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REVIEW ARTICLE

Framings in Indigenous futures thinking: barriers, opportunities, and innovations

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Abstract

Human societies face existential challenges on multiple fronts: climate change, biodiversity loss, altered biogeochemical flows, social unrest and injustices. Innovative solutions are needed to shift current trajectories towards a sustainable and just future. Futures thinking enables people to explore and articulate alternative futures and find pathways towards their desired futures. Indigenous people have the potential to make significant contributions to futures thinking because of their distinctive perspectives: the viewpoint of already living in a post-apocalyptic world in the context of colonisation, unique knowledges, worldviews, and perspectives on time, as well as significant contributions to safeguarding biological and cultural diversity. A body of literature is emerging where Indigenous peoples contribute to and lead futures thinking approaches; however, this literature is diffuse and highly diverse in its approaches and terminology. Thus, we take an innovation-seeking and systematic approach to (1) identify patterns and processes in futures thinking with, for, and by Indigenous people; (2) highlight innovative approaches; (3) bring together diverse and sector-specific terminology; and (4) foreground emerging strengths and weaknesses. We identified four framings of Indigenous futures thinking: Adaptation oriented, Participatory, Culturally grounded, and Indigenising. Factors contributing to innovation include strong involvement of Indigenous people in the research team, co-design, and authorship, using Indigenous methodologies, cultural protocols, and explicitly employing decolonisation and trauma-informed approaches. We spotlight the challenges of conducting an exhaustive literature review in an emerging field with inconsistent terminology (e.g., capturing regions where Indigeneity is contested). We also create a living glossary of terms to aid other researchers and communities in using and refining the suite of methods identified here, with the aim of stimulating further innovations in this field.

Keywords Indigenising · Futures · Innovation · Scenarios · Stories · Methodologies

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Introduction

Across the globe, human societies face major existential challenges from climate change, biodiversity loss, altered biogeochemical flows, and social unrest driven by competitive and accumulative social and economic systems that are causing growing inequities and injustices (Anderies et al. 2023; Richardson et al. 2023; Rockström et al. 2023). Innovations in technologies, transformations in governance, economic and social systems, and new capabilities that empower human agency and embrace human diversity are widely recognised as essential to meet these challenges (Biggeri and Tapia 2023; Díaz et al. 2019; Folke et al. 2021). Here, we undertake a systematic review to explore two facets that are gaining increasing attention in this context: Indigenous people, their[1] knowledge systems and perspectives; and our human capacity to imagine new futures and pathways towards achieving them (Brondízio et al. 2021; Cork et al. 2023; Whyte 2018). This review highlights innovative approaches and illustrates the breadth and diversity of subjects, approaches, and contexts of futures thinking by, with, and for Indigenous people. For the purposes of our review, we follow the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) in recognising that Indigenous peoples self-determine their own identity as Indigenous in accordance with their customs and traditions (UN General Assembly 2007).

We define 'futures thinking' according to Cork et al. (2023, p. 19.5) as "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". Futures thinking, thus defined, has been an everyday occurrence throughout humanity's history. Systematic and structured futures thinking has advanced over the last seven decades (Amer et al. 2013) and assisted people from diverse backgrounds to reach a common understanding of important issues, underlying causes, and pathways toward probable, possible, and/or optimistic futures. Diverse practitioners across business, science, arts, humanities, design, and media have contributed to an array of tools, theories, and approaches likened to 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 (Cork et al. 2023). The rapid growth in participatory futures thinking also provides the opportunity for people to become cooks themselves (Johansson 2021; Osteros-Rozas et al. 2015) through the co-development of these future visions. This growth in participatory approaches contributes to the recognised need by the futures community for plurality in futures approaches and attitudes towards futures (Mangnus et al. 2021).

Indigenous people make up 6% of the world's population, conserve 80% of the world's remaining biodiversity, and possess critical knowledge of adapting to social and environmental changes (Codjoe et al. 2014; ILO 2019; Sobrevila 2008), yet their perspectives are rarely present in futures thinking work. Indigenous people have the potential to make unique contributions in this area as a result of their distinctive perspectives. They share a perspective of already living in a post-apocalyptic world due to the radical alterations imposed by the influences of colonialism, industrialisation, and extreme political and economic systems (Whyte 2018), and the need for transformational change of these outside influences and societies to reassert their Indigenous agency and sovereignties. Transformational change includes moving from colonial to decolonial, from marginalised to active agents in shaping societies' futures, through acknowledgement of the legitimacy of Indigenous place-based experiences, worldviews, and rights to self-determination (Urzedo and Robinson 2023). In this regard, they have much to contribute when thinking about transformative futures needed to address the pressing human challenges faced across the globe. In addition to this is the perspective of their specific place-based knowledge and desire to continue to live in and sustain these places (Forest Peoples Programme 2020), as well as their unique knowledge systems, worldviews, and perspectives on time and the future (Mazzocchi 2020; Parsons et al. 2017).

