ANNUAL REVIEWS

Annual Review of Environment and Resources

Exploring Alternative Futures in the Anthropocene

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Annu. Rev. Environ. Resour. 2023. 48:25–54

First published as a Review in Advance on September 14, 2023

The *Annual Review of Environment and Resources* is online at environ.annualreviews.org

https://doi.org/10.1146/annurev-environ-112321-095011

Keywords

futures, imagination, scenarios, transformation, anticipation, cognition, future visions

Abstract

Many challenges posed by the current Anthropocene epoch require fundamental transformations to humanity's relationships with the rest of the planet. Achieving such transformations requires that humanity improve its understanding of the current situation and enhance its ability to imagine pathways toward alternative, preferable futures. We review advances in addressing these challenges that employ systematic and structured thinking about multiple possible futures (futures-thinking). Over seven decades, especially the past two, approaches to futures-thinking have helped people from diverse backgrounds reach a common understanding of important issues, underlying causes, and pathways toward optimistic futures. A recent focus has been the stimulation of imagination to produce new options. The roles of futures-thinking in breaking unhelpful social addictions and in conflict resolution are key emerging topics. We summarize cognitive, cultural, and institutional constraints on the societal uptake of futures-thinking, concluding that none are insurmountable once understood.

Contents

1. INTRODUCTION

The term Anthropocene acknowledges that Planet Earth has, for at least 70 years, been experiencing accelerating change in planetary processes, driven primarily by humans rather than geological forces (1, 2). Many manifestations of these changes pose major, even existential, threats to large parts of humanity and other life on Earth (1, 3). It is increasingly apparent that incremental changes within the structures and functions that define current relationships between people and the environments they inhabit (hereafter referred to as social-ecological systems) are not sufficient to address the most severe effects of the Anthropocene, and that fundamental transformations are required at scales from local to global (4–8).

Conceptualization of and requirements for transformations have received considerable attention (5, 7, 9). In this review, we focus on two critical requirements for transformative change that are argued to be poorly developed across humanity and hence are key areas of vulnerability in the Anthropocene. One of these vulnerabilities is limited cognitive and/or institutional capabilities for understanding and acknowledging humanity's current predicament (i.e., the relationship between people and the planet). The other vulnerability is poorly developed capabilities to imagine new futures—ones involving possibilities not encountered before—and the possible pathways toward achieving them (6, 10, 11).

Achieving the understanding and imagination needed to drive societal-scale decision-making is a so-called wicked problem because of the complexity of the issues and the diversity of their conceptualizations; uncertainty about possible outcomes of decisions; and the difficulty of getting people together, at appropriate scales, to achieve a shared understanding (6, 12). During the acceleration phase of the Anthropocene, scholars and practitioners from a range of disciplines have been progressively developing, applying, and refining approaches to help people explore their beliefs and assumptions related to the above issues, along with their implications for producing different possible futures (e.g., 13–16).

The range of disciplinary and other knowledges engaged in these sorts of activities has grown dramatically over the past two decades. This growth has not only added richness to thinking about alternative futures (hereafter called futures-thinking, which we define in Section 3.2) but also introduced philosophical, terminological, and methodological plurality that can be confusing when first encountered. In this review, we extract key ideas and conclusions from a large, diverse, and growing range of literature. We note recent promising developments and offer suggestions for building on them while also addressing aspects of potential confusion. Our objectives are to help newcomers to futures-thinking make sense of what has been happening in scholarship and practice and to encourage existing participants to reflect on past and recent developments (although we cannot possibly hope to have covered all important work on and around this topic).

After outlining our process, we clarify terminology that can derail dialogue about futures-thinking if not addressed. We then consider recent thinking about cultural, cognitive, and institutional constraints that have influenced how futures-thinking approaches have evolved, so as to help readers appreciate the significance of recent developments. Next, we update previous reviews to consider how approaches to futures-thinking have been influenced by the coemergence of the Anthropocene. We then focus on a series of interlinked developments over the past two decades, related to the issues of understanding and imagination mentioned above, that, we argue, are making the hope of societal engagement in futures-thinking more achievable. In the final two sections, we consider high-level insights into the nature of pathways toward desirable and sustainable futures and then reflect on what can be generalized about the range of possible alternative futures and the role of futures-thinking in helping humanity build capacity to identify desirable and undesirable futures and shape pathways toward the former.

Anthropocene: used in this article as a shorthand to refer to the period since the 1950s, which has seen exponential increases in human impacts on global ecological systems, with implications for the nature and quality of life, across all societies

Futures-thinking: diverse scholarship and practice, drawing on multiple disciplines across the sciences, arts, and humanities, that explore the nature of change, how humans conceive of futures, the range of possible (not just probable) futures, and how alternative futures might emerge

The literature that potentially relates to our objectives is vast, growing, and in massive flux. There is a core literature that draws on the social sciences, the humanities, and other disciplines to produce approaches and methods for engaging people in thinking about futures. These approaches and methods are broadly what we refer to here as futures-thinking. Beyond this core, scholars, especially in the social sciences, have been thinking and writing for many years about the nature of the future, how people perceive it, and the social and cognitive processes by which people form their perceptions and visions of futures. Some aspects of these two bodies of thought and literature have increasingly been converging, with a stronger flow from social sciences into futures-thinking than in the reverse direction. It is impossible to do justice to all of this literature. We attempt here to distill some of the key issues, focusing on recent efforts to bring all of them together to help societies address the challenges of the Anthropocene.

2. OUR PROCESS

We have adopted a best and richest sources approach (17), starting with a broad literature search, augmented with advice about key references and authors from our diverse group of expert coauthors. Initially, we searched titles for "future(s)," "scenarios," and "foresight," alone and in all combinations, as well as combinations of those words with "Anthropocene." Searches for "Anthropocene" as a keyword led to other relevant articles. We used the databases accessed by ReadCube Papers software, supplemented with SCOPUS for journals not covered by ReadCube (e.g., *Journal of Futures Studies*). The publications thus identified were sources of other key publications, which were assessed manually by the lead author.

The coauthors have had different interactions with this literature. Our coauthor team is drawn from universities and research agencies across five continents (Europe, Africa, Asia, Australia, and North America), with many years of relevant research and practice as well as peer recognition as experts in the diverse fields associated with futures-thinking. Many have worked at the interface between colonizers and colonized people and have deep awareness of how issues of power inequities, economic and cultural hegemonies, history, context, and traditions affect futures-thinking. Nevertheless, our positionality and lenses reflect our privileged roles and voices. We look forward to critique and input from scholars and practitioners, including those with interpretations different from ours.

3. TERMINOLOGY

In the futures-thinking literature, terminology is often used without explanation, as if all readers understand meanings or use terms and jargon in the same way. This can seriously impede engagement in futures-thinking (see also Section 4.3). Therefore, we explain our use of key terms in this section and briefly summarize alternative uses.

3.1. Anthropocene

The term Anthropocene is increasingly used to indicate a period in Earth's geological history in which human activities are the strongest force affecting planetary processes. The origins and assumptions behind this term have been reviewed elsewhere (18) and critiqued often (e.g., 2, 19, 20). Various alternative names have been proposed, each involving underlying assumptions and beliefs about the nature of the challenges and the potential solutions (2, 18, 20). These different terms give rise to debate about when this period began, including 1,000 years ago, when the transition from the Holocene to the Anthropocene might have begun, or the sixteenth or nineteenth century, or the 1950s. We use the term Anthropocene as a common-usage shorthand to refer to the period since the 1950s, often called the Great Acceleration (21), which has seen

an exponential increase in impacts of humans on global ecological systems with consequences for the nature and quality of human lives and lifestyles, across all societies. This period, we argue, has not only created an urgent need for society-wide futures-thinking but also stimulated efforts toward meeting that need. We recognize that using any term and focusing on any period can influence how people think about how pasts, presents, and futures are interrelated. Throughout this review, we emphasize the importance of critically examining all assumptions brought into futures-thinking (e.g., Sections 4.2, 4.3, 5.1, 7.4, and 8).

