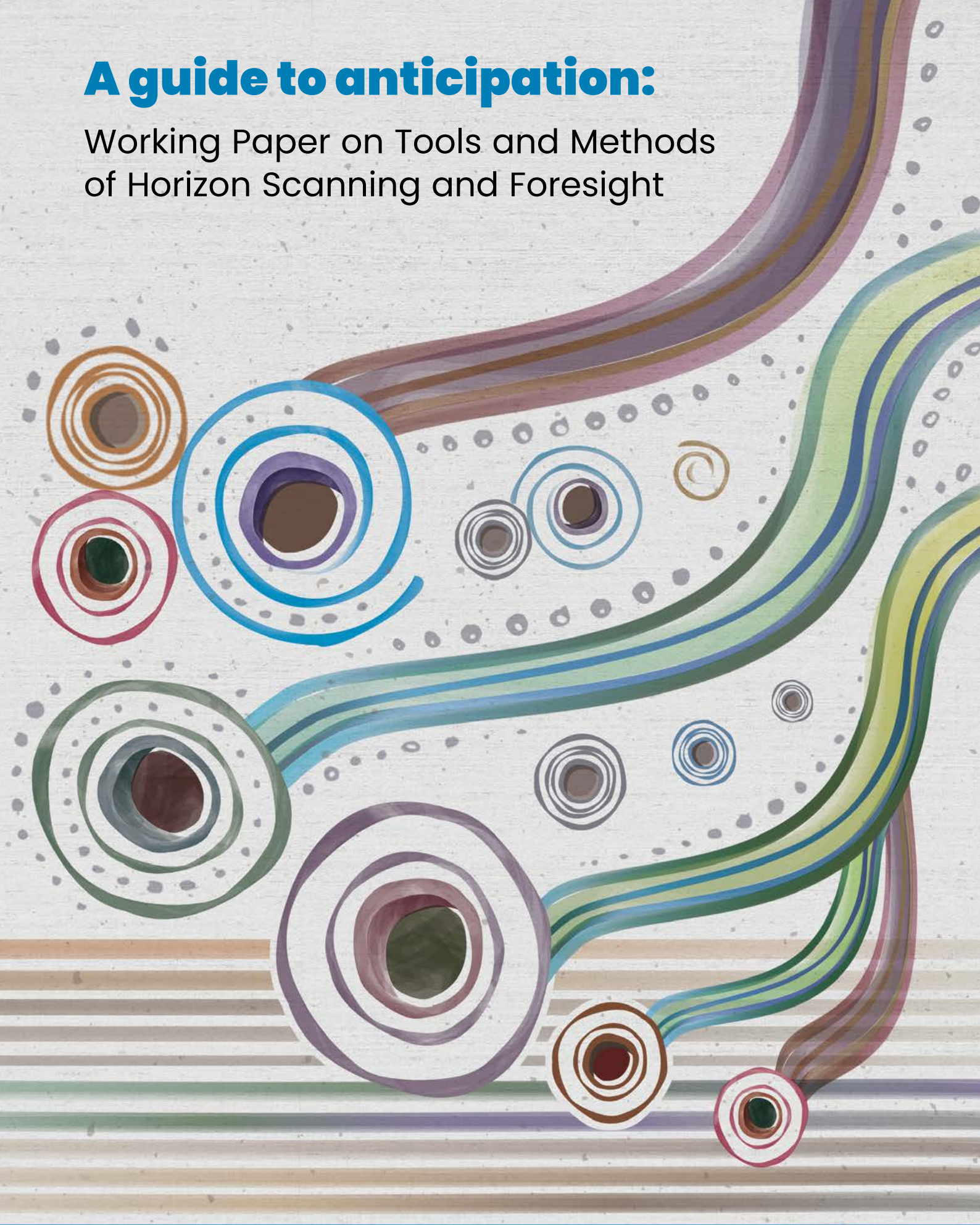
A guide to anticipation:

Working Paper on Tools and Methods of Horizon Scanning and Foresight



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1 Introduction: Foresight for a sustainable future

Dina Abdelhakim, Anne-Sophie Stevance, Peter Bridgewater

Foresight is receiving growing attention on the international stage as a set of tools to support proactive sustainable development. As the world grapples with rapid and unprecedented changes, especially related to the environment and technology, there is a renewed focus on looking into the future to identify drivers of change and uncertainty which can inform decisions taken today. Foresight is one of the main pillars identified in the UN Secretary-General's report *Our Common Agenda* to reinvigorate multilateralism and ensure more anticipatory global governance. The United Nations Environment Programme (UNEP) and the International Science Council (ISC) have partnered on a global horizon scanning and foresight exercise, designed to analyze a vast array of inputs focusing on the future of planetary health and human wellbeing.

The ambitious "Foresight Trajectory" led by UNEP aims to expand its capacity to identify emerging issues and potential disruptions early on and embed foresight in its working patterns to build a future oriented culture within the organization. A global foresight report entitled "*Navigating New Horizons: A Global Foresight Report on Planetary Health and Human Wellbeing*" was published in July 2024; it presents trends and identifies signals of change and disruptions that are likely to affect planetary health and human wellbeing up to 2050. The process carried out in partnership with the ISC has resulted in experiential learnings that will contribute to embedding foresight in the strategic thinking and medium-term planning of UNEP and the ISC, so that both organizations can embrace a more proactive approach to addressing environmental concerns as they arise.

As part of the foresight exercise, the ISC and UNEP have also identified a need to reflect on the field of foresight and horizon scanning itself, and its multiple approaches, tools and practices through reviewing the landscape of available tools and methods developed over the past decades. This review shows how they address present day and future global challenges. This Working Paper presents the outcome of the review as a synthesis of existing foresight tools and methods from the empirical literature and provides critical reflections on new approaches and applications of foresight.

The Working Paper deliberately opens discussions through a set of essays on key areas that remain frontiers in mainstream foresight. Following a literature review, a series of three short essays delve deeper into specific areas of foresight, namely:

- The wealth of indigenous and local community approaches to foresight and futures thinking so often underrepresented in academic literature and the practice of international organizations;
- The integration of complexity and uncertainty in scenario planning; and
- The role of foresight in decision-making with important considerations on the actionability of foresight studies.

The insights presented here complement existing efforts to apply futures thinking and approaches within relevant institutional processes, including UNEP's Foresight Trajectory.

Given the transformation imperative set by the Sustainable Development Goals, and a rapidly shifting global risks landscape, it is necessary to expand the foresight toolbox, and recognize that foresight is fundamentally a process that needs to be robust, inclusive, integrative and transdisciplinary to inform decisions and actions for a resilient and sustainable future. ■

2 Overview of existing foresight tools and methods: a literature review

Lauren Sullivan, Maxine Newlands, Stuart Barrow, and Ana Rengel-Gonçalves

As humanity faces the risks and challenges of a complex and uncertain world, decision-makers in government, industry and other organizations seek to think about the future to prepare for events and exploit opportunities that may arise.

To achieve this, decision-makers may adopt horizon scanning and foresight to anticipate possible futures, generating evidence to inform planning, strategy development and priority setting.

Horizon scanning and foresight refer to systematic approaches to stimulate thinking about the medium to long-term future (more than 10 years). Horizon scanning and foresight activities involve exploring trends and emerging issues to be able to identify future challenges, opportunities and threats, disrupting the focus on immediate concerns and debates in the present to recognize and respond to future challenges and opportunities (Sutherland et al., 2009; Cook et al., 2014; Cuhls, 2020).

This section of the Working Paper presents an analysis of the methods and tools for horizon scanning and foresight activities, including the context of their applications and strengths and limitations. It is not a review of the global foresight landscape or an exhaustive catalogue of all current foresight methods. The Working Paper is intended to stimulate discussion on existing methods and considerations when conducting foresight activities.

Methods

A mixed methods approach was used, combining a literature review using a rapid review technique (Kelly et al., 2022, Cooke et al., 2021) and expert elicitation through interviews and participation observations at a UNEP and ISC meeting of the UNEP Foresight Expert Panel in Paris, 2023.

Bibliographic data was sourced from Web of Science, Scopus and Google Scholar. Grey or non-academic literature was sourced from the Publish or Perish software program. The search terms used are provided in the table 1 below. The search had a particular focus on environmental science and sustainable development, however foresight in other areas such as science policy, technology and innovation were also captured. Search terms using "Indigenous" and "Traditional Knowledge" were also included to capture work that involved engagement with Traditional Knowledges or Indigenous stakeholders. The search included literature published in Spanish; Portuguese; English; Japanese; French and Italian. As these are colonial languages, the search also looked for articles in non-colonial languages: Arabic; Swahili; Mandarin; Farsi; Tok Pigon; Creole and Hindi.

The following criteria were used to exclude literature that was outside the scope of the review. Application of the criteria left a literature review sample of 48 peer-reviewed articles and 31 grey literature items. A list of papers analyzed for the literature review is provided in Appendix 1. Additional relevant grey literature was identified through snowballing, interview data and desktop research.

Table 1: Search terms used for literature review.

Horizon scanning search string	Foresight search strings
Horizon scan*	Foresight
Horizon scan* AND foresight	Foresight AND science policy
Horizon scan* AND science policy	Foresight AND social-ecological
Horizon scan* AND social-ecological	Foresight AND biodiversity
Horizon scan* AND biodiversity	Foresight AND Indigenous
Horizon scan* AND Indigenous	Foresight AND Traditional Knowledge
Horizon scan* AND Traditional Knowledge	

Inclusion criteria

- 15 or more citations (for peer-reviewed literature)
- Describe Foresight methods or tools
- Describe Horizon scanning methods or tools
- Indigenous co-development/inclusion
- All fields of scientific research (e.g., health, environment, conservation, etc)

Exclusion criteria

- Theoretical or conceptual only papers (not applied research)
- Unsubstantiated data claims
- Full text not available
- Limited use of the terms foresight and horizon scanning in the text
- Less than 15 citations (for peer reviewed literature)

Literature was analyzed according to a framework that sought to address the following questions:

- What foresight tools and methods are currently in use?
  - What foresight tools and methods are applied in environmental science and sustainable development?
  - Who is using the methods and tools, why and in what contexts?
  - What is the theoretical/scholarly basis for these methods and tools?
  - What are the challenges or limitations of such methods/tools and how have they been overcome?
  - What new digital technologies such as AI, are being used or tested for horizon scanning or foresight and how?
- What evidence exists of the impact or effectiveness of foresight and horizon scanning in informing decision-making?

Six semi-structured interviews were conducted with horizon scanning and foresight practitioners from academia, non-government organizations and intergovernmental organizations. Interviewees were identified through the literature review, the Australian Academy of Science, ISC and UNEP networks. The selection of interviewees was based on experience, expertise and relevance to the research topic. The interview questions are provided in Appendix 2. Discussions with UNEP Foresight panel members at a Sensemaking workshop in Paris also shaped the authors' thinking on the methods and issues presented in the paper.

What is horizon scanning and foresight?

Horizon scanning and foresight are seen and characterized differently by different actors and studies. Definitions of the terms horizon scanning and foresighting are found within the fields of 'Future studies' or 'Futures', which refers to the broad academic and professional field that encompasses foresight methods. Papers from the literature review sample provided the following definitions.

Horizon scanning

Horizon scanning can be viewed as a preliminary step in the foresight process, but can also be sufficient for identifying future challenges and opportunities without progressing to a foresight process. It has been described as "the systematic search for potential threats and opportunities that are currently poorly recognized" (Sutherland et al., 2009) or "a systematic approach increasingly used to explore emerging trends, issues, opportunities, and threats" (Pérez-Jvostov et al., 2020).

This report adopts the following definition of horizon scanning from Cuhls (2020):

> *"Horizon Scanning is rather found at the beginning of any forward-looking activity and can be an automatized stand-alone approach for identifying "things to come" - which often means the identification of new science and technology and providing information about them"*

Foresight

There are several definitions of foresight, which over the past decade have changed little. An earlier definition from Meissner et al. (2013) explains that "foresight exercises go beyond simple predictions to become anticipatory intelligence, based on a wide diversity of viewpoints, and knowledge sources" and that "foresight studies are commonly understood as a measure supporting governments, public agencies and companies in designing future-oriented strategies". Put more succinctly, "foresight is an appropriate instrument to shape innovation systems and support policy-making processes" (Aguirre-Bastos et al., 2018).

The United Nations definition is similar, defining foresight as a "systematic, participatory, future-intelligence-gathering and medium-to-long-term vision-building process aimed at enabling present-day decisions and mobilizing joint action." (Resolution adopted by the General Assembly on 25 September 2015, A/Res/70/1).

What is agreed is that foresight, like horizon scanning, is about working towards "strategic and long-range (>10 years) planning and participatory futures studies" (Hobday et al., 2020). However, while horizon scanning is recognizing "things to come" based on evidence of trends, risks and opportunities, foresight can be understood as anticipating possible futures and planning (strategically and technologically) for the future at a decadal or longer timescale (Cuhls, 2020).

Process model for horizon scanning and foresight

Horizon scanning and foresight can be understood as systematic processes that move through interconnected and complementary stages. Different models for these processes are presented in various papers in the literature (Sutherland et al., 2009; Popper, 2008; Cook et al., 2014; Nash et al., 2022). These models overlap with each other but do not precisely align, with different aspects of the process receiving varying levels of emphasis across the lists and appearing under a range of names.

Figure 1 provides a combined model of the stages of horizon scanning and foresight based on the literature review and expert interviews for this paper.