The Iroquois confederacy, for example, has the Seventh-Generation principle, which underscores long-term thinking and making decisions with the coming generations in mind (Arden and Wall 1990). Aboriginal people (the primary term for Australian Indigenous people) often place events in a 'circular' pattern of time with individuals in the centre of 'time-circles' and with more important events perceived as being 'closer in time' (Janca and Bullen 2003; Melbourne-Thomas et al. 2023). Among the Yolŋu people of northern Australia, time and Country are both sung into existence through co-becoming in the Songspiral Wukun or Gathering of the Clouds (Bawaka Country et al. 2020). Among the Anishinaabemowin of the Great Lakes region of North America, 'time' is never an abstract concept (e.g., the future), but always carries greater specificity—*aabiding* (at one time), *azhigwa* (at this time), or *gomaapii* (for some time)—temporal multiplicity is learned from the land (Awâsis 2020; Richotte 2013). In the African philosophy

[1] We use the third-person plural pronoun ("they") and its possessive form ("their") as representing the overall authorship team while acknowledging that our Indigenous co-authors prefer the first-person pronoun and its possessive form ("we/our"), reflecting their commonality in diverse cultures and lifeways grounded in territory, and surviving colonisation, dispossession, and marginalisation to rebuild for sustainable futures.

of *ubuntu*, humans are viewed as situated within a complex web of relationships and this relationality extends to temporal views (Murove 2012). Under this African philosophy, human existence occurs in three dimensions—the living, the living-dead, and those yet to be born—underlying the temporal perspective of the intergenerational meeting of ancestors, currently living beings, and the unborn generations at any one time (Hunfeld 2022).

These and other unique Indigenous perspectives are being brought into Indigenous-led futures-oriented research spaces. For example, the Indigenous Futures Research Centre (IFRC; ifrc.ca), launched in late 2021, conducts research that responds to the needs and dreams of Indigenous people and communities. Similarly, the Initiative for Indigenous Futures (IIF; indigenousfutures.net) network has been active since 2015 to support development of the multiple visions of Indigenous peoples and their desired futures. Globally, fora such as the Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services (IPBES) and the Convention on Biological Diversity (CBD) are responding to the demand for inclusion of Indigenous knowledges and perspectives in global biodiversity assessments (Tengö et al. 2017). The inclusion of Indigenous perspectives in futures thinking and environmental sustainability arenas adds significant scope to innovation in this rapidly expanding area of research.

Indigenous peoples are contributing and leading innovative futures thinking approaches and, in doing so, are addressing the call for critical and political reflexivity in futuring processes (e.g., Rutting et al. 2022). However, this emerging body of work is widely dispersed across reports and scientific articles of different sectors and is tremendously diverse in its approaches and terminology. To clarify this evolving field, we conduct an innovation-focused and systematic review of futures literature. Our aims are: (1) to identify patterns and processes in futures thinking with, for, and by Indigenous people (hereafter, 'Indigenous futures thinking'); (2) highlight and categorise innovative approaches, particularly those that give voice to Indigenous people, represent their constructs and move towards decolonisation; (3) bring together diverse terminology and sector-specific thinking to create a glossary; and (4) highlight emerging strengths and weaknesses of the field. The objective of this review is, therefore, to provide both reflection and inspiration for further work in this exciting field, where science, creativity, and co-production meet.

Positionality statement

The research team for this review included a woman from Singapore, three women from lands now known as Australia—one Indigenous, one of mixed heritage, and one non-Indigenous—an Indigenous woman from Fiji, two non-Indigenous men, one from lands now known as Canada and the other from Scotland, and a non-Indigenous woman from South Africa. This mix of different Positionalities, together with our diverse disciplinary backgrounds across biophysical and social science domains, deepened our learning journey toward decolonising research and enabling critical reflexivity in the team. Such diverse Positionalities influence the way researchers consider the design, analyses, and framing of the findings and supported our literature review to be more diverse and inclusive. Our Indigenous co-author's methodological expertise shaped the explicit focus of strengths-based and trauma-informed approaches, which are central to Indigenous realities, and drew attention to evaluations of project processes and the practical applications of lessons learned for other First Nations groups. Our social scientist co-authors contributed expertise in qualitative thematic analysis, critical reflexivity of our overall analytical approach, and application of decolonial and social justice lenses. Our non-Indigenous environmental and ecological scientist co-authors informed the review approach through expertise in quantitative analyses, extensive futures practice, ensuring integrity to the evaluation of modelling approaches, robust literature search procedures, and high-level conceptual overviews. Our co-authors also brought extensive experience working in interdisciplinary teams at the science–policy interface, for example in the IPBES, the Intergovernmental Panel on Climate Change, and Australian Federal Government scientific committees on threatened species and water quality, which enabled access to diverse international networks of futures practitioners.