3.2. Futures-Thinking

Futures-thinking draws on many disciplines and theories, creating "definition confusion, dismal theory, and methodological chaos" (22, p. 3). Limited awareness of this pluralistic history has resulted in "frequent fruitless reinvention" (23, p. 177). There is an extensive philosophical literature on how humans conceive of the future. We use the plural, futures, to indicate that we are focusing on literature that explores multiple possible futures rather than trying to predict the most likely one.

Many terms are used to describe thinking about futures, including futures-thinking, futures-studies, futures-research, foresight, and strategic foresight, as well as *la prospective* and *futuribles* in French. These terms are contested, have different connotations, and have been associated with different methodological or philosophical traditions (13, 14, 16, 23–25). For example, strategic foresight is often used as a general term for futures-thinking, but it has also been associated specifically with business applications that seek to optimize future strategy within existing business models rather than "developing creative, novel and inclusive solutions" (23, p. 180; 26). In this review, we use the term futures-thinking broadly to include thinking and practice that enable people to understand how the present might sit in relation to the past and possible futures, broaden their imagination about possible futures, foster a shared understanding of desirable or preferable futures, and explore pathways toward those and other futures (see also Section 5.3 for a commentary on approaches and methods).

"Alternative futures" has been used explicitly to denote futures based on "historical archetypes" (13, 27). We adopt the more general usage of this term, however, to mean multiple futures—of any sort—that might unfold under alternative sets of circumstances (28). Our use of the term in this way emphasizes respect for, and exploration of, multiple ideas, values, and worldviews, especially those that to date have been underconsidered in futures-thinking globally because of cultural biases, constrained imagination, or other factors limiting the breadth and depth of societal futures-thinking (Section 4).

Other adjectives used with the word futures include possible, plausible, probable, and preferable (29, 30). We illustrate the differences between these types of futures in **Figure 1**, using the concept of the Futures Cone, noting Voros's (30) inclusion of "preposterous" to denote futures that people might imagine but reject as ridiculous. The Futures Cone concept originated with Sangchai (31), was refined by Hancock & Bezold (32), and was then used more widely by Voros (30). Here, we use "possible futures" to mean all futures that are imaginable—even ones depending on knowledge not currently available—and "plausible futures" to mean a subset based on existing knowledge (29). We discuss preferable futures in more detail in Section 7.2.

"Scenario" is used inconsistently and often without definition, not only in futures-thinking (22) but also in many other areas of scholarship and practice and in everyday conversation. By scenarios, we mean narratives constructed to explore alternative futures and to test or develop the logic behind the futures-thinking involved. Inputs to scenarios vary widely (e.g., models, creative works), as do processes (e.g., expert-driven, participatory) and objectives (e.g., optimizing and

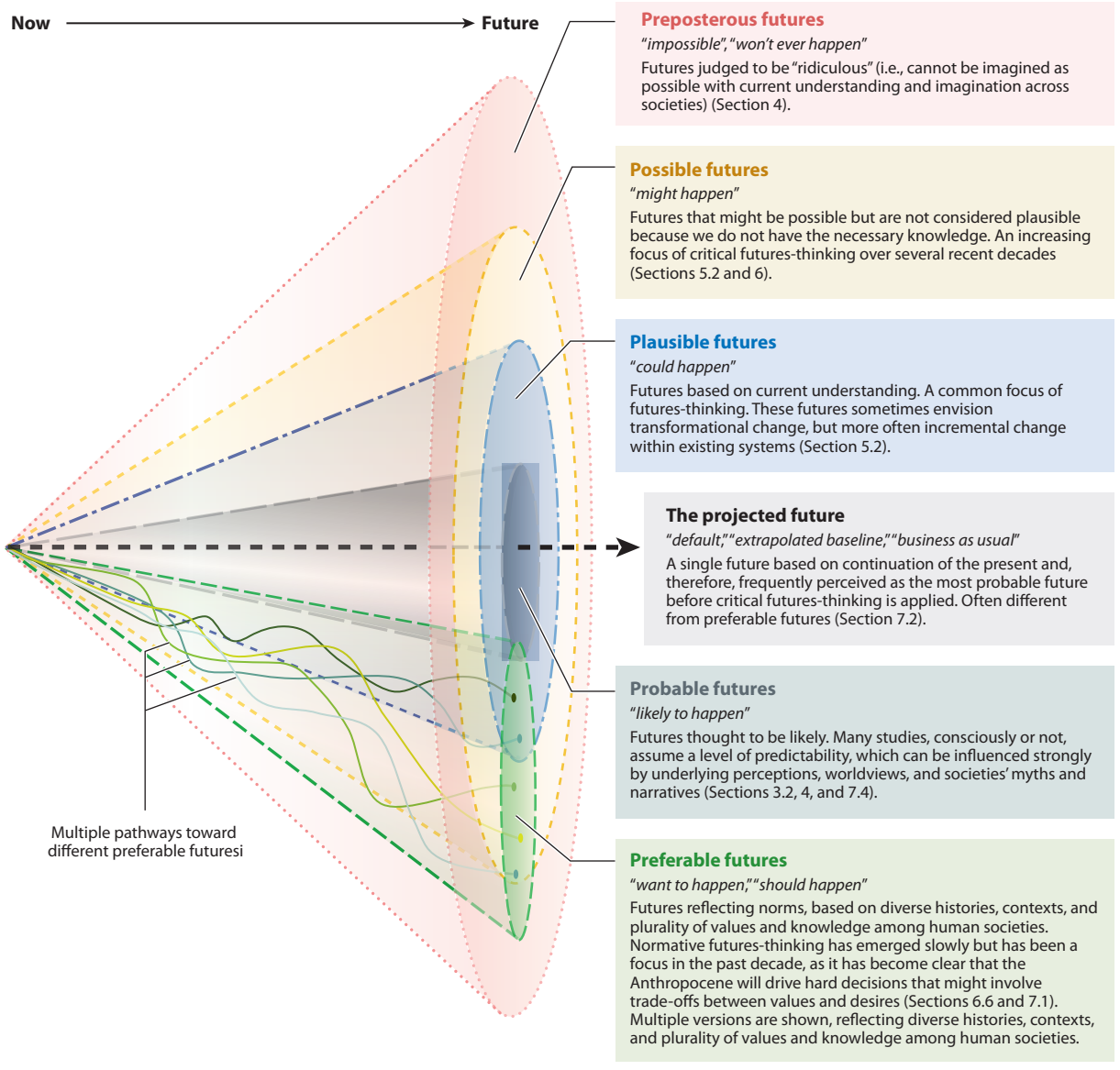

Figure 1

Interpretation of Voros's (30) Futures Cone in relation to the types of futures-thinking explored in this review. The cone illustrates how, as time passes, the range of potentially imaginable alternative futures increases. Recent futures-thinking research and practice conclude that more of this potentially imaginable space must be accessed if humanity is to address challenges and opportunities posed by the Anthropocene. The outer limits of the cone represent the limits of the possible, indicated by a dashed line to suggest porosity, as the limits are impossible to define precisely and may change over time. The wavy solid lines within Preferable Futures acknowledge that there can be many desirable futures and pathways toward them. Figure adapted with permission from Joe Voros.

enhancing current power structures, challenging the status quo, fostering novel futures) (22, 23). We note also that the word "narrative" has many and diverse interpretations in the literature of the humanities, and some futures-thinking has been criticized for not embracing that literature sufficiently (33).

"Critical" has been used to describe theory and methods in futures-thinking over recent decades. Drawing on poststructural thought and critical social theory (26, 28), critical futures-thinking questions power and other relationships and delves deeply into perceptions, worldviews, myths, and other factors underpinning human consciousness and how people think about the present and the future (14, 28, 34). It also acknowledges the need to consider viewpoints of multiple cultures and questions the colonizing and dominance of Western/modern futures-thinking to date (see Section 4.1). The literature refers in various ways to Western biases in futures-thinking (e.g., 16). These biases exist partly because most research and practice have been carried out by futures-thinkers whose origins and/or training is in Europe or in countries whose histories are strongly connected to Europe. More broadly, the word Western has been used as a synonym for modernistic or modern science: thinking typically generated in universities, research institutions, and private firms following paradigms and methods typically associated with the scientific method consolidated in post-Renaissance Europe on the basis of wider and more ancient roots (35). It is typically transmitted through scientific journals and scholarly books. Modern science differs from, but is not necessarily exclusive of, other knowledge systems, including Indigenous and local knowledge (35).