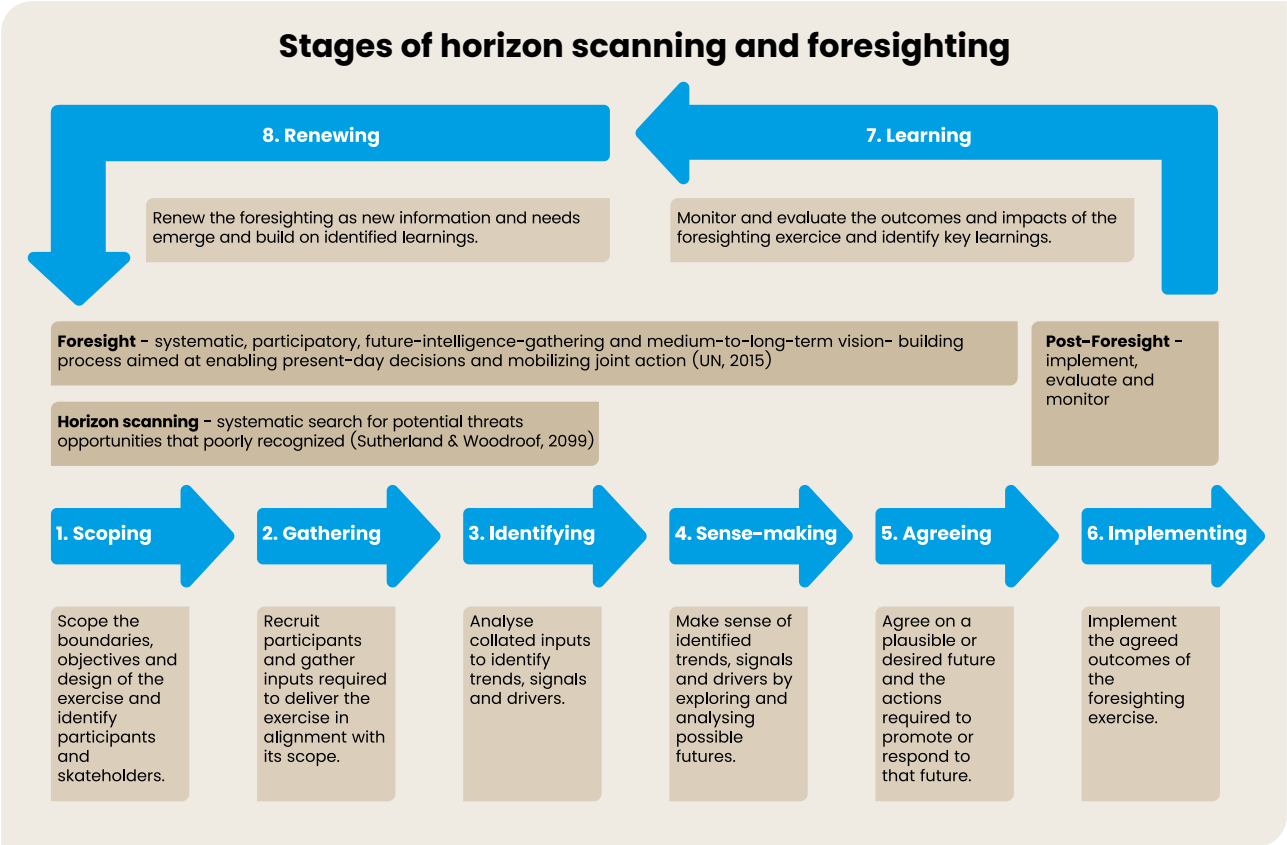

Figure 1: Infographic summary of the stages of horizon scanning and foresight processes which builds on models previously presented by Popper (2008), Cook et al. (2014), Nash et al. (2022), and Burgelman et al. (2014).

Horizon scanning methods

Applications of horizon scanning identified in the literature include strategy making, policy-making, risk management, threat identification and research prioritization. In the literature, horizon scanning was used to explore mid to long term future issues, developments, and trends, such as identifying research priority areas for conservation or potential invasive species threats.

End users of horizon scans included a range of stakeholders, such as policymakers and advisors, government and military stakeholders, citizen science organizations, industry, investors, conservationists, grassroots organizations, local and indigenous communities, and academic researchers.

Horizon scanning activities typically aim to find new, emerging or less well-understood issues or 'weak' signals as future challenges. Weak signals are used to highlight potential problems or concerns in specific fields and identify future opportunities and threats. Identifying these signals provides added depth to risk or confidence analysis.

The most commonly used horizon scanning method in the peer-reviewed literature review sample was the Delphi method, or variations of the Delphi method. Literature reviews, scientometrics (Hess, 1997) and Delphi were highly represented methods in the grey literature sample. Other tools used in multiple studies include: SWOT analysis (Nagimoc et al., 2018) and road mapping (see Table 2).

Delphi Method

Delphi exercises use structured surveys that draw on experts' knowledge and usually focus on areas of uncertainty or incomplete knowledge (Häder et al., 1995). Surveys are administered in two or more rounds, where the previous survey results are provided for feedback, and participants can modify their responses based on the input of other experts and incorporate new information (Cuhls, 2020). The process aims to synthesize opinions, identify and assess issues and build consensus. Delphi exercises often aim to achieve convergence or opinion, in contrast with explorative scenarios which aim to span diverging ideas.

New and Emerging Signals of Trends (NEST)

The New and Emerging Signals of Trends (NEST) model applies the Delphi method of collecting data via expert networks (Kim et al., 2013). NEST looks systematically for weak signals of emerging future trends. Unlike the creative foresight approaches (see Table 2), this model combines quantitative approaches (such as pattern recognition and cross-impact analysis) with qualitative approaches (such as environmental scans, brainstorming and Delphi studies).

Novel tools and techniques

Some newer techniques were noted in the literature, including:

- Analysis of discourse and trends on social media platforms, which can provide more recent and emerging information than published literature (Lehoux et al., 2018).

- Artificial Intelligence tools are emerging to complement existing foresight practice, expanding information gathering and supporting analysis and visualization. Uses described in the literature and interviews included handling large volumes of data, recognizing patterns and making predictions, assisting with crafting scenario narratives and creating visualisations (Sutherland et al., 2019; Stucki et al., 2023). Foresight practitioners should be aware of the limitations of AI tools and use them to complement human expertise. The lack of transparency in AI algorithms and their decision-making processes creates the "black box" problem, and also makes AI systems not well suited to generating scenarios independently as this misses the key aspect of the explorative learning process involved in scenario development (Stucki et al., 2023). Furthermore, AI lacks both contextual understanding and intuition, meaning human foresight experts remain crucial to the foresight process.

Table 2 presents an analysis of all horizon scanning and foresight, methods and tools captured in the literature review sample.

Horizon scanning evaluation

Synthesizing the results of horizon scanning as an effective method was only found in one study, which describes an evaluation of a horizon scanning exercise ten years on from when it was first conducted (Sutherland et al., 2019). The study found five of the 15 issues identified in the horizon scan showed a major increase in importance from 2009-2019.

Only one study in the literature review presenting a formal evaluation of a horizon scan suggests a gap in the peer-reviewed literature on evaluation of the implementation of horizon scanning outcomes by end users, including those generating the foresight analysis.

Foresight methods

Foresight applications in the literature sample included the environment and climate change, technology and innovation, military and defence, agriculture and food security, and health.

Foresight was also conducted at multiple levels (local, national, regional and global) and on varying timescales (annually to decades into the future). End users or stakeholders identified in foresight studies were policy- and decision-makers, governments, industry, researchers and academics, grassroots organizations, and local and Indigenous communities.

The most common foresight methods and tools that emerged from the literature review were expert panels or workshops, Delphi and Delphi-like methods, and scenarios. In the grey literature, the Delphi method, expert panels and modelling were commonly used techniques. An interviewee noted that they had used artificial intelligence as a tool to create visualizations of information gathered through foresight processes. Di Pasquale & Padula (2015) and Skulimowski (2014) discuss a few AI and software tools with applications in foresight research, such as online analytical processing and ranking algorithms. Table 2 presents an analysis of foresight methods, including the strengths and weaknesses of each.

One interviewee commented that foresight is distinct from risk analysis or resilience planning. Risk analysis and resilience planning focus on assessing potential threats and preparing for the consequences of events, whereas foresight is more open-ended and explores how a system may evolve into the future.

Popper (2008) proposes a 'foresight diamond' (Figure 2) which maps foresight methods based on their capabilities based on four categories: creativity, interaction, evidence and expertise. The diamond also shows the nature of each method, which is either qualitative, semi-quantitative, quantitative, or considered an 'other' method.

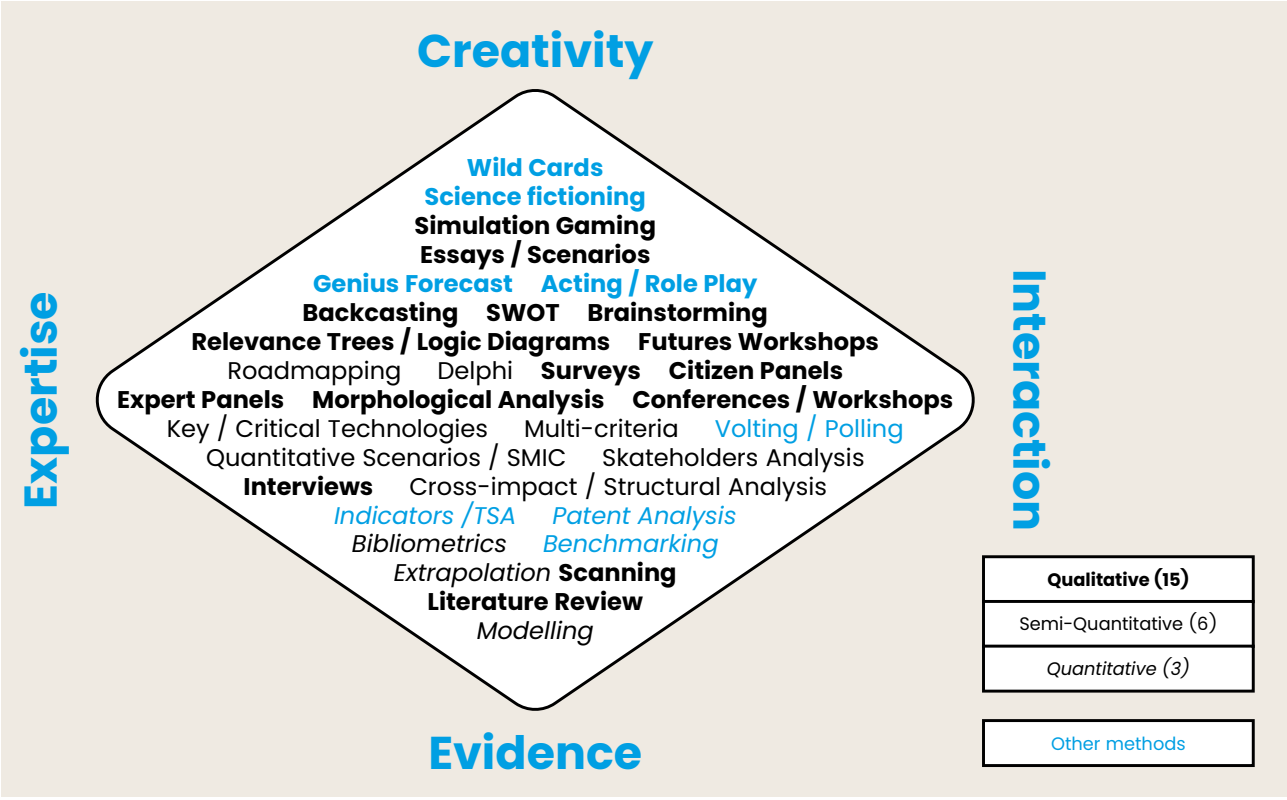

Figure 2: Foresight diamond. From Popper (2008).

How are methods selected?

The selection of foresight methods depends on the context, aims and desired outputs. A study by Popper (2008) found that methods are selected by a multifactor process that is only sometimes clear or systematic. According to that study, the selection of a foresight method is mostly influenced by:

- the nature of the method, whether qualitative and/or quantitative
- the combination of foresight methods, such as using brainstorming as an input for a Delphi process
- the level of evidence, expertise, interaction or creativity involved in a method
- the R&D context, such as R&D intensity. This may indicate the availability of knowledge about emerging issues and technologies, and reflect capabilities to use the methods.
- the desired outputs produced from the method - scenarios, roadmaps, or lists of research priorities or technologies.

The depth of expertise of the practitioner may also influence the selection of methods (Slaughter, 2004).

Georghiou and Cassingena (2013) note that there needs to be a clear rationale or agreement on which combinations of methods are most valid in which situations (Georghiou et al., 2013). The nature and type of knowledge inputs influence the robustness and legitimacy of a horizon-scanning or foresight process (Hines et al., 2018).

Foresight approaches typically involve a combination of methods. For example, literature reviews, scenarios and expert panels are often used in conjunction with other methods (Popper, 2008). An analysis of 886 foresight studies found that, on average, foresight exercises used a range of five or six methods (Popper, 2008).

Interview discussions highlighted that foresight is a *process* requiring strategic planning in the scoping stages. Methods are selected based on how well they serve the aims of the foresight exercise and how they fit together. It is essential that this planning considers the intended end users' needs and their level of understanding of foresight. Outputs must clearly communicate uncertainties or limitations of the findings.

Foresight outcomes and evaluation

Different foresight methods produce different outputs, such as scenarios, roadmaps, lists of technologies and SWOT analyses, which influence policy, strategy and decision-making. The literature review found limited available evidence on ongoing monitoring, formal evaluation of the implementation of foresight or ways to measure outcomes. This "learning" phase of the foresight process (monitoring and evaluation; see Figure 1) should be embedded in the foresight process framework (Popper, 2008).

However, it was noted in peer-reviewed literature and interviews that the foresight process itself can be transformational. The main benefits described include the development of knowledge and foresight networks, identifying knowledge gaps, building futures literacy, and allowing communities to be proactive rather than reactive in their decision-making (Sutherland et al., 2009; Carayannis et al., 2017).

