so, how?	System boundaries are a point of contention. If 'the environment' is seen as separate from 'human systems', biodiversity is a matter of managing the environment. The formulation of concepts such as that of 'socio-ecological systems' collapses this boundary and sees human and environmental action as part of the same effort.
Sources of contextuality	Did the system definition/ modelling process arrive at closure with respect to the set of relevant variables of its elements? If so, how?	The last few years have seen as resurge in interest in theories of symbiosis and in 'nexus' modelling (for instance, with the water-energy-food nexus). Both trends point to an intensification of 'relevant variables' to be considered.

Table A3.6 Examples of diagnostic guidance questions for the complex nature of the biodiversity loss challenge

Framing plurality	Are there alternative framings of the challenge? Who advocates them, and what are their matters of concern and care? Who advocates the main framing, and with what matters of concern and care?	Alternative framing of humans and nature as one are emerging from academia and are long-standing in many indigenous cultures, such as Sumak Kawsay (Quechua tribes, Ecuador), Suma Qamaña (Bolivia) (EEA, 2023g).
Framing stability	Is the main framing dominant, hegemonic, contested, in development, stable? Which types and sources of power are important in the framing process?	Dominant framing of nature as capital and of the market as the means to manage natural resources through monetary valuation and the concept of 'ecosystem services' provided to humans.
Plurality of values	Are values in dispute? How do values contribute to the framing of the challenge and the definition of the system?	The value of nature and how to value nature (whether through monetary valuations or by assigning it constitutional rights) are central to the understanding of governance of biodiversity.
Stakes	Are stakes high, for whom and why?	Biodiversity loss aggravates climate change, and a healthy ecosystem is paramount in mitigating climate change. Stakes are high for life on earth, human and non-human.
Urgency	Is the challenge deemed urgent? By whom and why? What are the implications of deeming it urgent?	Biodiversity loss can be described as a long-term crisis but in need of urgent action.

Table A3.7 Examples of diagnostic guidance questions for the systemic nature of the challenge addressed by the 'Beyond GDP' debate

System description		
Systemic nature	Is the challenge defined in terms of the presence or future danger of an undesirable state of a complex system?	The need to go 'Beyond GDP' is presented as a response to the undesirable state of resource depletion and the impossibility of long-term sustained (resource intensive) economic growth in a finite planet.
Interdependencies	Which are the known/ important/relevant causal interdependencies in the system corresponding to the challenge framing?	There is abundant scholarship on the dependence of economic growth on energy consumption (Giampietro et al., 2013; Hall, 2018) and resource consumption, as studied by the ecological footprint (Wackernagel and Rees, 1996) and virtual water (Hoekstra, 2003).
Attractor patterns	What is known about the phase space and the attractor patterns of the system? Are there lock-ins, instabilities, opportunities or risks of transitions?	The 'beyond GDP' debate addresses a double lock-in: (1) on the biophysical side, the economic model is heavily dependent on resource consumption and there are numerous criticisms to the idea that economic growth can be decoupled from energy and resource consumption; (2) on the governance side, there is a lock-in with regard to the reliance on the GDP indicator, which reinforces governance by prediction and control.
Causality	Are there upward and downward causal pathways across levels and scales? Is the system richly connected? Are there important nonlinearities? Are cascades of impacts expected?	The economic system is understood as being embedded in a larger ecosystem, which acts as supplier of natural resources such as energy, water and raw materials and as sink for emissions and waste – this interconnection is captured by the reference to the concept of socio-ecological systems.
Paradoxical effects	Which paradoxical effects (such as rebound effects) are expected or suspected?	The relative decrease in energy consumption per unit of GDP observed in EU countries over the last 20 years is 'the effect of the increasing share of the services sector in the GDP of mature neo-liberal economies combined with the outsourcing of industry and agriculture to developing countries' (Kovacic et al., 2018). This means the relative decoupling of resource consumption from GDP in the EU comes at the cost of an increase in resource consumption in countries that export goods to the EU and a re-location of environmental impacts to less developed countries.
System definition		
Radical open-ness	Did the system definition/ modelling process arrive at closure with respect to system boundaries? If so, how?	There are multiple alternative indicators that have been developed with the aim of moving 'beyond GDP' and that show a wide variability in the definition of system boundaries (with some indicators zooming out of the economic system to include the ecosystem and other zooming in to focus on individual wellbeing) and in the definition of relevant variables (which range from economic, to social and environmental dimensions). See Table A3.8 below for an overview.
Sources of contextuality	Did the system definition/ modelling process arrive at closure with respect to the set of relevant variables of its elements? If so, how?	
Validity and plausibility	How much should descriptions and models of the system be trusted?	There are strong criticisms both of GDP and of alternative indicators such as ecological footprint (Giampietro and Saltelli, 2014) and the Human Development Index (Klugman et al., 2011).

Table A3.8 Examples of diagnostic guidance questions for the complex nature of the challenge addressed by the 'Beyond GDP' debate

Framing plurality	Are there alternative framings of the challenge? Who advocates them, and what are their matters of concern and care? Who advocates the main framing, and with what matters of concern and care?	There are many alternative framings. Matters of care range from happiness to environmental sustainability. Advocates of alternatives include a growing list of actors, including EU institutions.
Framing stability	Is the main framing dominant, hegemonic, contested, in development, stable? Which types and sources of power are important in the framing process?	The use of GDP is the dominant framing and the 'beyond GDP' initiatives represent the plurality of attempts at contesting the dominant framing.
Uncertain-ty	What are the sources of technical, methodological and epistemological uncertainties in the knowledge considered relevant to the challenge, and what is their significance? Is the knowledge contested? What is the knowledge pedigree?	Epistemological uncertainty is central to the debate, which aims to define wellbeing and progress independently of GDP. Methodological uncertainty is prominent in all attempts to measure 'hard to quantify' variables, such as happiness, wellbeing and sustainability. Technical uncertainty is likewise ubiquitous as efforts directed towards alternative quantification are fraught with data gaps.
Plurality of values	Are values in dispute? How do values contribute to the framing of the challenge and the definition of the system?	The 'beyond GDP' debate is a debate about values: measuring GDP gives value to a monetary understanding of wellbeing and sustainability. The effort to change language of valuation is an effort to prioritise different values.
Stakes	Are stakes high, for whom and why?	Stakes are high both for people and nature, who would benefit from alternative indicators that help make visible issues such as inequality and environmental degradation and for governing institutions, which would be equipped with statistical tools that make issues beyond GDP legible.

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