Thinking about the full complexities of systems involving humans interacting with their own human-made environments as well as the rest of the natural world is an important part of understanding the present and imagining what might be possible in alternative futures. We use "social-ecological systems" to mean this full suite of interactions, and we use "systems-thinking" to mean, generally, thinking about such systems without inferring any other connotations that systems-thinking or systems analysis might have.

4. CHALLENGES AND CONSTRAINTS

In this section, we summarize literature on factors that can affect how and why people think about, understand, and imagine futures, so that readers can appreciate what has driven the development of approaches and tools for futures-thinking (Section 5.3). We build on numerous recent reviews (e.g., 10, 23, 36–38).

4.1. Cultural Biases

The vast majority of futures-thinking studies have been located in Western countries and therefore reflect Western/modern interpretations of modes of inquiry, time and space, gender roles, technology, and social and institutional organization (15, 16, 23, 26, 39, 40). There are indications that this imbalance is starting to be addressed through broader geographic and cultural foci (6, 41–43; N. Terry, A. Castro, B. Chibwe, G. Karuri-Sebina, C. Savu & L. Pereira, manuscript submitted), including Indigenous perspectives (44–48), deeper thinking about cultural issues such as feminism (40, 49) and gender (50), consideration of radical alternative economies (51–54) and lifestyles (55), and broader inclusion of anthropological perspectives on how different cultures approach futures-thinking (56, 57).

4.2. Cognitive Processes

Humans avoid information overload by metaphorically filtering information through behavioral and cognitive interpretations of how the world works (58). Such filtering can lead to cognitive biases or thinking fallacies, such as underestimating slowly emerging threats, overconfidence in the ability to predict and control the future, and seeking single-cause explanations for complex issues (36, 59, 60); the so-called tragedy of the horizon (e.g., political inertia and short-termism; 61); "black swan" thinking (overlooking possible futures because there is no past equivalent; 60); and

excluded futures (the tendency of decision makers to focus on futures that unfold gradually from current patterns and trends; 62). Mental filters are constructed from beliefs, experiences, culture, education, other aspects of lived experience, and individual psychological development (38). Many approaches to futures-thinking systematically explore assumptions inherent in cognitive biases and delve deeper into societies' narratives and myths (14, 24, 28, 34, 38, 63, 64).

Recent syntheses of literature on human memory reveal close links between the parts of the brain that generate images of possible futures and the areas that store memories of past events (65). These links might limit a person's ability to imagine more novel futures, but there is also evidence that stimulation of conceptual thinking can bring other parts of the brain into play and generate more radical ideas and images (65, 66). While people differ in their degrees of ability and/or willingness to engage in futures-thinking (38), it appears that stimulating the imagination with images, experiences, and ideas about novel futures can broaden thinking about possible futures (10, 66).

4.3. Societal Futures-Thinking Capability

Achieving societies that are collectively aware of their present situation and can think helpfully about future trajectories and their implications requires not only that individuals and groups have the psychological capabilities for futures-thinking but also that institutional arrangements allow futures-thinking to be coupled with decision-making processes. In this subsection, we consider recent thinking about the challenges of building futures-thinking capability at multiple scales. In Section 7.4, we consider possible future responses to these challenges.

Capability for futures-thinking at societal scales is suggested to be low in many (perhaps most) parts of the world (37, 67), although evaluation methods are nascent (68, 69). Significant recent research in psychology, sociology, anthropology, and other disciplines has overlapped and merged with futures-thinking to conceptualize, explore, and review elements of individuals' and societies' capabilities and processes for engaging with futures. This literature is at a stage of complexity and opacity that makes it very hard for us to summarize and, potentially, for those entering the practice of futures-thinking to comprehend. For example, Ahvenharju et al. (69) reviewed the interrelationships between three concepts used frequently in the literature. They describe futures-literacy (37, 70) as "a normative concept that is intended to improve anticipative capacities of organisations and societies" (69, p. 5), while futures-consciousness encompasses a wider range of psychological processes beyond cognition, including future-orientation (see also 71), anticipation (see also 70), prospection (see also 72), and projectivity. Social foresight is a broader term that includes all of the above and supporting institutional arrangements (29, 67). Embedded within these concepts are topics such as future-related cognitive skills, personality dimensions, thinking styles, analytical approaches (69), metaphors, and mechanisms for dialogue to produce outcomes such as scenarios, forecasts, trends, and road maps (71).

The hidden and unhidden assumptions brought to futures-thinking can affect the implications, actions, and outcomes of futures-thinking and can also challenge futures-literacy, especially when unknowingly intertwined (37, 73, 74). Muiderman et al. (73) identified multiple assumptions underpinning approaches to anticipatory governance in literature across diverse disciplines. For example, some approaches appear to assume that the probability of future risks and opportunities can be identified and managed, leading to formal planning and strategy development around probable futures. Other approaches assume that the future is unknowable and that futures-thinking must explore multiple uncertainties, leading to actions that build broad-based preparedness for multiple possibilities and mobilize diverse actors. A related set of assumptions involve the political implications of futures-thinking, including how it privileges particular ways

of thinking and influences what futures are created. Several scholars have concluded that it is important to adopt hybrid approaches that consider multiple assumptions and approaches, and that this is done knowingly (37, 70, 74).

Mills's (75) "global bystander effect"—whereby humanity stands by while the planet declines—is an example of what Slaughter (14) argues has been denialism and abnegation of social responsibility for the emerging Anthropocene throughout the past few decades. This neglect of futures-thinking at societal scales possibly reflects historically entrenched social processes that see futures-thinking as the domain of specialists—such as gods, priests, shamans, and/or political, economic, and cultural elites (15)—and do not expect, or equip, citizens to take an active role in thinking about and acting on societies' emerging futures. Slaughter (67) proposed that building social foresight requires progressive promotion of concepts of futures-thinking and then mainstreaming of methodologies and tools to move societies from unreflective futures-thinking by individuals to long-term, reflective, critical thinking as a social norm. He argued that achieving these goals requires addressing the often untenable assumptions and discourses that hold societies in past and present trajectories.

Ison et al. (76) observed that hierarchical traditions, structures, and cultures of command-and-control management tend to lock public-sector agencies into technical/rational thinking that discourages novel collaborations and ways of exploring future possibilities. Bazerman (59) gave examples of institutional barriers in climate change policy, including government departments working as silos; diffuse responsibility across governments for addressing multifaceted challenges; dysfunctional incentives (including perverse rewards for actions that make the situation worse, and lack of rewards for avoiding disasters); political influence by vested interests; fake or incorrect information via mainstream and other media; and, in general, lack of coordination between recognizing emerging challenges, prioritizing action, and mobilizing necessary resources.

The literature reviewed here illustrates how building futures-thinking capability at societal scales faces numerous challenges. However, it also illustrates a positive development of the past two decades: increasing recognition that human motivations and consciousness (of self and others) alongside institutional context should all be considered both as drivers of change and as components of futures-thinking processes. In Section 7, we consider possible ways to address these challenges.

5. COEMERGENCE OF FUTURES-THINKING WITH THE ANTHROPOCENE

In this section, we first review literature on the nature of the Anthropocene and its challenges for futures-thinking. We then revisit and update past reviews of the emergence of systematic and structured futures-thinking since the 1950s. We finish the section by summarizing key aspects of frameworks and tools for futures-thinking to put Section 6, on recent developments, into context.