Table 2 Analysis of horizon scanning and foresight tools

Adapted from: *Cook, Wintle, et al., 2014; Popper, 2008; Sutherland & Woodroof, 2009*

Method/tool	Horizon scanning	Foresight	Description	Application	Strengths	Limitations
Scientometrics	✓		Collection of data which includes bibliometrics and patent analysis. Provides quantitative evidence.	This is useful to obtain basic quantitative data; identify leading researchers, and the most often cited work (Marginson, 2022).	Allows exploration of science and technology development and research hotspots Can be used to identify gaps/niches for technology development	Not suitable for long-term foresight (Li et al., 2017). Unable to show impact or qualitative data for context.
Big data analysis (Proskuryakova, 2019)	✓		Using big data analytics (e.g. machine learning) on open information sources e.g. research publications, documents/reports, patents, research grants	Used with datasets from sources such as social media and bibliometrics to look for patterns, knowledge gaps, trends and emerging areas of research. Proskuryakova, 2019)	Can be used to create maps and visualizations Used to analyze a large sample size	Can be backward-looking Biases inherent in academic publishing can limit perspectives
Analysis frameworks	✓	✓	Applying existing analysis frameworks (e.g. PESTLE, STEEPV, SWOT) to identify drivers of change or analyze systems. These analytical frameworks are not specifically designed for foresight but are often used as part of a foresight process.	Helpful in identifying the strengths and weaknesses of results and possible solutions. Can be used as part of a brainstorming process and precursor to scenario development e.g. see Nash et al (2022).	Many are straightforward and flexible Allows integration of different types of information	May be subjective or biased Single level analysis
Environmental scanning	✓		Monitoring internal and external environments of a business, industry or market to detect opportunities or threats. Focus on political, economic, social and technological events or trends. Information sources include media, news, academic papers, websites, etc.	Useful for strategic planning, risk management research, policy compliance and generally keeping up to date with industry best practice.	Uses latest data to identify new changes	Broad range of data must be continually collected Additional analysis is needed for detailed forecasting (Kim et al., 2013).
Cross-impact/structural analysis (Di Pasquale et al., 2015; European Foresight Platform, 2024).		✓	Process to analyze relationships between variables or events to account for cross impacts and infer the likelihood of future events (Popper, 2008; Di Pasquale & Padula, 2015; Bradfield et al. 2005). Produces a matrix of estimates of event interdependence. Probability distributions of trends and variables can be estimated to provide numerical estimation of futures.	Helpful in identifying weak signals, designing scenarios, economic forecasting, policy development and evaluating risk (Popper, 2008).	Allows exploration of chains of causality and estimate dependencies between events Can be used to identify weak signals (Kim et al., 2013).	Challenging to conduct if a large number of events are considered Reliant on level of expertise of people involved in the analysis May not accurately represent the reality of a complex system (European Foresight Platform, accessed January 2024).
Morphological analysis		✓	Method to map potential solutions to a problem and determine futures. Used to suggest new developments and build (Popper, 2008).	Breaks down complex problems into smaller, analyzable parts, to explore and understand the various dimensions and possibilities related to that problem.	Can help bridge gap between foresight and strategic planning	Based on critical judgement, so may be subjective or open to errors (European Foresight Platform, accessed January 2024).

Method/tool	Horizon scanning	Foresight	Description	Application	Strengths	Limitations
Multi-criteria analysis		✓	Method which analyses actions or solutions against a range of criteria. Used as a prioritization and decision support tool for complex situations or challenges.	Can be useful for decision-making by providing a structured framework for evaluating alternatives choices across a range of fields and industries (Popper, 2008).	Helpful to prioritize solutions to support decision making	Use may be limited if interactions and incompatibilities between several actions need to be considered (European Foresight Platform, accessed January 2024).
Modelled scenarios / simulation		✓	Using mathematical techniques to describe a system and study the effects of different conditions or make predictions about a system under different conditions. Examples include IPCC Assessment Reports (2023), FAO (2018), Shell scenarios (2023), Intergovernmental Panel on Biodiversity and Ecosystem Services (2016).	Helpful in forecasting possible and probable scenarios, future problems, challenges and solutions, resource planning and directing scientific research, and prioritization processes.	Helpful to simulate a system and make predictions	Assumptions need to be well-understood and communicated. Difficult if lack of evidence/data to inform model.
Mapping e.g. systems maps and knowledge networks	✓		Conceptual representation of a system or network to show relationships between relevant factors or indicators. Examples include systems maps and knowledge networks.	Used for project management, short- and medium-term strategies and science policy development.	Provides understanding of factors affecting the central issue	Requires pre-existing knowledge
Issue tree	✓		Breaks down main question into a set of sub-questions. Used to identify elements of the overarching issue that need to be considered.	Also known as a mind mapping; good for visualizing a problem and potential connections between issues to seek solutions. Helpful when there is no clear solution or for multidiscipline collaborations.	Identifies key information	Limited utility if issue/ scope is not well-defined
Stakeholder mapping/ analysis	✓		Process to identify stakeholders with interest in an issue. This tool is used in conjunction with other tools and methods.	Important initial step to find the right stakeholders for a project design, relevant experts or participants, communication strategies and resource allocations.	Identifies important stakeholders	Used in conjunction with other methods
Literature review	✓		Systematic search for information, trends, key issues, drivers, threats and opportunities in published research literature.	Used to review and evaluate previous research for the purpose of providing new knowledge.	Uses published, often peer-reviewed literature	Can be backward looking Biases inherent in academic publishing can limit perspectives

Method/tool	Horizon scanning	Foresight	Description	Application	Strengths	Limitations
Science/speculative fiction analysis		✓	A form of creative foresight that involves analyzing creative texts (literature and film) to provide warning signals, themes and patterns of concerns about the future (de Freitas et al., 2020; Bina et al., 2017).	Encourages alternative ways of thinking about the relationship between nature, technology and human logic and a future beyond traditional western human thinking	Creative representations can reflect societal/ cultural values and concerns that resonate with the public Allows consideration of ethical implications and dilemmas raised by alternative futures Can provide alternative framings or visions and help question assumptions	Needs to be used alongside evidence-based methods
Essays		✓	Images of the future which describe major trends and/or stakeholders roles in a particular scenario.	Way of providing focus to explore and analyze trends, can provoke debate and critical analysis of future scenario design.	Provide background and meaning to events	Can be subjective
Social media analysis	✓		Web-based method sampling from social media platforms using key words to identify issues, trends, drivers, emerging technologies, etc.	Good for a general scanning of different knowledge sources before beginning a horizon scanning exercise. Can be used to identify issues arising in public discourse and analyze public sentiment or social acceptance. Knowledge sources can include conference themes and papers, media releases and reports, hashtags, mentions, and likes as a broad introduction to a subject matter. Sometimes called a semi-bibliometric study (Uhl et al., 2017)	Can be used to identify novel or emerging issues/innovations that may not yet be reported in academic literature	Web-based horizon scanning difficult to reproduce as digital content changes and social media platforms yield results that vary across users, space and time.
Surveys	✓	✓	Consultation of experts through a survey to gauge opinion on a given topic. Can generate quantitative and qualitative data.	Used to systematically gather information from a sample of individuals to draw conclusions, make informed decisions, or contribute to knowledge in a particular field.	Common technique Good for gathering key experts/actors perspectives and identifying recurring themes/issues. Can be used to survey a large sample to generate more data/ perspectives Can perform quantitative and qualitative analyses	No interaction between experts/actors
Interviews	✓	✓	On-on-one questioning with key experts or stakeholders, can be structured or unstructured.	Structured or semi-structured where there are a set of questions used to elicit information from an individual. Semi-structured interview questions are used to encourage conversation and not prescriptive. Can be used in Delphi, Stakeholder mapping, Survey, gaming and crowdsources design.	Common technique Good for gathering key experts/actors perspectives	No interaction between experts/actors

Method/tool	Horizon scanning	Foresight	Description	Application	Strengths	Limitations
Brainstorming		✓	Creative and interactive group sessions to generate new ideas	Similar to issue trees and mind mapping.	Allows exploration of issues and generates new ideas or new knowledge Promote creative thinking Commonly used method (Popper, 2008).	Subjective and dependent on expertise May be difficult to organize large-scale meetings with international experts
Expert workshops/panels	✓	✓	Assembling experts to identify and discuss issues, themes, questions, drivers, etc. based on their knowledge and experience. Can be used to facilitate consensus building.	See Delphi method below.	Interactive Use to build consensus, refine issues Can help promote creative thinking Expertise provides credibility Can be adapted to include different methods, such as the Seeds approach (Pereira, 2021).	Can be difficult to identify breadth of expertise needed Findings are influenced/biased by the expertise and process used
Citizen panels	✓	✓	Engaging groups of diverse stakeholders and/or citizens to identify and discuss issues, themes questions, drivers, etc. e.g. CIVISTI method.	Good for judging social licence about a subject matter and formally engaging community stakeholders.	Interactive Gather broad perspectives and concerns from non-experts Involve citizens in long-term planning and agenda setting (Gudowsky et al., 2016).	Difficult to determine quality of contributions Subjective
Scenarios/narratives	✓	✓	Qualitative descriptions of futures (based on evidence/data) to facilitate exploration of plausible events and impacts.	Effective where there is ambiguity and uncertainty in order to build analytical rigour and agreement (Smith et al., 2011).	Helps prepare for change and test current strategies and systems Can help to promote creative thinking Can be used as part of an interactive process	Time and labour intensive to develop Scenarios are hypotheticals with limited dimensions, essentially just a "verbal model" (interviewee).
Delphi method	✓	✓	Participatory approach involving consultation of experts using Delphi methodologies, usually involving multiple rounds of polling and feedback using questionnaires. Approaches include scoring or ranking issues using set criteria.	Enables a consensus to be developed through expert elicitation. Often run as a workshop or small (<10 people) focus group or surveys/polls (Smith et al., 2011).	Good at generating an overview of issues Expertise provides credibility Well-recognized and established approach Can allow issues to be ranked. Can overcome undue influence from high-status advocates (Popper, 2008). Can identify consensus or divergence on an issue	Time and labour intensive Can be difficult to design and execute well Vulnerable to group effects, which may lead to unrepresented views or missing important issues Participants may drop out during the process

Method/tool	Horizon scanning	Foresight	Description	Application	Strengths	Limitations
Technology roadmap		✓	Constructing a vision or projection of future possible technological developments or environments (European Foresight Platform, accessed January 2024) Used to identify direction and actions to achieve a goal.	Works well in combination with other foresighting methods, such as mapping, Delphi, and scenarios.	Visualization through a roadmap can help to communicate important elements and relationships in a complex system Create a tool to facilitate shared understanding between different stakeholders e.g. government, industry	Traditionally applied to technological developments and may not be easily adaptable to different areas. Does not easily allow for large-scale participation
Back-casting	✓	✓	Describes vision of preferred future and then work backwards to identify key steps and requirements to achieve it. Used to visualize barriers to a goal.	Can be used to work backwards to present day and see what policy levers, laws, changes in markets or infrastructure may be needed or avoided to inform solutions and strategies (Smith et al., 2011).	Can be a stand-alone activity.	Needs to be structured carefully to identify all relevant factors
Trend impact analysis/ extrapolation/ megatrends	✓		Examine past performance/outcomes to project future trends.	See backcasting. Gordon & Glenn, 2004 and Di Pasquale & Padula, 2015)	Helps to understand drivers.	Past performance not necessarily good indicator for the future.
Open forums and crowdsourcing	✓		Elicit contributions to open forums e.g. online forums	Open forums are a good starting point to ask for broad reactions and inspirational suggestions. Crowdsourcing is attractive for those whose ideas foresighting organizers want to provoke and attract, and capable of anticipating emerging technologies (Smith et al., 2011).	Gather input from a wide range of contributors. Can be used to survey a large sample to generate more data/ perspectives	Difficult to ensure quality of contributions
Gaming and role play		✓	Games played in groups designed to replicate real life scenarios to aid in decision-making and strategy building.	Helpful for research on motivation, new technologies, communication and cultural competency (role playing).	Interactive Help facilitate creative thinking Provides practical and strategic insights Enhance understanding of issues and diverse viewpoints Aid in testing behavioural assumptions to inform how people might think or react in different situations	Imagination and commitment required from players Strategic behaviour and knowledge by players is required (European Foresight Platform, accessed January 2024).

Examples of methods used in foresight activities in different organizations

Horizon scanning and foresight have been used across various sectors to inform national and international programs, such as science and technology strategies, innovation programs, defence strategies, economic development goals and corporate strategies. Here, we present some examples of foresight methods developed in a UN organization, industry and government to illustrate the range of applications of foresight methods.

Food and Agriculture Organization of the United Nations

In 2018, the FAO released a long-term foresight assessment of global food and agricultural systems, *The Future of Food and Agriculture – Alternative Pathways to 2050*.

This foresight exercise considered three alternative scenarios which included the challenges and strategic options for sustainable food and agriculture. The scenario narratives focused on long-term "mega-challenges" facing agriculture and food stability, informed by existing analysis of trends and challenges such as the 2030 Agenda, and Shared Socio-economic Pathways and Representative Concentration Pathways used in climate change modelling. The scenario narratives provided a "snapshot" of the world in a future period and described pathways from the current situation to the future situation. The three scenarios were "Business-as-Usual", "Towards Sustainability" and "Stratified Societies". Another key part of the exercise was identifying drivers which shape the scenarios, such as population growth, economic growth, technological progress and climate change.

FAO (2018) used two economic models to provide quantitative projections to test the scenarios and check consistency: the FAO Global Agriculture Perspectives System (GAPS) and the Environmental Impact and Sustainability Applied General Equilibrium (ENVISAGE) model. FAO GAPS focuses on the relationships between production and consumption of food, while ENVISAGE covers the whole economy in relation to the food and agricultural sectors. Consistency checks on the results from each model are performed, and subsequent adjustment of model parameters ensured internal consistency across both models. Aspects of the scenarios that were not accounted for in the quantitative modelling were included through qualitative considerations which build on relevant evidence.

The analysis of the three scenarios was intended to address the question of whether global food and agricultural systems will be able to sustainability feed humanity by 2050. The results generated were used to examine strategic options and actions that would need to be implemented for pathways conducive to sustainable and equitable food and agriculture development.

In an interview, foresight practitioners from FAO outlined their bottom-up approach to foresight programs at regional and village levels, where established foresight methods are tailored for different communities and stakeholders, their level of futures literacy, and scope and resources available. Inclusivity and jointly defining clear value propositions of the foresight exercise to all stakeholders was also identified as a key part of the approach by the interviewees.

A recent foresight synthesis report by FAO and the French Agricultural Research Centre for International Development, *Harvesting Change*: *Harnessing emerging technologies and innovation for agrifood systems transformation* combined literature review, real-time Delphi surveys, expert and multi-stakeholder consultations, interviews and panel discussions. A real-time Delphi study is a variation of the traditional Delphi method where, rather than multiple rounds of questioning, experts receive immediate feedback on theirs and others' input and can adjust their answers in real time. The process involved three stages: horizon scan of technologies and innovations impacting agrifood systems, scenario building on future scenarios in which agrifood technology and innovations emerge, and strategic decision making on how to anticipate and plan for developments.

Royal Dutch Shell scenarios

In 1960, Royal Dutch Shell (Shell) began to look at how the future might unfold and the subsequent impact this could have on the business given growing uncertainties and the limitations of forecasts for long-term anticipation. Shell has since produced and used many types of foresight exercises to anticipate global economic, social, and political changes and their likely impact on business, and modify decision-makers thinking in the face of uncertainty. Examples include the 7-questions interview technique and 2X2 scenario matrix.

The current Shell Scenarios (2023) methodology is based on a quantitative framework that underpins the logic of their scenarios. The quantitative framework is based on the World Energy Model (WEM) and the Global Supply Model that Shell (2017) have developed.

The WEM provides a scenario-based simulation of the world energy system, allowing quantitative tests of a given scenario. The usefulness of the WEM to Shell derives from a few key aspects:

- By holding many inputs independently, the WEM facilitates discussions on the interconnectivity of the inputs such as "if the energy system becomes constrained, which elements are likely to give?"
- Independent inputs also allow tailoring to a given scenario
- The WEM forces internal consistency, allowing plausibility checks of far-reaching assumptions, by drawing on historical data and well-known empirical relationships
- It is not a target-driven or optimization model, and thus avoids the issue of the model driving the scenario.

The WEM has been used in a variety of foresighting exercises by Shell. In 2023, Shell published the Energy Security Scenarios. This project aimed to explore how different country archetypes are likely to react to the increasing security tensions worldwide and asks the question: "Can a world desperate for immediate security also meet the long-term challenge of climate change?". To try to answer this question, two scenario narratives were developed – "Archipelagos" and "Sky 2050". The "Archipelagos" scenario explores a future that is driven by the increasing importance of national security in 2022, whereas the "Sky 2050" scenario takes a normative approach, starting with a desired outcome by 2050 and then works backwards to explore how this desired outcome could be achieved (back-casting).

By directly comparing these two scenarios and their respective quantitative data, Shell was able to explore the different trends that can be expected depending on the national priorities of nations over the next 30 years. Additionally, potential pathways to move from the more 'realistic' "Archipelagos" scenario to the more 'idealistic' "Sky 2050" scenario could be explored. Key disparities in the uptake of renewables, the expected energy prices worldwide, and global supply needs are identified.

Singapore Centre for Strategic Futures

The Centre for Strategic Futures (CSF) in Singapore was established in 2009 as a futures think tank within the Scenario Planning Office in the Prime Minister's office. The CSF is focused on issues that may be blind-spot areas, pursuing open-ended long-term futures research, and experiments with new foresight methodologies (Centre for Strategic Future, accessed January 2024).

The CSF is part of the Strategy Group in the Prime Minister's Office in Singapore. The CSF's work aims to position the Singapore government to navigate emerging strategic challenges and harness potential opportunities through their foresighting work (Centre for Strategic Future, accessed January 2024). Their foresight work can be broken into three key areas:

- Building capacities for strategic anticipation and risk management
- Developing insights into future trends, discontinuities, and strategic surprises
- Communicating these insights to decision makers for informed policy planning.

The foresighting work performed by the CSF is centered on its suite of foresighting tools called Scenario Planning Plus (SP+). The SP+ serves six purposes:

- **Defining Focus** – This establishes the nature of the problem in order to find appropriate solutions. Tools such as the Cynefin Framework Problem Definition are used.
- **Environmental Scanning** – To determine potential challenges and opportunities. Tools in SP+ include Emerging Issues Analysis, which engages a wide range of stakeholders to identify critical emerging issues.
- **Sense Making** – Using raw information to produce a comprehensive picture of a given issue. Tools include Driving Forces Analysis and Prioritization, which examines how a potential trigger event can alter existing trends and then prioritizes them on their potential impact on stakeholders.
- **Developing Possible Futures** – Creates narratives and models to explore plausible futures. Tools include Scenario Planning, where scenarios are created to challenge assumptions and to elucidate thinking on long-term strategies, and Backcasting, which works backwards from a desired future outcome to identify potential policies that will be required to reach that outcome.
- **Designing Strategies** – Create and explore strategies by taking into account the developed insights into the future. Tools include War-Gaming, where strategies and conflict simulations are explored.
- **Monitoring** – Tracking indicators of anticipated futures or implemented strategies. Tools include Early Warning Systems, which are used to analyze risks, monitor and warn of potential threats, and build a response capability to these identified threats.

The CSF therefore incorporates all aspects of foresighting into their work, from initial identification of potential issues, through to mapping possible futures to design effective strategies to mitigate identified issues, and then finally monitoring for signals of these mapped-out futures.

Cross-cutting challenges in horizon scanning and foresight exercises

While there are strengths and limitations associated with individual methods (Table 2), the literature review and interviews highlighted several cross-cutting challenges experienced when conducting horizon scanning and foresight exercises, and solutions to mitigate them.

Dealing with a lack of evidence base and uncertainty

Horizon scanning and foresight methods rely on the availability of knowledge – for example, of emerging technologies or environmental signals – or access to appropriate experts. Uncertainty is inherent in imagining the future and the evidence base is never complete. Where there are evidence gaps, emphasis is placed on the knowledge of experts (Peyton et al., 2020). Consensus-building methods which involve discussion can allow gaps in evidence or contradictory information to be explored (Roy et al., 2019). Confidence levels can be used to indicate uncertainty in assessments and are beneficial when communicating outcomes to foresight end users (Peyton et al., 2020; Roy et al., 2019) and have been applied to horizon scanning exercises, for instance in invasive alien species studies (Roy, 2023 personal correspondence).

Identifying knowledge gaps is also a valuable outcome of foresight processes and can help direct research effort (Nesshöver, 2016).

Selecting participants and mitigating bias

The outcome of participatory foresight depends on the participants, and foresight practitioners carefully consider and select participants based on the expertise and perspectives needed. However, participants each bring their own knowledge, experience, and agendas which influence the outcomes of the foresight process. This bias includes selection bias, response bias and group biases. For example, in a Delphi exercise, the opinions of experts impact the prioritization of topics or issues. Such consensus methods that rely on the opinions of experts should consider and address issues of accuracy and judgement (Roy et al., 2019).

Strategies to mitigate bias and improve balance in evidence gathering, as described in the literature and interviews include:

- Convene a large and diverse group of experts (Sutherland et al., 2016; Parker et al. 2014)
- Include non-experts in discussions to challenge collective assumptions.
- Use voting and scoring/ranking techniques to reduce the impact of dominant individuals (Parker et al. 2014)
- Use triangulation processes to improve reliability (Angelstam et al., 2021).
- Apply an anonymous process in gathering questions/issues and prioritization to avoid social pressure and response bias.
- Apply confidence levels to indicate the level of certainty on issues identified by experts (Roy et al., 2019).
- Facilitate discussion where the proposer refrains from speaking until other views are heard to avoid locking in a pre-determined framing and open discussion to other ways of thinking about problems.

An additional consideration is how to address gaps in expertise identified during the foresight process. Assigning confidence levels based on these gaps is one way to address this (Peyton et al., 2020). Flexible approaches may allow input from additional experts at different stages in the process if gaps are identified.

Foresight facilitation

Interviews highlighted that working with foresight tools requires skilled facilitation to draw out ideas that address the aims of the process, minimize biases and reduce the impacts of power dynamics on marginalizing diverse voices in discussions. Finding people with these skills can be a challenge, which was identified in interviews and discussions as a potential area for capability-building.

Multidisciplinary foresight activities

Using foresight to examine complex issues requires perspectives from multiple disciplines to understand the problems, challenge assumptions and explore futures. Experts from different disciplines bring different epistemology, values, terminology and approaches to issues. Establishing a common understanding and consistent terminology among participants supports the exercise (UNDP Regional Bureau for Asia and the Pacific, 2022).

Deterministic foresight vs. exploring possibilities

The purpose of foresight is to challenge thinking, reframe issues and engage with futures, rather than offer definitive answers or predict what the future will hold. However, deliberative processes like foresight are often technocratic and deterministic, with prescriptive outputs regarding what should be done. This limits the exploration of futures and ideas and can marginalize non-Western worldviews or futures (Muiderman et al., 2023).

Potential ways to overcome this problem include combining empirical/data-driven approaches with exploratory and comparative techniques and ensuring that participants understand what the problems are (reframe the problem) and how they might be addressed, rather than approaching issues from a solely empirical and deterministic standpoint (Gaub, 2019).

Identifying novel and genuine 'horizon' issues

Horizon scanning and foresight exercises seek to identify new issues that are genuinely on the 'horizon,' i.e. not yet on policy agendas. However, this can be challenging as participants may identify more current issues. While issues reported may have emerged, they are still at an early stage in the policy cycle or the process may identify a new dimension of an existing issue (Parker et al., 2014).

Thinking about the future: diverse worldviews and foresight

A reflection from this literature review is the dominance of Eurocentric/Western or Global North ideas, research and methods in the literature on foresight. Most of the peer-reviewed research identified in this literature review originates from Global North countries (based on the institution of the lead author) and is published in English. Non-European countries represented in the literature sample include the Southeast Asia countries of South Korea, Singapore and Malaysia; Africa countries of Ghana, Botswana, Kenya; Latin American countries of Colombia, Brazil; other countries were Iran, India, China, and Russia.

It is critical to acknowledge that foresight studies sit within an academic, Western/Eurocentric knowledge system, and that foresight processes can enforce hegemonic conceptions of desired futures. This has important implications for global foresight activities that seek to be open to pluralistic worldviews, identify new or surprising issues and consider alternative futures (Muiderman et al., 2023; Stirling, 2008). Power dynamics influence which issues are explored, the types of knowledge that is considered credible, and what is prioritized. This can reinforce dominant framing or policy narratives, even when input based on diverse worldviews is actively sought (Muiderman et al., 2023; Stirling, 2008).

There are examples of foresight practice in non-European or non-Western countries that focus on broadening consideration of possible futures, promoting equity and 'opening up' foresight processes, for examples see Bennett et al. (2016), Pereira et al. (2018), Rutting et al. (2023), Muiderman et al. (2023).

Systematic analysis of Global South foresight work and in-depth exploration of issues of decolonizing foresight is out of scope of this literature review, however, some issues that have arisen in the literature review and interviews are presented here for consideration:

- Interviewees have reported that translators and facilitators who are able to navigate different concepts and contexts to conduct horizon scanning and foresight across different cultures are important for foresight success and finding skilled people can be challenging.

- Interviewees highlighted that incorporating scientific knowledge and the wider inclusion of local contexts and priorities requires nuance and understanding of cultural contexts and local values. For instance, in some countries, biodiversity issues are deeply connected with socio-diversity or cultural-diversity. Therefore, horizon scanning and foresight exercises focused on environmental disciplines would require incorporating those concerns in order to have legitimacy.

- Diverse conceptualization of timescales across cultures and languages is another consideration that impacts foresight processes which follow a Western, linear view of history, present and future (Muiderman et al., 2023; Kothari, 2005; Hunfeld, 2022).

- The few studies addressing Indigenous Knowledges or Indigenous communities in the literature review point to a potential need to further investigate Indigenous Knowledges in the context of foresight and horizon scanning and how communities are consulted and impacted by these exercises.

- The enduring of Indigenous cultures worldwide and the identifying characteristics of intergenerational knowledge transfer are evidence of longevity, sustainability and future planning within Indigenous societies (United Nations Department of Economic and Social Affairs, 2021). Research findings from foresight and horizon scanning studies undertaken with Indigenous and other stakeholders speak to the diversity of scenarios and unique futures that could be imagined by collaborating with stakeholders who reflect a multiplicity of knowledge systems and worldviews (Bennett et al., 2016; Pereira et al., 2018). Rather than trying to adapt Indigenous ways into westernized frameworks, there could instead be space to open dialogues with Indigenous stakeholders, that invite other perspectives and insights into the possibility of foresight. ■

3 ESSAY 1

Foresight Visions: Embracing Community-led and Indigenous Perspectives

Ranjan Datta and Wilfred Lunga

Preamble

The field of foresight has evolved through insights from military strategy and planning (von Kármán, 1947; Kahn 1960; Gray, 1999), business and corporate strategy (Porter, 1980), systems theory (Checkland, 1981), futurism and futurology (Toffler, 1970), science fiction and speculative fiction (Asimov, 1951), and Environmental Scanning and Trend Analysis (Aguilar, 1967). The private sector has also contributed to the development of the field to inform their long-term strategies (Vecchiato, 2012). More recently, a stronger emphasis has been put on the diversification of approaches in relation to the call for sustainability transition and transformation, increased stakeholder participation, and the need to develop visions of alternative futures. Now, in the polycrisis era, the experiences and knowledge systems of Indigenous, Black, and marginalized communities of the Global South, building on decolonial scholarship and environmental justice (Datta, 2020; Datta, 2023; DiAngelo, 2018; Kendi, 2019; Smith, 2012; Tuck & Yang, 2012) highlight the potential for foresight approaches and practices to learn from and be informed by indigenous and local knowledge (ILK) (UNDP, 2022). Building synergies between ILK and scientific knowledge systems has been recognized as a key opportunity to move towards sustainable ecosystem governance at multiple scales (Takeuchi 2010; Tengö et al., 2017). One result from engaging with this diversity of views is a more inclusive and socially just approach to foresight.