5.1. The Anthropocene and Its Challenges

Anthropocene risks have physical, ecological, and social dimensions (e.g., climate change, biodiversity loss, social inequality and injustice). They arise from cross-scale interactions within interconnected social-ecological systems, at multiple spatial (local to global) and temporal (years to millennia) scales, and often feature discontinuous (tipping-point) change (77). If futures-thinkers are to work with societies to improve understanding and imagination (i.e., the vulnerabilities identified in Section 1), they must help people come to grips with these interactions across multiple scales; uncover and reflect on thinking biases; stimulate conceptual thinking (see Section 4.2); and

include wider ranges of societal sectors, cultures, and ways of knowing than has been done in the past (77–82).

Major changes in thinking are needed to address Anthropocene risks. Slaughter (79, p. 120), for example, called for

> becoming more aware of current contradictions; embracing insights into the state of the global system; acknowledging, valuing and applying signals of change; cultivating scepticism about the assumed importance of science and technology; exploring the potential of human, cultural and institutional innovation; and designing and implementing a range of high-quality responses—especially in education.

Ahlqvist & Rhisiart (26) identified potential barriers to critical futures-thinking, including adherence to fixed ideas about political goals and actions, the nature of truth, and the geopolitical organization of the world. Jasanoff (83, p. 851) argued that disciplines should soften their boundaries and become "more attuned to the purposes than the results of inquiry." She suggested that the challenges of the great acceleration call for a shift in the questions that societies should ask, away from "What do we know, how do we know it, and is it right?" and toward "What do we not know, why do we not know it, and is it right not to ask?" Youssef Nassef, director of adaptation works within the United Nations Framework Convention on Climate Change (UNFCCC), when asked in 2022 why adaptation matters, commented: "[W]hile we used to ask 'adaptation to what?', we now should ask 'adaptation towards what?'" (84). This response indicates an important shift away from a passive approach of adapting to stresses and shocks and toward actively seeking a desired future state.

The potential roles of power distributions, inequity, and inequality in shaping futures are addressed often in the political science literature, raising questions such as: How might international governance change (including possibilities for humanity acting in unison as a collective organism)? How might belief and faith systems diverge or converge? How might awareness and experience of the Anthropocene change people's responses to it? How might physical and social planetary boundaries be assessed and acted on? Who decides what happens and how? Whose knowledge counts? Who benefits from the problem or the solutions? How might injustices—to both human and nonhuman life-forms—be addressed, and by whom? How might diverse values be accommodated in notions of desired futures? How might all of the above change as resources become scarcer and competition for them increases (26, 77, 78, 80, 85, 86)?

There have been calls for more humility in putting humanity's currently powerful planetary influence into perspective in the long term (83). This perspective is reflected in calls for more consideration of deep, big, and macro history; searching for patterns and drivers of social change stretching back to the origins of humans (87) and even further, to the beginning of the cosmos (88); and drawing on macro-historical thinking from across many cultures often omitted from Western/modern futures-thinking (89).

5.2. Coemergence

The origins and evolution of futures-thinking have been reviewed, interpreted, and reinterpreted almost constantly over several decades, each with different emphases (e.g., 13–16, 26, 90). Here, we observe parallels between the emergence of post-1950s futures-thinking and the Great Acceleration phase of the Anthropocene up to the mid-2010s. We do so to provide context for the review of key developments in the past two decades in Section 6. In short, this coemergence has been regarded as an interplay between two traditions—a utilitarian one that has focused mostly on optimizing futures within existing business and other governance systems, and a critical one that has sought to generate ideas and possibilities for new futures, especially ones

featuring higher levels of equity and human well-being and more sustainable relationships with the planet (26). Attention has focused overwhelmingly on Western countries and traditions, which some have considered a type of colonization by, and of, futures-thinking, although encouraging countertrends have occurred elsewhere, especially recently (e.g., 16; see Section 6.5).

Typically, reviews consider structured and systematic approaches to futures-thinking to have emerged in the 1940–1950s. Before that, there was an increasing focus on progress through science, technology, and rationalization starting in the 1700s, flowing through traditions such as utopian thinking, science fiction, and systems analysis. Operations and strategic research were refined during World War II and were subsequently adopted by business strategists (13, 15, 16, 24). After World War II, emphasis on rebuilding and creating nations and economies drove a strong focus on technological forecasting and institutionalization of futures-thinking, continuing through the 1940s–1960s, especially in the United States and some of Europe (14–16). As uncertainties around social, technological, economic, and environmental futures grew, the concept of considering multiple, possible alternative futures (rather than forecasting the most likely ones) emerged. Serious inclusion of natural environments in futures-thinking did not feature strongly, at least in Western/modern thought, until the 2000s and 2010s (91).

Normative futures-thinking (a focus on seeking particular futures), which is now a strong focus (Section 6), emerged during the 1950s–1970s in the United States and some of Europe. At that time, however, normative futures-thinking mainly considered futures preferred by businesses and governments. A parallel approach, exploring desirable futures for public organizations and civil society, emerged around the same time in France (13), but it had a lower profile in the literature until its intent remerged in the 1990s (92, 93).

During the 1960s–1980s, when economic interests competed with environmental issues for corporate, government, and public attention, futures-thinking developed two different but sometimes overlapping foci—one corporate and one environmental. Scenario planning became deeply embedded in corporate planning, with a focus on optimizing business performance (14, 16). Often there was minimal consideration of businesses' broader social and environment roles or impacts, as the often-cited example of Royal Dutch Shell illustrates (94). In parallel, modeling of broader social-ecological systems, exemplified by the Club of Rome's influential 1972 report (95), raised concerns about humanity's negative effects on the rest of the planet. These concerns later gave rise to national and international policies, lobby groups, and political movements around environmental sustainability (14–16). Warnings about the escalating Anthropocene were not publicly embraced by businesses and governments at the time (13) but are considered to have strongly influenced futures-thinking of the late 1900s, the 2000s, and the 2010s (96).

From the 1980s through the 2000s, corporate foresight continued to dominate futures-thinking in Europe, the United States, Australia, and other developed countries (16, 97), although researchers were beginning to focus on the nature of the human psyche and consciousness and on the interconnections between humans and ecological systems (14, 33, 93, 98–100). A review by Fergnani (97) revealed a 40-fold increase in the number of futures publications between 1990 and 2017. Almost half of these were classified as corporate foresight, another substantial proportion reflected on aspects of the discipline, and relatively small proportions directly addressed significant challenges for humanity or environmental futures.

5.3. Approaches and Tools

Philosophies, theories, frameworks, approaches, and tools to support futures-thinking have been drawn from disciplines in the corporate arena; sciences, arts, and humanities; and other areas of creative thinking (e.g., design and media), leading to the often-repeated perception of

methodological confusion. The literature has been reviewed frequently and recently (13, 22, 101–104). There have been attempts to develop overarching theories for futures-thinking, including critical futures (28, 34), Integral Theory (14), and Anticipatory Systems Theory (70), but no single theory is likely to meet all needs and circumstances. Here, we provide a broad summary to give context for the rest of this review.

Most approaches to futures-thinking include similar elements but with different names and descriptions, in different combinations, and using different tools, depending on expertise, experience and preferences of the facilitators and the participants (105–107). These elements include interviews, literature reviews, and other methods for clarifying the focal issues; collection and analysis of relevant information about how society and other aspects of the world interact to affect the focal issues (this information can include analysis of past and emerging trends, possible new trends and/or combinations of trends not previously seen, and people's different viewpoints, beliefs, and interpretations of facts, which can themselves drive actions); a prospection (looking forward in time) element that might include visioning, scenarios, or other ways of exploring and depicting multiple futures (see also **Figure 1**); an output element, including reports, presentations, or other forms of communication; and a strategy element, including formulation of steps and actions over multiple time horizons. As discussed in Section 5.2, the relative emphasis on these elements (e.g., expanding understanding and awareness versus developing strategies to achieve particular objectives) varies widely between projects. An increasing variety of approaches and tools are used to stimulate the imagination so that futures not previously considered become apparent. Such approaches include the use of stories, including science fiction, art, music, film, and games (6, 108–113; see **https://survivethecentury.net**), as well as deep reflection on worldviews, beliefs, and myths that underpin people's futures-thinking (14, 34, 63, 64), increasingly including Indigenous peoples' perspectives (43, 47, 114, 115; N. Terry, A. Castro, B. Chibwe, G. Karuri-Sebina, C. Savu & L. Pereira, manuscript submitted).