Often overlooked, incorporating indigenous and local knowledge into various foresight methods, such as scenario planning (Schoemaker & Mavaddat, 2023), horizon scanning (Curry & Hodgson, 2023), the Delphi method (Skulmoski & Hartman, 2023), backcasting (Robinson et al., 2023), technology foresight (Geels & Schot, 2023), and strategic foresight (Rohrbeck & Kum, 2023), is crucial for deepening our understanding of emerging trends and future possibilities. This integration fosters the creation of community-led, transdisciplinary solutions. By recognizing and leveraging knowledge and practice embedded within indigenous communities, foresight practitioners can produce invaluable insights, enabling holistic and sustainable approaches to anticipating and navigating future changes and developments (Datta, 2020; Datta & Starlight, 2024; Kristóf & Nováky, 2023).

Indigenous and local community methodologies for Foresight

Foresight discussions in the global South may not always align with local contexts, leading to the exclusion of contextualized approaches, particularly those incorporating decolonial and anti-racist perspectives. Challenges such as scientific literacy, the digital divide, and language barriers further impede inclusive public engagement approaches, as highlighted in the literature (Finlay et al., 2021; Ishinaha-Shinere, 2017). There is an urgent need to reassess foresight landscapes in the global South, advocating for a reimagining of epistemologies, policies, and practices.

Indigenous peoples and local communities across all continents possess a wealth of traditional knowledge systems that inform their future planning and decision-making practices (Nyamnjoh, 2019). For instance, in Latin America, indigenous communities have cultivated sophisticated foresight methods rooted in traditional and ecological knowledge (Huntsinger & Bailey, 2019). Similarly, in the Asia-Pacific region, scenario planning and foresight techniques have been integral in anticipating and responding to environmental and social shifts (Berkes & Folke, 1998; Toledo et al., 2019). However, the prevailing narratives of the global South's future often reflect western

worldviews, perpetuating the dominance of external ideals and aspirations, as highlighted by Pereira et al. (2020), and neglecting preferable, plausible, futures.

Indigenous worldviews and perspectives from the global South offer rich insights and approaches for future action beyond conventional boundaries of foresight and planning. These perspectives emphasize community-led, culturally grounded, and holistic approaches. Instead of simply projecting future trends from dominant narratives, such community-led foresight critically examines power dynamics, amplifies marginalized voices, and emphasizes the socio-political contexts shaping future trajectories. Indigenous worldviews often emphasize interconnectedness and the relationship between humans and nature. This challenges the conventional reductionist and individualistic approaches often found in Western planning and foresight (Meyer, 2023).

Marginalized populations in the global South frequently rely on community-led initiatives, steeped in local knowledge and traditions, to drive change. These initiatives ensure that solutions are culturally relevant and sustainable. Foresight practitioners must collaborate with communities using participatory action methodologies grounded in community engagement, self-determination, and empowerment (Minkler & Wallerstein, 2011). Together, they can co-create visions of plausible and desirable futures that prioritize social justice, sustainability, equality and cultural authenticity, shaping more equitable futures.

As globalization advances, it should be able to bring different world views into contact – including worldviews of different indigenous groups. However, in reality, the collective ability to envision a wide range of futures has become increasingly constrained, often by predetermined narratives shaped by colonial histories. This predetermined shaping of views not only constrains the potential of the global South, but also limits the exploration of diverse possibilities inherent in local cultures and traditions. Additionally, it impedes the imaginative exploration of profoundly transformative alternatives (Pereira et al., 2020). Consequently, there is a growing call for a decolonial approach in imagining diverse futures for both people and the environment.

Decolonialism entails moving beyond the worldview that marginalizes anything diverging from a Eurocentric perspective as inferior, irrelevant, or dangerous (Datta, 2018; Santos, 2021). The argument advocates for embracing diverse temporalities, knowledge systems, and ways of life (Mignolo, 2021). Additionally, Mashigo (2018) contends that "Africans in Africa" require a distinct approach from Afrofuturism, proposing a project envisioning Africa's future "postcolonialism." He highlights the necessity of recognizing varied needs and contexts in imagining futures or reimagining a fantasy present, which differ significantly worldwide. Mashigo suggests that in Africa such a project must consider the divergent paths of each nation on the continent, all inevitably shaped by the legacy of colonialism.

Weaving decolonial and antiracist[1] perspectives from, and within, communities engaged in foresight not only enriches the discipline by broadening its worldviews but also nurtures a more equitable and inclusive approach in shaping future realities (Boyce and Peters, 2014). This meaningful transformative pursuit recognizes the interconnectedness of past, present, and future, affirming the necessity of challenging dominating narratives and cultivating futures that uphold the dignity and agency of all communities.

Significance of community-led decolonial and antiracist perspectives in foresight

Community-led approaches to foresight have emerged as integral components of decolonial and antiracist foresight practices. Several studies, e.g. Minkler & Wallerstein (2011), emphasize the importance of community engagement, indigenous and local communities' self-determination, and empowerment in shaping foresight processes. Community-based participatory action methodologies

[1] Antiracist foresight horizon scanning involves actively seeking to identify and address potential future trends, events, and developments through a lens that prioritizes equity, justice, and the dismantling of systemic racism. This approach acknowledges that future scenarios and innovations can either exacerbate or alleviate existing racial inequalities, and thus aims to anticipate and mitigate potential harms while promoting inclusive and equitable outcomes for all individuals and communities.

facilitate collaboration between foresight practitioners and communities, allowing for the co-creation of visions of plausible and preferable futures (Datta, 2018). In some ways these centuries or millennial-old collaborations and thinking run parallel to trans-and interdisciplinary thinking in science. While transcultural approaches are essential in all societies, community-based approaches are particularly vital, as they centre on the experiences and knowledge systems of indigenous, black, and marginalized communities, ensuring that future visions can prioritize social justice, sustainability, and cultural authenticity. DiAngelo (2018), Kendi (2019), and Yancy (2021) further underscore the necessity of challenging systemic racism and promoting equity within foresight endeavors. This requires integrating decolonial and antiracist approaches and ensuring historically marginalized voices are included. This approach fosters more inclusive and equitable strategic planning, addressing biases and systemic inequalities in future-oriented research and decision-making.

Building upon decolonial scholarship, foresight endeavors, particularly in the global South, must confront the legacies of colonialism, while also addressing contemporary issues such as environmental degradation, economic inequality, technological divides, and social injustice by creating a meaningful bridge between traditional and western technological knowledge systems. Studies by Patel (2019) and Mukhopadhyay (2021) further explore the implications of colonial legacies and contemporary challenges on foresight practices in the global South, highlighting the imperative of integrating diverse perspectives and addressing systemic inequities in envisioning future trajectories towards environmental sustainability.

Mbembe (2020) argues for the decolonization of imagination as a fundamental step towards reimagining and reshaping futures in the global South. Bridging knowledge systems and engaging diverse cultural and historical narratives, foresight practitioners can facilitate the emergence of alternative futures that prioritize social justice and collective well-being. Menakem (2017) highlights the intersectionality of race, trauma, and healing, further underscoring the importance of integrating antiracist perspectives into foresight practices.

By acknowledging and addressing historical traumas and systemic injustices, foresight practitioners can postulate futures that promote healing, resilience, and empowerment within marginalized communities. Mignolo (2018) emphasizes the need to decolonize knowledge hierarchies and a meaningful integration of all knowledge systems in foresight practice. While often traditional knowledge systems are differentiated from "western" knowledge systems, the use of the epithet "western" masks the origins of modern science (see Poskett, 2023). Thus, challenging hegemonic narratives, centering marginalized voices, and embracing epistemic diversity, this integration enriches the discipline and fosters diverse futures.

Indigenous and local knowledge (ILK) foresight perspectives and practices

Indigenous and local knowledge systems are increasingly recognized as invaluable reservoirs of foresight, providing unparalleled perspectives on environmental, social, and cultural dynamics. Acknowledging the wealth of indigenous and local knowledge available, foresight practices in the global South are undergoing a transformative shift towards participatory models. These models prioritize public involvement and engagement, alongside a commitment to inclusivity, as fundamental pillars. This paradigm shift reflects a growing appreciation for diverse voices and perspectives.

At the international level, the Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services (IPBES) although dealing with knowledge products, rather than foresighting *per se*, has recognized that indigenous and local knowledge (ILK) systems need to be included in their processes of reflection and foresight, often without use of that word (Hill et al., 2019; McElwee et al., 2020). IPBES sees ILK as verified, implemented, challenged, and applied within its own processes of validation (Díaz et al., 2015) and conceptualizations, for example, of what is 'nature' and 'sustainability'.

Diverse internal practices of indigenous peoples, as well as local communities of the global south occupying their traditional territories, ensure saliency, legitimacy, and credibility for their knowledge. Such practices are based on a range of techniques, including historical experiences via natural

experiments, expert peer-review, cultural norms, and collective procedures to evaluate and validate knowledge (Tengö et al., 2014). Some of these processes are akin to current foresighting techniques practiced in the global north.

The crucial distinguishing feature of ILK systems is that they are established, controlled, and managed through formal *and informal* institutions that guide practice (Tengö et al., 2017). These institutions arise *in-situ*, some spanning regions and continents, reflecting beliefs, values and learning from collective practices, lived experience, everyday observation and monitoring of the environment. These practices are situated within the context of long-term people-nature interactions and have persisted in these human communities over millennia. The practices and techniques are transmitted through a myriad of forms, including song, dance, paintings, rituals, accounting, and tenure systems organizing the lives of millions of people across the world.

ILK foresight perspectives and practices involve shifting paradigms to public engagement. This acknowledges the importance of Indigenous knowledge systems in foresight processes and recognizes Indigenous communities as active participants and knowledge holders in developing foresight visions. These transformative visions have the potential to enrich the discipline of foresight, fostering more inclusive and socially just approaches to envisioning and shaping future realities in the global South and beyond. The key perspectives and practices are given in the Table below.

Table 1

Indigenous Knowledge foresight perspectives and practices.

Key Perspectives and Practices	Description	Sources
Participatory and Inclusive Approaches	IK foresight practices prioritise participatory and inclusive approaches, involving Indigenous communities as active participants in the foresight process.	Adhikari, B., Di Falco, S., & Lovett, J. C. (2004)
Community-Based Foresight Initiatives	Foresight initiatives are often community-based, with Indigenous communities leading the process and shaping the outcomes.	Moller, H., Berkes, F., Lyver, P. O., & Kislalioglu, M. (2004)
Emphasis on Collaboration and Partnership	IK foresight practices emphasize collaboration and partnership between Indigenous communities, researchers, policymakers, and other stakeholders.	Quiggin, J. (2013)
Respect for Indigenous Rights and Cultural Sovereignty	IK foresight initiatives respect Indigenous rights, cultural sovereignty, and intellectual property rights, ensuring that Indigenous knowledge is used and shared appropriately and ethically.	Watson, A. (2009)
Public Engagement and Knowledge Mobilization	IK foresight practices prioritize public engagement and knowledge mobilization, ensuring that foresight outcomes are widely shared and accessible to all stakeholders.	Tuhiwai Smith, L. (2012); Alhassan et al., 2019; Weingart et al., (2021)
Capacity Building and Empowerment	IK foresight initiatives focus on capacity building and empowerment within Indigenous communities, equipping community members with the skills and knowledge to actively participate in future planning and decision-making processes.	Lejano, R., Ingram, M., & Ingram, H. (2013)
Ethical Considerations and Cultural Sensitivity	IK foresight practices are guided by ethical considerations and cultural sensitivity, ensuring that Indigenous knowledge is used and shared in ways that are respectful, responsible, and culturally appropriate.	Nakashima, D. J., Galloway McLean, K., Thulstrup, H. D., Ramos Castillo, A., Rubis, J. T., & Ogiek, M. (2012).

Recognition of indigenous and local knowledge systems as valuable sources of foresight

As noted earlier, synergies between ILK and scientific knowledge systems have been recognized as opportunities to move towards sustainable ecosystem governance. And yet, scientific initiatives have, at times, resulted in ILK being removed from its cultural context, distilled, and synthesized to the extent that undermines its original meaning and on-going capacity for validation, change and adaptation (Agrawal, 2002). The result is a legacy of mistrust: indigenous communities identify some risks of collaboration such as knowledge theft, lack of appropriate benefit sharing, and heightening of power inequities (Reid et al., 2006). Equitable partnerships that address power asymmetries and provide indigenous peoples with opportunities to navigate the engagement between science and ILK in ways that strengthen their rights and governance, and do not further entrench histories of oppression, are critical to allow such different knowledges to be woven in more western foresighting approaches (Whyte, 2018).

Examples of indigenous communities' approaches in foresight

Indigenous communities in the global South employ diverse approaches to foresight, drawing upon traditional knowledge systems to navigate environmental and social changes. In Africa, traditional weather forecasting techniques, informed by observations of animal behavior and celestial movements, are integral to predicting weather variables that are crucial for livelihood decisions (Mhizha et al., 2020; Acharya, 2011; Moyo & Chaminuka, 2018; Omenyo, 2015). Pacific island nations rely on traditional ecological knowledge for seasonal calendars and marine navigation (Nyong et al., 2007). First Nations in Australia follow similar practices (CSIRO, 2024).

In the Amazon rainforest, indigenous groups employ processes conceptually resembling scenario planning to anticipate deforestation and climate change effects on their communities (Santos et al., 2019; Huntsinger & Bailey, 2019). Also in Brazil, environmental activists are mobilizing against environmental racism and land dispossession faced by Afro-Brazilian communities. Anti-racist principles and solidarity aim to protect ancestral lands, conserve biodiversity, and promote environmental justice (Silva & Sousa, 2021).

Projects like "Futuros Posibles" in Colombia engage indigenous knowledge to envision alternative futures for sustainable development (Ramírez, 2017), while in Medellín, Colombia, a foresight-based urban planning approach successfully weaves Indigenous perspectives in addressing social inequalities and promoting sustainability (Arboleda, 2017). In Mexico, feminist approaches to water governance are reshaping policies and practices to address gender disparities and ensure access to clean water for all. Feminist community-based approaches, incorporating intersectionality and solidarity, seek to challenge patriarchal structures and promote water justice (Luna & Momtaz, 2020).

In south Asia, the coastal communities of Bangladesh, where climate change exacerbates existing vulnerabilities, community-led foresight initiatives have emerged to address adaptation needs. These initiatives prioritize indigenous knowledge systems and participatory decision-making processes, empowering local communities to anticipate and respond to climate-related challenges (Datta & Kairy, 2024; Rahman et al., 2020). Indian cities grappling with rapid urbanization and social inequality are employing anti-racist approaches to urban planning to address systemic discrimination and marginalization. By engaging with diverse stakeholders and centering the needs of marginalized communities, these initiatives aim to create more inclusive and equitable urban futures (Heard & Wigginton, 2023; Hoelscher & Aijaz, 2016).

In post-apartheid South Africa, decolonial approaches to education have been integral to envisioning more inclusive and equitable futures. By decentering Eurocentric curricula and amplifying indigenous knowledge, these initiatives seek to address historical injustices and empower marginalized communities (Pillay & Naicker, 2021). Foresight practices in Nigeria are integrating intersectional perspectives to envision more equitable health futures. By considering the intersecting impacts of race, gender, and class on health outcomes, these initiatives aim to address systemic inequalities

and promote health equity for all. In rural Kenya, decolonial approaches to agriculture are challenging monocultural practices and promoting agroecological solutions informed by indigenous knowledge. By centering local farming practices and prioritizing food sovereignty, these initiatives aim to build resilient agricultural systems that nourish communities and sustain the environment (Njuki et al., 2019). And in Ghana, postcolonial approaches to health policy are challenging Western biomedical frameworks and incorporating indigenous healing practices. By recognizing the plurality of health knowledge and valuing local expertise, these initiatives aim to improve health outcomes and promote cultural integrity (Asante et al., 2021).

All these case studies highlight the diverse ways in which knowledge-based, decolonial, and anti-racist approaches are being applied in foresight practices within the global South, offering pathways to more equitable, just, and sustainable futures.

Key methodologies emphasizing these approaches include:

- **Community-Based Participatory Research (CBPR):** CBPR emphasizes collaboration between researchers and community members in all stages of the research process, including problem identification, data collection, analysis, and action. In foresight, CBPR methodologies empower communities to identify their own needs, aspirations, and priorities for the future, ensuring that future visions reflect the lived experiences and cultural values of diverse communities (Datta et al., 2015; Israel et al., 2013).

- **Narrative and Storytelling:** Narrative and storytelling methodologies recognize the power of storytelling in shaping perceptions of the past, present, and future (Smith, 2019; Polkinghorne, 2021; Gabriel, 2020; Brown, 2018; Clandinin, 2022). In foresight, narrative approaches involve collecting and analyzing diverse stories and narratives to uncover underlying values, beliefs, and assumptions about the future. By amplifying marginalized voices and challenging dominant narratives, these methodologies would enable foresight practitioners to co-create alternative futures that reflect the plurality of human experiences and through this process, marginalized communities are empowered to contribute their perspectives and visions to the collective construction of more inclusive and equitable futures (Brown, 2018; Clandinin, 2022; Gabriel, 2020; Lejano et al., 2013; Polkinghorne, 2021; Smith, 2019; Wagner, 2020).

- **Intersectionality:** Intersectionality theory, developed by Kimberlé Crenshaw (2013), highlights the intersecting dimensions of identity, such as race, gender, class, and sexuality, and their impact on social inequalities (Cho et al., 2013; Davis, 2020; Nash, 2016; Hankivsky & Cormier, 2021; McCall, 2019). Applied to foresight, intersectional methodologies involve examining future scenarios through an intersectional lens to understand how different forms of oppression intersect and compound to produce unique experiences and vulnerabilities. By centering intersectional perspectives, foresight practitioners can develop strategies and interventions that address the complex and intersecting needs of diverse communities (Nash, 2016; McCall, 2019; Davis, 2020; Cho et al., 2013; Hankivsky & Cormier, 2021).

- **Decolonial Worldviews:** Decolonial epistemologies challenge all hegemony of knowledge systems and centre Indigenous, ancestral, and other marginalised knowledge. In foresight, decolonial methodologies involve engaging with diverse epistemological traditions and ways of knowing to envision alternative futures that reflect the cultural diversity and richness of human experience. By decolonising knowledge production processes and valuing diverse ways of knowing, decolonial methodologies promote epistemic justice and empower marginalized communities to shape their own futures (Tuhiwai Smith, 1999; Mignolo, 2018; Quijano, 2007; Smith, 2012; Tuck & Yang, 2012).

- **Anti-Racist Analysis:** Anti-racist analysis involves critically examining how race and racism intersect with other forms of oppression to shape social structures and power. In foresight, anti-racist methodologies involve identifying and challenging racial biases and assumptions embedded in future scenarios and by centering anti-racist principles and perspectives, foresight practitioners can develop more equitable and inclusive futures that address systemic racism and promote racial justice (DiAngelo, 2018; Kendi, 2019; Bonilla-Silva, 2006).

- **Indigenous Land-based Transformative Planning:** Indigenous land-based learning serves as transformative research methods that honour Indigenous ways of knowing, fostering deep connections to land, culture, and community while challenging colonial research paradigms (Wilson & Yellow Bird, 2005; Cajete, 2020; Wilson, 2019).

International organizations like UNESCO, the International Science Council, and the World Future Council increasingly emphasize diverse perspectives, supporting research, advocacy, and dialogue for inclusive and sustainable futures globally (Ziai, 2016; Walter, 2018). Authors like Liu Cixin and Vandana Singh offer distinct regional perspectives from China and India, respectively, enriching future discourse with elements of history, culture, and philosophy (Solomon, 2019; Kaminski, 2021). Indigenous communities employ unique cultural perspectives and traditional knowledge systems in future studies, using storytelling as a conduit for transmitting cultural wisdom and envisioning alternative pathways forward. However, Western-centric methodologies often overshadow the contributions of societies globally, underscoring the importance of valuing and integrating perspectives for inclusive dialogues about the future (Wivel & Wœver, 2018; Solomon, 2019).

In summary, emphasizing the worldviews of indigenous peoples and local communities in foresight offers critical frameworks for challenging colonial legacies, centering marginalized voices, and envisioning futures that prioritize equity, justice, agency, and solidarity. ■

4 ESSAY 2

Future directions for scenario and foresight practice amid 21st century complexity and uncertainty

Anita Lazurko, László Pintér, and Vanessa Schweizer

The 21st century is a time of disruption and transformation. Unprecedented anthropogenic impacts on the environment, such as through climate change and biodiversity loss, are increasing the risk of nonlinear and irreversible changes to the Earth systems. These risks are coupled with rapid societal changes such as the rise of artificial intelligence, increasing wealth inequality, eroding trust in institutions, and political polarization, which interact with biophysical risks in complex ways. Together, this complexity generates what some call a polycrisis – i.e., systemic, co-occurring, and potentially cascading risks – with outcomes that are difficult to imagine and impossible to accurately predict. Amid this polycrisis, there is widespread acknowledgment of the need for transformative change to achieve a sustainable and just future. Such transformations may be necessary yet are unpredictable and contested, as they emerge from widespread systemic changes that implicate actors with diverse perspectives, values, and stakes in the transition.

Taken together, these 21st century conditions paint a picture of possible futures that may radically depart from the present. Foresight approaches such as scenarios play an important role in anticipating and navigating this widening scope of future uncertainty. Scenarios are depictions of plausible futures and can serve as 'laboratories' to formulate and test assumptions about how the world works and where it may be heading. Prominent examples of scenarios include the Representative Concentration Pathways- Shared Socioeconomic Pathways scenario framework used by the Intergovernmental Panel on Climate Change, the Nature Futures Framework produced by the International Science-Policy Platform on Biodiversity and Ecosystem Services, and the scenarios underpinning the United Nations Global Environment Outlook reports. Scenarios are developed in diverse contexts including and beyond global assessment reports and serve multiple purposes, such as exploratory research, decision support, or citizen engagement, and could be useful for anticipating and navigating the disruptive decades ahead.

However, recent critiques of scenarios call into question their ability to reflect the unique uncertainties and complexities of our time, pointing to the need for more agile and holistic complex systems analyses than are offered by traditional scenario methods. Of particular relevance are questions regarding the ability of scenarios to capture nonlinear and disruptive changes, as scenarios conventionally have not considered sharp discontinuities with past trends (Raskin & Swart, 2020). The insights gained – or not gained - from scenario processes are likely to affect risk management decisions with significant and potentially lasting or irreversible material outcomes (Lawrence et al., 2024). Further, overly narrow or unimaginative assumptions about possibilities for transformative change can impact the ambition, inclusivity, and effectiveness of strategic actions to achieve a sustainable future.

Despite these critiques, scenario practice still has an important role to play in societies' ability to anticipate and navigate the 21st century. Scenarios remain the most established and accessible means for engaging with future complexity and uncertainty, and processes of envisioning and strategizing toward desirable futures are considered important for motivating and navigating transformative change. Here, we propose that harnessing the ongoing potential impact and relevance of scenarios requires greater attention to three future directions for scenario research and practice: 1) leveraging the use of scenarios as representations of social-ecological uncertainty and complexity, 2) viewing the scenario development process as a site of social learning, not simply a means to an end, and 3) ensuring scenario practice enhances futures literacy by reflecting more critically on the inherent ambiguity and openness of the future.

Scenarios as representations of social-ecological uncertainty and complexity

Our first proposed future direction for scenario practice highlights the use of scenarios as representations of social-ecological uncertainty and complexity. While scenarios are well-established in integrated global change assessment and in decision-support in sectoral, regional, or problem-focused contexts, they are also often questioned (e.g., Parson et al., 2007; Parson, 2008). For example, a common approach to developing scenarios is the Intuitive Logics method, which is a two-by-two matrix that generates four distinct scenarios from two interacting drivers of change (Schwartz, 1996). Scenarios generated using this method have been criticized for numerous reasons, including that they simplify the future as defined by two drivers of change when reality is far more complex, they do not adequately deal with non-linear or 'wildcard' events such as global pandemics, and they do not address the question of what we should 'do' about the challenges ahead.

The limitations of two-by-two scenario matrices have in some cases been addressed by combining them with iterative, participatory construction of transition pathways and with exploring scenario robustness in response to shocks caused by a range of wildcards (Frantzeskaki et al., 2020; Harrison et al., 2019). Importantly, Intuitive Logics scenarios are not the only option: a wide range of tools and techniques have been developed and tested across the fields of futures studies, anticipatory governance, and sustainability science (Bishop et al., 2007; Muiderman et al., 2020).

Recent developments in scenario practice highlight possibilities for scenarios to better surface social-ecological complexity, thereby generating insights that are commensurate with the uncertainty of the 21st century. System-theoretical approaches like morphological analysis or cross-impact balances develop scenarios as plausible (i.e., internally consistent) outcomes of diverse, interacting, qualitative and quantitative drivers of change (Weimer-Jehle, 2006). For example, the cross-impact balances method was used to co-develop "big picture" scenarios of a river basin under climate change, considering future scenarios as emerging from diverse social and ecological drivers of change (Lazurko et al., 2023a).

System-theoretical methods *begin* with a complex systems analysis that surfaces assumptions about how the system is understood to work, how drivers interact, and how they may change in the future. This systems analysis can be done in collaboration with experts, decision makers, and other stakeholders, so they are exposed to and understand underlying assumptions and see how their knowledge is reflected in the outcome. System-theoretical methods then *end* with scenarios that serve as alternative representations of that social-ecological complexity, providing a digestible basis for engaging decision makers and policy makers.

Similarly, emerging approaches like the Seeds of Good Anthropocenes (Bennett et al., 2016) develop desirable futures as emerging from nurturing small-scale 'seeds' of transformation (i.e., innovative ideas, ways of living, and transformational projects) to scale within higher-level systems. These methods are often combined with creative and imaginative arts-based methods to stimulate more diverse and radical visions of a sustainable future and pathways for achieving them. Embracing a wider range of such complexity-based tools can help ensure scenario practice remains salient and legitimate amid the potential for disruption and transformation.

Scenario processes as sites of social learning

The second proposed future direction for scenario practice emphasizes the role of scenario processes as sites of social learning. While approaches to scenario development vary, they also serve diverse purposes. In some cases, scenario development is simply meant to generate scenarios as an end-product that can be used to aid in decision making, such as to stress-test policies or to guide strategic action. However, scenario development *processes* surface legitimate questions related to why it might be desirable for the future to differ from the present, the evidence and assumptions underlying the scenarios and the representativeness of the perspectives of those involved in the scenario process. In other words, the scenario development

itself surfaces unique insights and influences the way representations of the future are accepted as credible and legitimate, which in turn affects the degree of trust in scenario results and their usefulness in decision-making. Insights gained from involvement may contribute to deeper changes in understanding of the dynamics of socio-ecological systems that point well beyond the scenario process and outputs. Consequently, the depth and breadth of insights gained in the process of scenario development highlights the need for scenario practice to move from *product* to *process* – i.e., to embrace the role of scenario development as a site of social learning (Johnson et al., 2012).

To contribute to social learning, scenario processes need to add to the understanding of not only individuals, but also at the collective level. Social learning usually assumes learning by social networks, through the active interaction of those involved in the construction and analysis of scenarios. Scenario development builds up complexity and understanding through multiple stages, where assumptions are articulated, woven together in coherent models and/or narratives, and where their implications and projected consequences are explored. Iterative construction of complexity in a participatory process means that stakeholders articulate often hyper-contextual positions, integrate them with the perspectives of others, and in the process of uncovering connections and relationships between partial perspectives of a larger complex system, rise above their own subjective understanding of how the future may unfold. Through this process social actors are gradually drawn into learning about systemic interlinkages, inherent uncertainties, and possible implications for the future.