Numerous typologies have been suggested. These classify approaches around purpose (e.g., visionary, exploratory, normative/target-seeking, policy screening, retrospective policy evaluation), direction (projecting forward from current trends or "backcasting" from an envisioned future to the present), type of reasoning (deductive versus inductive), depth of thinking about human worldviews and consciousness (e.g., political, critical, integral), reliance on evidence versus imagination, being informed by quantitative versus qualitative data, and participation (broad stakeholder participation versus expert judgment) (13, 24, 28, 81, 101, 102, 116).

The relative merits of different approaches and methods have been contested (e.g., 13), but most of the studies we review in the following sections use combinations of approaches that maximize benefits while minimizing potential problems. The current situation has been compared metaphorically with an Asian food market, in which different theories and methods have their stalls and consumers can choose what they require to meet their different tastes and needs (S. Inayatullah, personal communication, 2022). This profusion of choice comes with two warnings. First, the growing ease of rapidly collecting and synthesizing empirical data in the digital age could favor thinking within existing paradigms and systems, rather than allowing time to imagine radical, transformed futures, for which few data exist. Second, method selection is not value free; therefore, examination of potential methodological biases should be a key part of reflexivity in futures-thinking (26).

6. RECENT DEVELOPMENTS

In the past two decades, impacts of the Anthropocene have intensified and awareness has increased across many societies. Doubts have been raised about whether current social-ecological

systems can recognize and meet the challenges fast enough. This has focused more attention on the questions that critical futures-thinking explores (Section 5.1).

In 2015, Schultz (15, p. 328) reflected, "We are at the early stages of a fifth wave." She envisaged this fifth wave as a shift away from technocratic and deterministic approaches and toward "understanding of the hidden social and cultural determinants of our futures"; adaptive systems modeling and wider and deeper engagement with people via digital platforms, including games; and a shift in geographic focus away from Europe and the United States and toward the Pacific Basin and Asia (a reflection on Schultz's links with the University of Hawaii's Research Center for Futures Studies). Previously, Wheelwright (117, p. 108) had also used the wave analogy, suggesting that futures-thinking was experiencing a sixth wave (i.e., the early stages of a profession) and was moving into a seventh: "bringing knowledge and understanding of futures concepts, tools and methods to individuals, the general public" (consistent with Slaughter's recommended progression to "social foresight"; see Section 4.3).

In this section, we focus on some key developments that motivated Schultz's and Wheelwright's forecasts and on significant developments since. One development that we do not review in detail here is the proliferation of new databases and online hubs to support futures-thinking (e.g., 118, 119; see **http://www.biospherefutures.net**, **https://sustainability-innovation.asu.edu**). These complement existing databases that emerged in the late 1990s and early 2000s (e.g., 14, 67, 120).

6.1. Diversification of Disciplinary Engagement

As mentioned above, there has been a considerable increase, especially in the past decade, in engagement in futures-thinking by disciplines or elements thereof that were not previously considered mainstream in futures-thinking, including law, anthropology, sociology, philosophy, metaphysics, history, design, media studies, psychology, and others (55, 56, 82, 121–124; see **https://www.nearfuturelaboratory.com**). Economic factors have long been considered change drivers in futures-thinking, but often within existing neoclassical paradigms. Fresh perspectives on economic systems and interrelationships with social and biophysical planetary boundaries are features of the past decade (e.g., 51–54, 125).

6.2. New Methodological Syntheses

In addition to numerous previous reviews (see Section 5.3), several broad-scale collaborative syntheses of approaches and methods for futures-thinking have been performed to simplify their complexity for broader academic and nonacademic audiences. These syntheses explicitly link approaches to steps in policy and decision processes and connect diverse knowledge systems (e.g., 24, 80, 81, 101, 126, 127). Especially notable is a major report on scenarios and models (81) for the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), which is intended for a diverse audience specifically engaged in addressing Anthropocene challenges, including climate change and declines in biodiversity and ecosystem functions.

6.3. Global Bodies

Adding to the growth of professional bodies catering for futures-thinking researchers and practitioners (128), several major international bodies have, in the past two decades, focused on global futures with the escalating Anthropocene in mind (for a review, see 129). Since the early 2000s, futures-thinkers associated with the Intergovernmental Panel on Climate Change and the UNFCCC have developed and updated scenarios that explored how social and economic settings might affect and be affected by different trajectories of greenhouse gas emissions (100, 130–133). The Millennium Ecosystem Assessment coupled detailed analyses of past trends and policy

lessons with a scenario-building process to generate a set of scenarios for global futures to 2050 and 2100, which were also used to stimulate futures-thinking at subregional scales (33, 134–136). The IPBES was established to correct past inattention to relationships between people and ecosystems (91) and has given impetus to futures-thinking via its methodological assessment on scenarios and models (Section 6.2) and the Nature Futures Framework (NFF) (Section 6.6). The United Nations Environment Programme's Global Environmental Outlooks (GEOs) have also had a strong futures orientation, including how to bend the curve toward sustainability (GEO-5) and linking bottom-up thinking with integrated assessment model outputs (GEO-6) (137).

6.4. A Focus on Transformation

It is widely recognized that the Anthropocene is pushing many aspects of social-ecological systems to their limits, potentially triggering irreversible changes (or tipping points) once they reach certain thresholds (1, 7, 8, 138). Research on ways to keep social-ecological systems away from these thresholds, or manage transitions through them, has focused mainly on system characteristics that result in adaptability, resilience, and transformability (see **https://www.resalliance.org/key-concepts**). Discontinuous (i.e., tipping point or threshold) change has been a challenge for systems modelers and futures-thinkers for many decades because, although such change is known to occur, it is difficult to imagine and challenging to model mathematically (139). The coining of the term Anthropocene is itself a transformation in thinking about humanity's relationship with the planet (14, 51, 83, 140, 141). The literature reviewed in the following subsections illustrates how futures-thinking, especially in the past decade, has focused on transformation in several ways, including research needs (e.g., 5, 86, 142), creating opportunities for radical futures-thinking across societies (e.g., 143; see Section 6.5), exploring social and other mechanisms for transformations (e.g., 5, 11, 74, 144, 145; see Section 7.4), and considering possible pathways by which transformations might unfold (see Section 7).

6.5. Participatory Futures-Thinking

The past two decades have seen a large number of futures-thinking projects engaging wider ranges of people across more diverse societies and geographic scales, including urban to national, than has been common in the past (e.g., 4, 6, 12, 31, 48, 114, 115, 145–153). These projects have been motivated by perceptions that mainstream planning and knowledge systems are not adequate to address the growing challenges of the Anthropocene, especially if transformations to futures not previously conceived of are required (Section 6.4). Such projects have engaged people living and working at different levels in social-ecological systems and have employed advanced understanding of the psychology and sociology of participatory engagement and cocreation/coproduction of knowledge. A particular change in focus has been an increase in participatory futures-thinking with people in less developed countries and, especially, Indigenous populations (6, 12, 41, 42, 44, 45, 48, 114, 115, 129, 136, 153).

The methods employed have been diverse (12). Some projects have produced scenarios, whereas others have focused primarily on visioning (for the distinction, see 148). Two commonly used approaches have been a version of the Manoa method, which amplifies so-called weak signals to generate scenarios, and the Three Horizons Framework, which graphically guides dialogue about change over multiple connected time frames (6, 151). Benefits of such approaches include uncovering a plurality of desires and values for futures, recognizing and sharing diverse ways of knowing and sense-making not otherwise accessible, facilitating social learning by sharing assumptions and worldviews and increasing awareness of diverse interpretations of reality, uncovering multiscale dynamics of social-ecological systems not typically included in system models, stimulating innovation, and mitigating conflicts by encouraging social learning (4, 12, 91,

148, 149, 151). Challenges include the complex coordination and high costs often required, risks of unrepresentative engagement and/or domination by some viewpoints, difficulties in ensuring consistency or comparability across scales, potential for incompatibility between people with different knowledge and experience sets, and a common lack of relevant data in appropriate forms to support the processes (12, 91).