Scenarios often integrate quantitative and qualitative information, contributed in a participatory process by different scientists and actors. Quantitative (e.g., model-based) and qualitative (e.g., descriptive, visual, or art-based) contributions to scenarios not only require different ways of knowing and learning, but also open channels for recognizing new types of uncertainties, risks, and opportunities for the adaptive behaviour and management that would be hard to recognize based on more narrow epistemologies and evidence. Approaches have also been developed to bridge diverse linguistic and epistemic uncertainty concepts to enrich and integrate quantitative and qualitative aspects of scenarios using, for instance, 'Centre of Gravity' operators that decode and demystify the quantification of heterogeneous linguistic values provided by diverse stakeholders (Pedde et al., 2018).

Contributions of scenarios to social learning have been documented in many practical contexts, such as the collective envisioning of future scenarios in the Minnesota 2050 project. The project was a collaborative effort between the University of Minnesota and Regional Sustainable Development Partnerships, citizen-driven networks to foster sustainable development across the State of Minnesota in the United States. The project was an academic-public sector partnership that engaged citizens, scientists, and community leaders of the complex socio-ecological system of the State. The project used a participatory scenario workshop to provide input to a parallel process to develop a Statewide Conservation and Preservation Plan, which aimed to synthesize the best scientific advice to guide decision making about conservation programs and funding. An analysis of the project found that stakeholder engagement in charting scenario trajectories contributed to co-learning about risks and uncertainties and identifying and discussing options for collaboratively addressing them through coping and adaptation (Johnson et al., 2012).

At the global level, UNEP's well-established Global Environment Outlook (GEO) process based on integrated environmental assessment (IEA) was explicitly branded not only as a flagship scientific report, but also as a multistakeholder process of learning and synthesis that built the knowledge and capacity of those involved. Through IEA's inherent foresight component, GEO contributed to broadening the base of participatory scenario methods as sites and occasions of social learning (Bakkes et al., 2022). GEO's contribution to the practice of forward-looking IEA could not happen without recognizing that conducting credible scenario processes require process design and management knowledge that is oriented toward multiple outcomes, including social learning (Jaeger et al., 2007). A case can be made that capacity to undertake scenario analysis and facilitate such social learning should be available as an integral and permanent component of social institutions, to enable a critical review and adaptation of earlier scenario insights in response to unforeseen events and new knowledge.

Scenario practice to enhance futures literacy

Our final proposed future direction for scenario practices suggests how scenario practice can and should enhance futures literacy. The capacity to reflect upon the deeper subjectivities underlying efforts to understand the future points to the need for a broader collective capacity to critically examine and more intentionally curate the ways we bring ideas about the future into the present. This capacity can be understood as 'futures literacy', which is "the competency that allows people to better understand the role of the future in what they see and do" (UNESCO, n.d.). For example, pessimistic assumptions about the plausibility of transformative pathways to address climate change or biodiversity loss or fears about the risky or even apocalyptic nature of the future influence human behaviour and choice in complex ways.

Scenarios are not predictions, and no single scenario approach can comprehensively explore the uncertainty and complexity of the future. As discussed, the need to (1) embrace a wider range of complexity-based scenario approaches and (2) leverage the role of scenarios as sites of social learning points to an inescapable challenge for scenario practice: (3) persistent openness of the future, which means that any effort to anticipate the future will be limited.

In other words, amid the complexity, speed, and unprecedented scale of socio-environmental challenges, any scenario development process produces "a particular frame of the future that includes certain future conditions and values while excluding others" (Lazurko et al., 2023b). This means that subjective choices made by those facilitating and participating in scenario processes — such as in the choice of framing or methodology — bears consequences for which future conditions and values are represented in scenarios and taken seriously.

Since there are multiple ways to approach scenario development, this means that ambiguity is inherent to the process. Navigating such ambiguity requires deeper consideration of the diversity of choices and options available in scenario development, aligning those choices with the purpose and desired outcomes of the exercise, and considering the ethical consequences of choices for the perspectives that are made visible or invisible. For example, scenario processes that exclude global South regions and stakeholders or the voices of youth exclude the very perspectives for whom major transformations may most directly occur. These considerations can ensure that participants in a scenario development process have the appropriate representation, freedom, and motivation to explore the inherent 'openness' of the future and to systematically enrich scenarios with 21st century complexity and uncertainty.

Building more agility and reflexivity into our individual and collective assumptions about the future can help overcome cognitive and political biases that influence decision making, thereby helping scenario exercises reach into higher levels of learning within and beyond scenario processes (e.g., 'transformative' learning at the level of paradigms and worldviews). In this way, futures literacy is not only a matter for science but is a 21st century skill that will allow us to leverage various means for bringing a desirable future into the present. ■

5

ESSAY 3

From Horizon scanning and Foresight to policy actions

Peter Gluckman, Hema Sridhar, Marc Saner, Andrea Hinwood, Jason Jabbour, Edgar E. Gutiérrez-Espeleta, and Diana Mangalagiu

Strategic foresight is being increasingly used to explore futures and provide insight to planning and programming in governments, public institutions, international organizations and companies. Foresight has the potential to help overcome institutional silos and support proactive rather than reactive decision-making. The United Nations reform agenda and the Secretary-General's publication, 'Our Common Agenda', recognizes this and calls for all UN agencies and member states to engage strategic foresight practices more deeply and to address global systemic risks and "future proof" our collective decisions.

Traditional policy planning focuses on understanding the current situation and context to make decisions about policies and investments. While forecasting has been relied upon to justify actions, there's been a lack of ability to plan effectively for resilience against disruptions and uncertainties, despite repeated calls for new approaches. Over the past decade, challenges requiring innovative planning and decision-making have become more frequent. Rapid changes in the global environment, the abundance of data across domains and disciplines, and complex and interconnected problems all indicate the need for new approaches (Buehring et al., 2020; Robinson et al., 2021).

From an organizational capacity perspective, strategic foresight means the ability of an organization to look ahead and use that insight to shape its strategy. It helps decision-makers by discussing potential future scenarios in a structured way, considering changes, uncertainties, and complexities. (UNEP, 2023; OECD, 2020; Cuhls, 2020). Using a variety of methods and tools, strategic foresight enables organizations to both anticipate and plan for risks, opportunities and changes that may significantly influence the stewardship responsibilities of the organization towards a desirable future. Moreover, strategic foresight can help to uncover/discover underlying assumptions and biases.

It is worth emphasizing that foresight does *not* mean predicting or forecasting the future. The use of scenarios and probabilistic models of the future, for example, are useful tools to explore the range of potential trajectories, particularly those that confront the challenges of surprise, scale, diversity, and imagination (Pereira et al., 2021). However, foresight and scenarios are not synonymous and have different audiences. In general, foresight methodologies create a disciplined approach to try to understand a range of influences/stresses and events/shocks that may occur and shape our future and hence inform policy decisions in the present. Scenarios, while not a requisite part of strategic foresight, can assist foresight by broadening the span of collective thinking about different possibilities (Pereira et al., 2021; MacKay & McKiernan, 2018; Rhisiart, 2015; Bezold, 2010; Scoblic & Tetlock, 2020).

Strategic foresight acknowledges that regardless of the specific outcomes we're focused on, we're dealing with intricate, interconnected systems with multiple layers. The emergent properties of these systems can be influenced in various ways. From the point of view of the decision maker, the key purpose is to inform decision making through structured analysis and anticipation. In part, this is done by scanning the horizon and looking for clues (signals of change) which are often hidden among disconnected pieces of information. These help better understand the range of futures that might emerge and thus prompt actions that will hopefully constrain the range of emerging futures to one that is acceptable, if not desirable (Cook et al., 2014).

There are several elements to consider. First, one needs to take a very open view of the system(s) of interest – none of which operate in isolation. By definition, foresight needs recognition that no domain of interest is completely independent of others. What therefore may be assessed as an unimportant factor, event or observation at one time, may become, if circumstances change, vitally significant at some future stage. Thus, too narrow an analytical focus can be problematic. For example, COVID-19 quickly exposed multiple supply chain issues which would not necessarily have been part of either a public health or policy assessment of risk prior to the pandemic (ISC, 2022). To develop this more inclusive view requires a multi-stakeholder approach. To take another example: mental health issues in young people have risen rapidly in past decades, predominantly due to recent socio-technological change (Stubbing et al., 2023), rather than medical issues. But this conclusion, with important interventional implications, will not necessarily be promoted by those with interests within the medical system.

Therefore, it's essential to organize the key inputs for foresight in a manner that allows us to comprehend the system under examination, consider the diverse interests of stakeholders involved, and understand how it operates, might operate, or could be influenced by other complex systems. New methods are evolving such as emerging techniques of interrogation and system mapping such as cross-impact balance methodologies (Weimer-Jehle, 2023; Kurniawan et al., 2022; Schweizer, 2020) and employing AI to dissect complexity (Roponen & Salo, 2023). But in interpreting any complex model, it remains critical to identify what is known and what is not known, what is speculative and what is (within limits) plausible.

It is helpful to think in terms of two kinds of factors that can affect the future. Those which are acute (a shock) – such as a natural disaster or pandemic or an industrial accident or the outbreak of conflict or the collapse of government. And those which are chronic (a stress) and slowly emerge; for example sociological or demographic or technological change or the climate crisis. It is also important to consider where human agency matters in affecting the future, and agent-based models – computer simulations used to study the interactions between people, things, places, and time – may be of assistance. For example, two of the issues in considering how the climate crisis will evolve are how governments, populations or individuals will respond on one hand, and on the other hand, how fast or effective new technologies will be in changing current trajectories.

An illustration of why we must adopt an inclusive approach is the case of rapidly emerging technologies. Their effects cannot be isolated from considerations within various societies, such as social acceptance, responses, and how they influence behaviors at different levels, ranging from individuals to corporations to organizational culture (Sridhar & Gluckman, 2023). As such, social acceptance and its interdependence with technological innovation presents a conundrum that cannot be outsourced to experts alone – here, inclusive planning becomes crucial (Hermann, 2023). Similarly in climate change, predictions of the future must consider not only technological change but the behaviour change in governments and citizens and the idea that resilience, adaptability and societal acceptance are moving targets. Foresight has to include in its considerations these broader types of future influence and feedback.

All of this might be seen to turn foresight into nothing more than a crystal ball. But when done well it can help policy makers and communities shape the future by envisaging actions that may make the future more or less acceptable and enable preparation for issues that could be coming down the line. This therefore requires processes that are rigorous and formalized yet enable new mental models of strategic thinking.

In many cases it may make sense to proactively embed foresight techniques and principles into existing risk assessment systems. Both processes are interdependent and need to embrace uncertainty and new channels and sources of information and 'weak signals' that indicate a potential for the emergence of new risks, or the exacerbation of existing threats. But conversely, foresight shifts the lens to also consider unidentified opportunities. Where strategic planning, risk assessment systems and scientific advisory mechanisms are already well-developed, foresight may, at least in theory, be easier turned to action. But this is not always the case.

In the political and policy communities there is a danger of dismissing foresight as an intellectual game of little value, as indeed many risk assessments can be ignored (Gluckman & Bardsley, 2021); thus the key is to create mechanisms and behaviours to minimize that danger. First, foresight must be owned by those agencies and individuals that have expertise and are respected by all stakeholders including the government. Second, they need to define the domain of interest and preferably have generated the demand for analysis from the policy community. It is well established that unsolicited scientific advice is rarely acted upon. Success depends on building the demand before undertaking the work. Third, inclusive processes must be built to understand the systems of interest, the relationships, stresses and shocks that might influence the system. There is a need to weigh up under what circumstances a currently minor factor might become important. And finally, there is a need for effective communication – too often excellent work can be undermined by hubris or overwhelming the audience with jargon and technicalities. There is a skill in this interface and the mode of communication. It is important to define the actors at the interface and the product, be it report, presentation, or infographic. Only then can foresight be expected to be converted to action.

In many ways this is analogous to the principles that underpin the concepts of brokerage in scientific advice (Gluckman et al., 2021). In communicating about the future one needs to define what is known, what is unknown, the scope of futures ahead, the factors that might influence that range, and most importantly those actions that might shift the shape of the futures landscape in a way that is seen to be more desirable. That communication needs to be trusted and perceived to be impartial.

Foresight is in a sense part of a broader canvas. Indeed, risk assessment and management and foresight should be core to the stewardship role of any government in protecting a nation's human, social, environmental and economic assets. Foresight can be argued to both enhance that stewardship role but also help play a role in shaping a better future.

Sadly, the reality is many governments have been rather good at ignoring risk assessments. The reasons for doing so have been described elsewhere (Gluckman & Bardsley, 2021). Both political realities and cognitive biases contribute to that. In general, it is because risk assessment is about things the likelihood of something happening and then if it does, its consequence. To address such risks requires investment in preventing something that may not happen: preventing it does not create political advantage. But on the other hand, not preventing something that was assessed as a risk does cause political cost when it happens, but often that blame can be shifted back in time to an earlier government or entity, hence ignoring the advice.

There are warnings in this. Strategic foresight needs to emphasize not only negative influences but also the positive opportunities it creates. The policy community will gravitate towards the latter. Thus, well-presented foresight can ensure that the futures landscape is better understood and used to inform decisions.

The discussion above has largely focused on the government as the point of action. But the same principles apply at every level of decision making in society; be it central or local government, business or civil society. We cannot predict the future, but we have some ability to shape it. Whether we shape it well or badly depends on how we develop, understand and communicate to all stakeholders how that future might be negatively or positively placed. That is turning anticipatory foresight to action. ■

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Section 3: Essay 1: Foresight Visions: Embracing Community-led and Indigenous Perspectives

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Appendix 1 – literature review sample

Authors	Title	Year of Publication	Article link
Popper, R	How are foresight methods selected	2008	https://www.scopus.com/record/display.uri?eid=2-s2.0-54849439737&origin=resultslist&sort=plf-f&src=s&sid=3d6becee60ebb1b271857f9c92ff9fc51&sot=b&sdt=b&s=%28ALL%28foresight+method%29+AND+AUTHOR-NAME%28Popper%29%29&sl=50&sessionSearchId=3d6becee60ebb1b27185f9c92ff9fc51
Sutherland, W & Woodroof, H	The need for environmental horizon scanning	2009	https://www.sciencedirect.com/science/article/abs/pii/S0169534709001888
Patiño J.; Whittaker R.J.; Borges P.A.V.; Fernández-Palacios J.M.; Ah-Peng C.; Araújo M.B.; Ávila S.P.; Cardoso P.; Cornuault J.; de Boer E.J.; de Nascimento L.; Gil A.; González-Castro A.; Gruner D.S.; Heleno R.; Hortal J.; Illera J.C.; Kaiser-Bunbury C.N.; Matthews T.J.; Papadopoulou A.; Pettorelli N.; Price J.P.; Santos A.M.C.; Steinbauer M.J.; Triantis K.A.; Valente L.; Vargas P.; Weigelt P.; Emerson B.C.	A roadmap for island biology: 50 fundamental questions after 50 years of The Theory of Island Biogeography	2017	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85017403570&doi=10.1111%2fjbi.12986&partnerID=40&md5=964eeb49240171a4c9fc3fcb4e2bd3e9
Caffrey J.M.; Baars J.-R.; Barbour J.H.; Boets P.; Boon P.; Davenport K.; Dick J.T.A.; Early J.; Edsman L.; Gallagher C.; Gross J.; Heinimaa P.; Horrill C.; Hudin S.; Hulme P.E.; Hynes S.; Macisaac H.J.; McLoone P.; Millane M.; Moen T.L.; Moore N.; Newman J.; O'Conchuir R.; O'Farrell M.; O'Flynn C.; Oidtmann B.; Renals T.; Ricciardi A.; Roy H.; Shaw R.; Van Valkenburg J.L.C.H.; Weyl O.; Williams F.; Lucy F.E.	Tackling invasive alien species in Europe: The top 20 issues	2014	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84907258838&doi=10.3391%2fmbi.2014.5.1.01&partnerID=40&md5=83605d3422e7c68c72e4e7ca3db9f94f
Sutherland W.J.; Butchart S.H.M.; Connor B.; Culshaw C.; Dicks L.V.; Dinsdale J.; Doran H.; Entwistle A.C.; Fleishman E.; Gibbons D.W.; Jiang Z.; Keim B.; Roux X.L.; Lickorish F.A.; Markillie P.; Monk K.A.; Mortimer D.; Pearce-Higgins J.W.; Peck L.S.; Pretty J.; Seymour C.L.; Spalding M.D.; Tonneijck F.H.; Gleave R.A.	A 2018 Horizon Scan of Emerging Issues for Global Conservation and Biological Diversity	2015	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85036626306&doi=10.1016%2fj.tree.2017.11.006&partnerID=40&md5=487053504edfeba0d408668f6abb0a68
Roy H.E.; Bacher S.; Essl F.; Adriaens T.; Aldridge D.C.; Bishop J.D.D.; Blackburn T.M.; Branquart E.; Brodie J.; Carboneras C.; Cottier-Cook E.J.; Copp G.H.; Dean H.J.; Eilenberg J.; Gallardo B.; Garcia M.; García-Berthou E.; Genovesi P.; Hulme P.E.; Kenis M.; Kerckhof F.; Kettunen M.; Minchin D.; Nentwig W.; Nieto A.; Pergl J.; Pescott O.L.; M. Peyton J.; Preda C.; Roques A.; Rorke S.L.; Scalera R.; Schindler S.; Schönrogge K.; Sewell J.; Solarz W.; Stewart A.J.A.; Tricarico E.; Vanderhoeven S.; van der Velde G.; Vilà M.; Wood C.A.; Zenetos A.; Rabitsch W.	Developing a list of invasive alien species likely to threaten biodiversity and ecosystems in the European Union	2019	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85058302920&doi=10.1111%2fgcb.14527&partnerID=40&md5=62301e25b95d0b84e2ae89d337ce4b18
Sutherland W.J.; Bardsley S.; Clout M.; Depledge M.H.; Dicks L.V.; Fellman L.; Fleishman E.; Gibbons D.W.; Keim B.; Lickorish F.; Margerison C.; Monk K.A.; Norris K.; Peck L.S.; Prior S.V.; Scharlemann J.P.W.; Spalding M.D.; Watkinson A.R.	A horizon scan of global conservation issues for 2014	2021	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84871693579&doi=10.1016%2fj.tree.2012.10.022&partnerID=40&md5=2beab7e237b20f303ebd43e3ee5e8385
Sutherland W.J.; Barnard P.; Broad S.; Clout M.; Connor B.; Côté I.M.; Dicks L.V.; Doran H.; Entwistle A.C.; Fleishman E.; Fox M.; Gaston K.J.; Gibbons D.W.; Jiang Z.; Keim B.; Lickorish F.A.; Markillie P.; Monk K.A.; Pearce-Higgins J.W.; Peck L.S.; Pretty J.; Spalding M.D.; Tonneijck F.H.; Wintle B.C.; Ockendon N.	A 2017 Horizon Scan of Emerging Issues for Global Conservation and Biological Diversity	2021	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85006880774&doi=10.1016%2fj.tree.2016.11.005&partnerID=40&md5=46a6391ba767d8c2ce97d23b464336a3
Rudd M.A.	Scientists' perspectives on global ocean research priorities	2014	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85008958260&doi=10.3389%2ffmars.2016.00002&partnerID=40&md5=c18c4aa2741a0ec1c220fd91ca343fed
Sutherland W.J.; Barnard P.; Broad S.; Clout M.; Connor B.; Côté I.M.; Dicks L.V.; Doran H.; Entwistle A.C.; Fleishman E.; Fox M.; Gaston K.J.; Gibbons D.W.; Jiang Z.; Keim B.; Lickorish F.A.; Markillie P.; Monk K.A.; Pearce-Higgins J.W.; Peck L.S.; Pretty J.; Spalding M.D.; Tonneijck F.H.; Wintle B.C.; Ockendon N.	A horizon scan of global conservation issues for 2013	2020	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85006880774&doi=10.1016%2fj.tree.2016.11.005&partnerID=40&md5=46a6391ba767d8c2ce97d23b464336a3

Authors	Title	Year of Publication	Article link
Carayannis E.G.; Meissner D.; Edelkina A.	Targeted innovation policy and practice intelligence (TIP2E): concepts and implications for theory, policy and practice	2017	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85027975709&doi=10.1007%2fs10961-015-9433-8&partnerID=40&md5=c622a36c7731c1e3651106b97ba61f4e
Tiits M.; Kalvet T. behind a paywall	Intelligent piggybacking: A foresight policy tool for small catching-up economies	2014	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84893060029&doi=10.1504%2fIJFIP.2013.058607&partnerID=40&md5=5788c1b064c36bdf224cf5dc6d9498e1
Weigand K.; Flanagan T.; Dye K.; Jones P.	Collaborative foresight: Complementing long-horizon strategic planning	2014	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84900553090&doi=10.1016%2fj.techfore.2013.08.016&partnerID=40&md5=2db43545058a37b1b287e4db1d98b41c
Spickermann A.; Zimmermann M.; von der Gracht H.A.	Surface- and deep-level diversity in panel selection - Exploring diversity effects on response behaviour in foresight	2014	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84900547020&doi=10.1016%2fj.techfore.2013.04.009&partnerID=40&md5=586defab01d418554cd5f23c8a62d49a
Nagimov A.R.; Akhmetshin E.M.; Slanov V.P.; Shpakova R.N.; Solomonov M.P.; Il'yaschenko D.P.	Foresight technologies in the formation of a sustainable regional development strategy	2018	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85051782679&partnerID=40&md5=f330c86c6b5a6067665513e2cedd83a8
Sutherland W.J.; Broad S.; Caine J.; Clout M.; Dicks L.V.; Doran H.; Entwistle A.C.; Fleishman E.; Gibbons D.W.; Keim B.; LeAnstey B.; Lickorish F.A.; Markillie P.; Monk K.A.; Mortimer D.; Ockendon N.; Pearce-Higgins J.W.; Peck L.S.; Pretty J.; Rockström J.; Spalding M.D.; Tonneijck F.H.; Wintle B.C.; Wright K.E.	A Horizon Scan of Global Conservation Issues for 2016	2013	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84955724018&doi=10.1016%2fj.tree.2015.11.007&partnerID=40&md5=67ee0d80a7b342fe27eca68d13c9f922
Peyton J.; Martinou A.F.; Pescott O.L.; Demetriou M.; Adriaens T.; Arianoutsou M.; Bazos I.; Bean C.W.; Booy O.; Botham M.; Britton J.R.; Cervia J.L.; Charilaou P.; Chartosia N.; Dean H.J.; Delipetrou P.; Dimitriou A.C.; Dörflinger G.; Fawcett J.; Fyttis G.; Galanidis A.; Galil B.; Hadjikyriakou T.; Hadjistylli M.; Ieronymidou C.; Jimenez C.; Karachle P.; Kassinis N.; Kerametsidis G.; Kirschel A.N.G.; Kleitou P.; Kleitou D.; Manolaki P.; Michailidis N.; Mountford J.O.; Nikolaou C.; Papatheodoulou A.; Payiatas G.; Ribeiro F.; Rorke S.L.; Samuel Y.; Savvides P.; Schafer S.M.; Tarkan A.S.; Silva-Rocha I.; Top N.; Tricarico E.; Turvey K.; Tziortzis I.; Tzirkalli E.; Verreycken H.; Winfield I.J.; Zenetos A.; Roy H.E.	Horizon scanning for invasive alien species with the potential to threaten biodiversity and human health on a Mediterranean island	2019	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85064835538&doi=10.1007%2fs10530-019-01961-7&partnerID=40&md5=d598407215713031cf11672792228f9af
Bina O.; Mateus S.; Pereira L.; Caffa A.	The future imagined: Exploring fiction as a means of reflecting on today's Grand Societal Challenges and tomorrow's options	2017	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84977472830&doi=10.1016%2fj.futures.2016.05.009&partnerID=40&md5=a22174d3f97d23225b435a13ed53ca3d
Zurek M.; Hebinck A.; Leip A.; Vervoort J.; Kuiper M.; Garrone M.; Havlík P.; Heckelei T.; Hornborg S.; Ingram J.; Kuijsten A.; Shutes L.; Geleijnse J.M.; Terluin I.; van't Veer P.; Wijnands J.; Zimmermann A.; Achterbosch T.	Assessing sustainable food and nutrition security of the EU food system-an integrated approach	2018	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85056731447&doi=10.3390%2fsu10114271&partnerID=40&md5=c0296f2344904ac03ec96f5a729b1559

Authors	Title	Year of Publication	Article link
Lehoux P.; Silva H.P.; Sabio R.P.; Roncarolo F.	The unexplored contribution of Responsible Innovation in Health to Sustainable Development Goals	2018	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85055900896&doi=10.3390%2fsu10114015&partnerID=40&md5=78cd78eab6e420625a494399facdf9c4
Nesshöver C.; Vandewalle M.; Wittmer H.; Balian E.V.; Carmen E.; Geijzendorffer I.R.; Görg C.; Jongman R.; Livoreil B.; Santamaria L.; Schindler S.; Settele J.; Sousa Pinto I.; Török K.; van Dijk J.; Watt A.D.; Young J.C.; Zulka K.P.	The Network of Knowledge approach: improving the science and society dialogue on biodiversity and ecosystem services in Europe	2016	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84974822840&doi=10.1007%2fs10531-016-1127-5&partnerID=40&md5=a85b242c3598aa5731cde03503b933fa
Li N.; Chen K.; Kou M.	Technology foresight in China: Academic studies, governmental practices and policy applications	2017	https://www.scopus.com/inward/record.uri?eid=2-s2.0-84995890333&doi=10.1016%2fj.techfore.2016.08.010&partnerID=40&md5=f8d437ea6b30acd34a75f7f8db5fd967
Cuhls K.E.	Horizon Scanning in Foresight – Why Horizon Scanning is only a part of the game	2020	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85159831744&doi=10.1002%2fffo2.23&partnerID=40&md5=c813430409bd7b642fa105daaa4e2a33
Sutherland W.J.; Fleishman E.; Clout M.; Gibbons D.W.; Lickorish F.; Peck L.S.; Pretty J.; Spalding M.; Ockendon N.	Ten Years On: A Review of the First Global Conservation Horizon Scan	2019	https://www.scopus.com/inward/record.uri?eid=2-s2.0-85059305919&doi=10.1016%2fj.tree.2018.12.003&partnerID=40&md5=7de4830f89ef5b38f981786127078329
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8 **Appendix 2** – interview questions

Interview questions

Introduction

- What is your name, position and field of expertise?

Horizon scanning

- What type of horizon scanning methods have you used?
- To what extent did you adapt already established horizon scanning methodologies?
- In your experience, what are the strengths of the horizon scanning methodology?
- In your experience, what are the challenges in horizon scanning?
- What lessons have you learned from implementing the horizon scanning approach?
- To what extent has horizon-scanning informed decision-making?

Foresight

- In what ways have you applied foresight methods?
  - What were the main outcomes?
  - What challenges did you experience?
  - What lessons have you learned from the foresight process?
- What was your motivation for using foresight methods or tools?
- What's the strength of foresight as a strategic approach?
- What are the limitations of the foresight process?
- To what extent has foresight informed decision-making?

General questions

- Have you translated a method used in one field (e.g. health) to another (e.g. environment)?
  - If so, can you describe the key outcomes?
  - What challenges did you face?
- How have the findings or your horizon scanning/foresight approach been applied and/or published?
- Have you worked or applied this work in the Global South?
- Did your approach encompass the Global South?
- Have you used digital technologies such as artificial intelligence for horizon scanning or foresight activities?
- Do you wish to add anything else?
- Can you suggest other experts we should talk to?

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