Relatively few rigorous assessments of the outcomes of participatory futures-thinking processes have been conducted (142, 154). While many appear to have achieved a shared understanding and encouraged learning about alternative planning and management of social-ecological systems, broader impacts on collective action for adaptation and/or transformation of social-ecological systems have yet to be demonstrated adequately (12). Pereira et al. (137) assessed an approach for integrating local- and global-scale information in decision-making. They analyzed information on local practices and perspectives, drawn from various participatory processes, using the type of framework employed in a global environmental assessments (for an example, see 155), potentially broadening and deepening the identification and assessment of transformative solutions and future pathways.

6.6. Clarifying Values

Focusing on transformation begs the question: transform to what? Answering this question requires awareness of what people value in the present and might value in alternative futures. In the early 2000s, scholars focused on identifying, classifying, and measuring benefits that people gain from nature and linking these benefits with thinking about alternative futures (e.g., 91, 134). The 2010s saw an increased focus on participatory futures-thinking with diverse communities around the world (e.g., Section 6.5). These projects aimed to help people discover their individual and collective needs and values through facilitated conversations about multiple hypothetical circumstances. Some futures-thinking processes have combined surveys with scenarios and/or other depictions of hypothetical futures to seek explicit views on comfort with, or preferences for, alternative futures (e.g., 48, 63, 64, 150, 156, 157; see Section 7.2).

One key example is the NFF project, which was established to clarify how people value nature and to balance a perceived preponderance of pessimistic environmental scenarios (see Section 7.1). Engaging multiple focus groups globally, it developed a heuristic tool that categorized values under the headings of "nature for nature," "nature for society," and "nature for culture/one with nature" (148, 158). A set of indicative scenarios and guidelines for applying them were developed to help people think about how multiple values might be combined in pluralistic futures (148, 158–160). A parallel project involving a more limited set of stakeholders produced a broadly similar set of values for nature but with a different organizing framework (161).

7. PATHWAYS TOWARD BETTER FUTURES

Scenarios and other depictions of alternative futures are mechanisms for bringing together insights from the analysis and interpretation phases of a foresight process (see Section 5.3), communicating those insights, and exploring their possible implications. The scenarios themselves are less important than the futures literacy developed using them (e.g., 37). This section does not review depictions of alternative futures in detail but, instead, draws insights about the pathways for reaching new, better, usually transformed futures and the challenges and opportunities that might arise along those pathways.

7.1. Seeds of Better Futures

Concern has been raised that pessimistic, including dystopian and apocalyptic, scenarios are overrepresented in futures-thinking, media, and other societal narratives (4, 162, 163; see Section 7.2).

EXAMPLES OF EMERGING ALTERNATIVE PERSPECTIVES

Scholarship on the Anthropocene has focused largely on futures from a white and Western (mainstream, European) viewpoint, limiting imagination about possible futures (10). A review of the diverse scholarship of Black, Indigenous, feminist, disabled, and other futures falls outside of the scope of this review, but we acknowledge fundamental differences in these traditions. For example, Indigenous and Black futurism often considers the past to be apocalyptic, given the histories of colonialism and exploitation and the associated ecological collapse, displacement, and genocide, and considers alternative futures to be postapocalyptic and potentially hopeful (164, 165). Speculative African fiction has played a key role in reframing relationships and generating new ideas about alternative, positive futures that include Indigenous, Black, feminist, gender, queer, and trans intercultural perspectives (50, 166, 167). A recent initiative in Australia offers futures-thinking with Indigenous peoples, based on Indigenous cultures and languages, to enrich future business models (168). Reconnecting with the cultures, memories, and histories embodied in diverse communities around the globe expands awareness of current situations for all cultures. It stimulates imagination about possible global futures, offering more options for mechanisms to shape future change in order to meet multiple needs and values.

Narratives about a future apocalypse are not universal, however. They are more characteristic of currently privileged societies that fear losing their status and lifestyles (39). Some disadvantaged societies, on the other hand, view the dominant challenges as recovery and renewal after past apocalypses, such as colonization (see the sidebar titled Examples of Emerging Alternative Perspectives).

In the past 5 years, many projects have sought to stimulate humanity's imagination about hopeful futures (e.g., 4, 6, 143, 147, 149, 151, 169, 170). The Seeds of Good Anthropocenes project, for example, focuses largely on the development of "radical positive visions of the future on the basis of existing real-world 'seeds' of a better future" (151, p. 174). These seeds embody notions of value and the beginnings of pathways toward desirable futures, including initiatives that involve enhancement of food-producing landscapes, improving the livability of urban areas, fostering new knowledge and education that can be used to transform societies, creating more equitable opportunities for decision-making, and encouraging social movements to build more just and sustainable futures (4). A seed database has been established and used to catalyze several participatory futures-thinking projects (6, 147, 171).

7.2. Preferable Futures

The assertion that humanity needs to expand its imagination about positive futures begs the question of whether it is possible to identify futures, and pathways toward them, that would meet the needs and hopes of most if not all people. The literature, and the experience of the coauthors of this review, suggests that there are elements of desired futures that are common across most of humanity, but how these elements might be expressed, and the pathways by which they might be achieved, is likely to differ significantly across cultures and societies (illustrated in **Figure 1**).

Nevertheless, recent research and practice, such as those reviewed in Section 6, have shown that it is possible to bring large groups of people (i.e., tens to a few hundred) together, face-to-face and/or virtually, to consider alternative futures and reach broad agreement on what is undesirable versus what is preferable. Such processes provide a basis for deeper dialogue about how to find preferable futures and ways forward that meet multiple needs even if they are not perfect solutions for everyone. The scale of these processes (i.e., the number and diversity of people meaningfully engaged) needs to increase to achieve societal-scale futures-thinking, although

that does not necessarily mean that everyone must be involved in the same events, in the same way, or at the same time. Processes for linking multiple, smaller-scale engagement should also be explored.

Creative approaches are needed that enable large numbers of people from diverse backgrounds to think about, and deliberate on, alternative futures and build shared visions of preferable futures. Various methods that are being explored include online platforms, surveys, deliberative citizens' assemblies, games, and films (110, 172, 190). Meaningful participation in these processes can take many forms. For example, simply filling out a survey about preferences for alternative futures can spark recognition of future possibilities and build the case for public preferences (157). Deeper engagement will require that we address current constraints, such as expense (172) and the potential for groupthink (173). Similarly, there will need to be longer-term engagement with representatives of diverse civil society, business, and government groups to mobilize their knowledge and engage their expertise. Such processes will be easier in places with well-developed and well-resourced civil societies that have established mechanisms for consultation and engagement and will be challenging in places that have fewer resources and are highly contested.

Analyses of hundreds of scenarios of alternative futures have revealed a small number of frequently repeated narratives, termed scenario archetypes (174). Although variously defined and named, the main themes among these archetypes include growth scenarios (involving continued economic expansion under market forces, often relying on policy adjustments to balance market failure), restraint scenarios (involving a shift toward sustainability and conservatorship), catastrophe scenarios (usually involving societal fragmentation and permanent or periodic collapse), and transformation scenarios (involving fundamental change that is often associated with technological innovation, but also major social change) (27, 129, 174, 175). As a generalization, participants in futures-thinking processes struggle to imagine viable growth scenarios without assuming major changes to current economic and social settings—otherwise, such scenarios tend to produce suboptimal social and environmental outcomes or slip into catastrophic futures (e.g., 93, 99, 152, 157, 175, 176). Futures in which there is reduced consumption of resources, and a focus on environmental management, cooperation, equity, and human well-being, are also often difficult to imagine but are consistently rated highly when people are asked to compare preferences for multiple alternative futures (e.g., 48, 150, 156, 157) or are asked to identify their hopes and desires for ideal futures (e.g., 114, 115, 152, 176, 177). Futures featuring strong individualism, competition, and a focus on market-based solutions to social challenges are rated highly by far fewer respondents, presumably those who see themselves as living comfortable lives in such futures. The latter sorts of futures are most likely to give rise to conflicting values, such as those between Indigenous peoples and others with a stake in how land is managed (48).

Three recent projects in southern Africa (6, 147, 171) engaged participants from diverse backgrounds and explored only positive (transformed) futures based on "seeds" (see Section 7.1). The resulting scenarios differed from one another in detail, because they were driven by different seeds and hence different pathways toward positive futures, but many common elements emerged across all scenarios and studies. These included devolved, cooperative, and empowering forms of governance; a decreased focus on consumption; a focus on communities rather than individuals; empathy, compassion, equity, and social safety nets; greening and rewilding of cities and rural landscapes; sharing rather than ownership; and respect for, and sharing of, all forms of knowledge.

The strong conclusion expressed by numerous leading futures-thinkers throughout the past two decades (e.g., 14, 78, 93, 125) is that incremental adjustment within current paradigms and systems is no longer an option that will allow humanity to survive the Anthropocene, let alone achieve sustainable levels of human well-being and harmonious relationships with other species (see also Section 6.4). As well as encouraging humanity to accomplish this transition as quickly

as possible, futures-thinkers have identified issues to be cautious about. Beers et al. (178), for example, noted the power of images shared in public discourse to influence attitudes and actions and remarked "that simple images can cause a disregard of complexity and that a negative societal image can stifle innovative potential" (p. 723). It is also important to take account of the different ways that people in different situations might view ideas like sustainability or equity, or how they might interpret green spaces, wilderness, freedom of movement, transportation, and the like (e.g., 179, 180). The Sustainable Development Goals are one statement of what a desirable future might include, and yet pathways toward achieving them likely involve serious trade-offs and radical redistributions of resources that will affect all of humanity, but in very different, positive and negative, ways (181). Sardar (23) noted that there are many ways to be human and many cultures, knowledge systems, histories, and other aspects of diversity that should not be lost in a rush toward consensus. He argued that futures-thinking should ensure that the future "remains continuously open to all potentials and possibilities of mutual diversities" (23, p. 183). At the same time, we should build on the many shared aspects of desirable futures that have been consistently identified and that acknowledge the need for diversity and equity.

7.3. Intervention Points

Many discourses around Anthropocene risks focus on undesirable tipping points in climate and social-ecological systems that could be triggered if humanity fails to act appropriately (1, 8, 125). On the other hand, discussions about creating positive futures have considered desirable tipping points and the interventions that might bring those about (125, 182–184). In this subsection, we highlight some key publications that illustrate actions that might drive transformations toward better futures.

Synthesizing thinking about how major change occurs in social-ecological systems, Bennett et al. (151) proposed four types of pathways through which local processes combine to result in global outcomes: aggregation (summing of regional processes, such as those resulting in food demand), compensation (offsetting of outcomes between regions, such as allowing versus banning deforestation), learning (actions in some regions enabling actions in others), and contagion (multiplicative spreading of the effects of actions in one place to multiple others). Such systems-level thinking underpins ideas about interventions, as explored below. The recent Earth for All report (125) identified five major "turnarounds" required to keep the planet physically and socially within livable limits: ending poverty, addressing gross inequality, empowering women, making food systems healthy for people and ecosystems, and transitioning to clean energy. It contrasts one future in which these five turnarounds are driven by interventions that transform economic systems with another future in which current settings persist with undesirable outcomes for humanity. The interventions in the former future relate to creating mechanisms to distribute the wealth of the global commons fairly; government interventions to accelerate the turnarounds; transforming the international financial system to facilitate rapid poverty alleviation globally; derisking investments in low-income countries and canceling debt; and investment in efficient, regenerative food and renewable energy systems.

The leverage/intervention points identified above are broadly consistent with the conclusions reached by Tàbara et al. (182) and Linnér & Wibeck (185), who, drawing on the seminal work by Meadows (186), identified mechanisms to achieve deliberate transformations of complex social-ecological systems. O'Brien (183) distilled much of this thinking by categorizing Meadows's 12 leverage points into three spheres of transformation: the practical sphere (behaviors and technical responses), the political sphere (systems and structures), and the personal sphere (beliefs, values, worldviews, and paradigms). Consistent with Meadows, O'Brien argues that the degrees of transformation required to address Anthropocene challenges require leverage in the (collective)

personal sphere (i.e., interventions aiming to transcend paradigms and change mindsets and goals of systems). Change within bureaucracies is largely in the political sphere and, hence, is considered less likely to achieve the degree of change required (187, 188). These findings illustrate why there has been such a strong focus on values and imagining desirable futures in the past decade.

Researchers are increasingly applying integrated frameworks that embed futures-thinking methodologies into engagement and systems-thinking methodologies, like the adaptation pathways approach described by Werners et al. (189). These holistic frameworks employ futures-thinking as part of a toolbox that aims to develop visions, question dominant value systems, challenge bureaucratic barriers, question paradigms, and imagine and develop solutions (all recognized as important leverage/intervention points). Importantly, these frameworks embed ways of considering values (ethics and morals) and coproduction of knowledge beyond traditional academic and disciplinary boundaries.

7.4. Coupling Futures-Thinking with Decision-Making

The preceding subsections are mostly optimistic about emerging processes for increasing understanding and imagination among moderately large and diverse groups of people. Yet questions remain about how futures-thinking might contribute to societal perceptions, norms, planning, and other governance structures and processes more broadly, in time frames commensurate with the Anthropocene's acceleration. Key challenges include addressing institutional barriers to thinking about radical alternative futures (such as those discussed in Section 4.3); improving knowledge-based interactions across academic disciplines and with nonacademic actors through transdisciplinary methods; and integrating values, knowledge, and perspectives across geographic and demographic scales (e.g., 78, 86).

Ahvenharju et al. (69) suggested ways to bring critical futures-thinking together with utilitarian approaches, which often are more closely connected with mainstream decision-making. Their suggestions included applying critical futures-thinking to the analysis of assumptions and narratives associated with businesses', governments', and others' everyday interactions with society and technology, and injecting ideas about radical alternative futures into utilitarian futures-thinking. They suggest that mediation and anticipatory governance are key parts of this convergence.

In relation to mediation, we note the novel proposal by Costanza and colleagues (190, 191) that the difficulty societies have in letting go of old ideas can be likened to addictive behavior and that therapies for addiction might be scaled up to societal levels. Motivational interviewing therapy (MI), for example, engages addicts in a positive discussion of their goals, motives, and possible futures. This approach shares assumptions and objectives with participatory futures-thinking (Section 6.5). In both cases, having visions of hopeful futures available is vital. Importantly, MI has also emphasized the importance of determining goals separately from consideration of what pathways might or might not be possible (190), which resonates with emerging ideas about refocusing economic policy on common goals generated by stakeholders, using mission-oriented innovation (53). In a similar vein, approaches to conflict resolution—such as those developed by Milojević (192), building in part on early research by Galtung (193) in relation to peace studies—use futures-thinking to refocus attention on hopeful and mutually acceptable futures and away from unhelpful, negative aspects of the past.

The concept of anticipatory governance (194) has been interpreted in relation to futures-thinking as "governing (or steering) in the present to engage with, adapt to, or shape uncertain futures" (73, p. 2). Like adaptive management, this concept implies recognizing complexity by adapting toward goals, underscoring the importance of considering what those goals could or should be (see Sections 6.6, 7.1, and 7.2). In an extensive literature review and a workshop with futures-thinking practitioners, Muiderman et al. (73, 74) identified four broad, partially

overlapping ways that futures-thinking might be coupled with governance processes, depending on the underlying assumptions about the future (see also Section 4.3): linking futures-thinking tightly with strategic planning and risk mitigation processes; reflexive dialogue that involves experts, stakeholders, and policy makers to build awareness of future possibilities and relevant preparations; deeper and wider engagement in processes designed to stimulate new ideas and visions and bring about collective, transformative action (e.g., many of the studies reviewed in Sections 6.5 and 6.6); and careful consideration of the intrinsically political nature of futures-thinking (see also 80) with ongoing interrogation and reflection on how this influence might help or hinder preparation for alternative futures. They concluded that most practitioners use combinations of these approaches, often without making the assumptions explicit.

From an extensive literature review, Alexandra et al. (195) suggested the following priorities for better engagement between adaptive governance and futures-thinking: (*a*) addressing political contestation and the sociopolitical context within which futures-thinking processes take place; (*b*) more coherently integrating knowledge across scales to inform futures methods, for example, by developing multiscale scenarios; and (*c*) developing scenarios that deal with continuity and bricolage of adaptations and transformations across scales. Conceptualizing future change in these ways might enable more pluralistic, transparent, and equitable futures-thinking, while examining sociopolitical contexts that might be necessary to generate the desired changes.

8. IMPLICATIONS AND CONCLUSIONS

The recent literature on futures-thinking, even when restricted to that specifically considering Anthropocene risks and opportunities, is immense and diverse in ideas and opinions. We have surveyed key developments across diverse aspects of this literature. Three strong messages emerge:

1. Transformative change is required to meet many of the challenges of the Anthropocene.
2. Achieving such change requires that humanity improve its understanding of the current situation, enhance its ability to coimagine and broadly communicate positive futures, and explore alternative pathways toward such futures.
3. Lessons learned and approaches developed during the emergence of futures-thinking over the past seven decades have provided models for achieving the above.

Concerted efforts to address psychological and cultural constraints on imagining alternative futures began in the 1990s with critical theory and practice that included change agents (humans), and their thinking and motivations, as drivers of alternative futures. These efforts have been enhanced in the past decade by critical questioning of assumptions and stimulation of imagination, drawing on ideas from fields including the arts, design, science fiction literature, neuroscience, and psychology. A renewed focus on values and the generation of seeds of visions of positive futures have been two major contributions, as has the increasing inclusion of Indigenous and non-Western/modern worldviews in futures-thinking.

Seven decades of futures-thinking, especially the past two, have shown that humans can, in principle, agree on many elements of preferred futures. These futures recognize that no detailed formulation of a preferred future (singular) would suit everyone, because different communities and societies have different unmet needs and are at different stages of achieving their aspirations, and because pathways toward any particular future will benefit some and disadvantage others. Although the hope of engaging large proportions of societies in meaningful futures-thinking has not yet been achieved, it is possible to bring moderately large and diverse groups of people together to have meaningful conversations about alternative multivalue futures and to explore

pathways toward such futures, as well as the synergies and trade-offs that each might involve (see Section 7.2).

The remaining challenges include scaling up participatory futures-thinking and strengthening its two-way links with diverse disciplines so as to imagine a greater range of future possibilities and apply more robust analyses of how to reach them. Vitally, this thinking must feed into mainstream decision-making and other governance processes to provide societies with workable alternative futures to aim for. Futures-thinking has evolved from an activity focused primarily on forecasting the most likely futures and optimizing within existing military, business, and policy systems to a field with an increasing component of critical and creative approaches. So-called emancipatory approaches offer the hope that humanity can overcome constraints to achieve just and sustainable futures, free of the relationships of oppression and subordination that characterize today's inequalities and power imbalances, and imagine workable alternatives to generate pathways toward more positive futures (14, 26).

Finally, there is an ongoing discourse about whether futures-thinking (by whatever name) is a field, a discipline, or a profession (e.g., 128, 196). This discourse is generated by a perceived societal need for guidance on approaches and standards. Professions emerged as bodies that help societies deal with knowledge that is too complex for most people to engage with. The literature we have reviewed suggests that there is some way to go before futures-thinking theory and practice become readily accessible across disciplines, let alone societies. While a traditional professional model might be relevant in business contexts, participatory futures-thinking, in particular, has cast specialists as coexplorers and coproducers of insights into alternative futures, rather than as expert consultants. Regardless of what sorts of governance arrangements might or might not emerge around futures-thinking, it appears that a critical mass of futures-thinkers is building, with the skills and willingness to work with people to understand the present and imagine alternative futures at community, organizational, and societal scales. Whether that will be sufficient to address the challenges of the Anthropocene will depend on several things, including the resources available, the willingness of societies' leaders, and the development of governance arrangements by which this thinking is coupled with critical decision-making.

SUMMARY POINTS

1. To achieve the transformations required to address Anthropocene challenges, societies need opportunities that bring a diversity of knowledge and perceptions together to seek shared understandings of current situations and to imagine what alternative futures might be possible, including radical ones never before imagined.
2. Incremental adjustment within current paradigms and systems is no longer an option that will allow humanity to survive the Anthropocene, let alone achieve sustainable futures with high levels of human well-being and harmonious coexistence with other species.
3. Lessons from more than seven decades, especially the past two, suggest that the diverse knowledge and expertise embodied in theories, philosophies, approaches, and methods for futures-thinking offer models for achieving the above, although coupling futures-thinking with mainstream decision-making and governance remains a challenge.
4. Many cognitive, cultural, and institutional constraints on broad societal uptake of futures-thinking exist, but none are insurmountable once understood.

FUTURE ISSUES

1. Continued exploration and refinement of approaches for scaling up from local (community) futures-thinking to larger scales, and linking them with top-down thinking about the big issues facing humanity, will be required to achieve societal futures-thinking.
2. Examples include comparison and synthesis across case studies to improve and operationalize ways to connect, engage, and empower large groups of people across societies, as well as technologies and approaches for collecting and analyzing relevant data to support quantitative and qualitative models that facilitate dialogue at multiple scales across societies.
3. While theories and ideas exist for coupling multiscale futures-thinking with social institutions and governance processes to build societal futures-thinking capacity, more case studies and demonstrations are needed to show how alternative governance arrangements can provide both imaginative and effective options, including pathways to pluralistic futures.
4. Such case studies would require not only exploring the implications of continuing existing ways of thinking and entrenched power structures but also giving societies confidence to try new approaches in ways that manage risks and opportunities in staged horizons, with checks and balances that anticipate and act on early warning indicators of both risks and opportunities.
5. There should be further exploration of the promise of applying futures-thinking as a therapeutic tool at societal scales (e.g., motivational approaches might help individuals and communities break free of addictions to unhelpful entrenched systems and/or might help groups that are in conflict focus on mutually desirable futures).

DISCLOSURE STATEMENT

The authors are not aware of any affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

ACKNOWLEDGMENTS

The lead author of Reference 1 is Professor Will Steffen, who has been described many times as a giant in research and communication about the Anthropocene and its implications for humanity. Will passed away in late January 2023. We dedicate this review to Will, acknowledging his huge contributions to not only helping people understand the nature of the current and future challenges of the Anthropocene but also articulating alternative pathways toward hopeful futures. We thank the *Annual Review of Environment and Resources* Editorial Committee and reviewers for feedback on our article. C.A. acknowledges funding by an Australian National University Research PhD Scholarship and a top-up scholarship from the Australian National University's Institute for Water Futures. C.W. acknowledges support from the Australian Research Council (ARC) (DE2001922). J.G.A.R. acknowledges support from ARC and the Northern Australia Environmental Resources Hub of the Australian Government's National Environmental Science Program, James Cook University. J.J.K. acknowledges support from the Swedish Research Council for Sustainable Development FORMAS (2019-01648). R.H. acknowledges that she is a life member of the Cairns and Far North Environment Centre, a subnational advocacy organization; a member

of the International Union for Conservation of Nature and Natural Resources (IUCN) World Commission on Protected Areas, an international advocacy organization; a member of the IUCN Commission of Social, Economic and Environment Policy, an international advocacy organization; and an Honorary Member of the Indigenous and Community Conserved Areas Consortium.

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