Methods

We focus on where Indigenous futures thinking has occurred in the context of environmental sustainability, while also engaging with applications from other fields including business, education, media, and health. We used a systematic, innovation-focused approach to identify publications that involved empirical futures thinking processes held by, with, and for Indigenous people. Innovation was defined as novel research practices that have not yet filtered through to typical research methods, or that impact the research process in novel ways (Xenitidou and Gilbert 2009). We used a systematic approach, but the emerging nature and diverse terminology of Indigenous futures made it impossible to be exhaustive (Grant and Booth 2009). We therefore focused on trends and innovations in the field of Indigenous futures thinking.

We identified relevant publications by searching academic databases (Web of Science, Scopus, and Google Scholar), using a wide array of search terms to capture the diversity of terminology used in the field of futures thinking and Indigenous people or groups (see S1 in electronic supplementary

material [ESM], and Fig. 1 for overall review process). These initial searches yielded 14,871 results, which were checked for duplicates ($n = 11{,}498$ unique publications). Publication titles and abstracts of these publications were screened using Rayyan, an artificial intelligence software that employs a learning algorithm that orders publications by relevance, based on past exclusion and inclusion decisions (Ouzzani et al. 2016). After screening with Rayyan, there were two manual screening stages where publications were only included based on the following criteria: (1) relevance to the review topic, (2) did involve Indigenous peoples in some way, (3) involved planning for, thinking about, or creating alternative futures, and (4) involved an empirical component rather than being theoretically based (Fig. 1). Further details of the screening and analytical stages of the review process we undertook are outlined in S2 in the ESM.

Following the two stages of manual screening, we identified 64 publications for review (Fig. 1; see S3 in the ESM for full publication list); 42 were identified from the systematic search and 22 from searching citations and suggestions from expert colleagues. The majority of the 22 publications missed by the systematic search did not use any of the generic key words for Indigenous (Aboriginal, First Nations etc., see S1), instead using a specific name

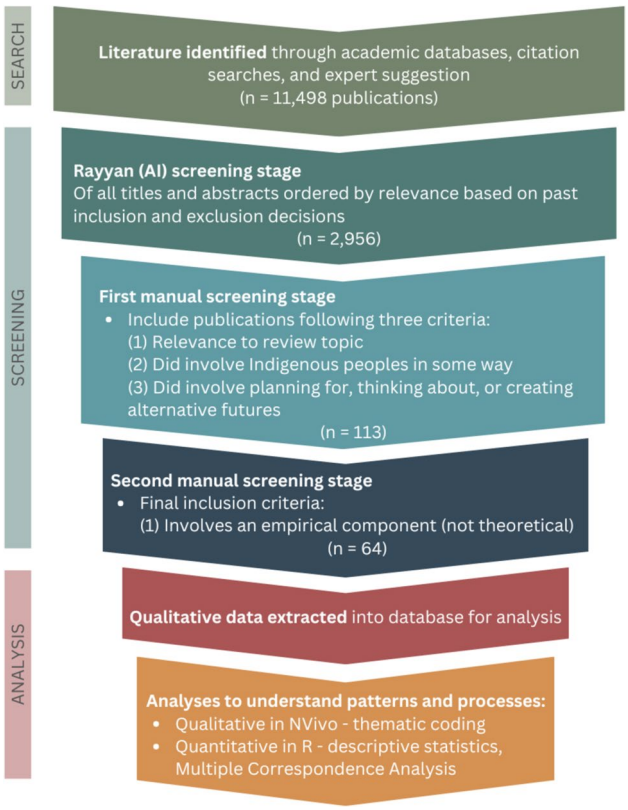

Fig. 1 Summary of literature review process followed, highlighting search, screening, and analytical stages

(for example Sami, Mvskoke), reflecting the challenge of exhaustive searching in this emerging field. We acknowledge that the diversity of Positionalities encompassed by the authorship team was a strength in trying to diversify our literature searching methods and broaden the scope beyond the literature results that would be derived through a rigid systematic review process. Our diverse Positionalities also enabled us to recognise the limitations of our approach and capabilities (e.g., Maclean et al. 2022; Hill et al. 2024). For example, a key limitation was searching the literature in English, resulting in the exclusion of relevant futures thinking processes reported in other major languages such as Spanish, Bahasa Indonesia, Portuguese, Mandarin, French, and Russian (Khanna et al. 2022).

Categorical and other qualitative data were extracted from these 64 publications for analysis under the following broad categories: geographic information, participants, aims, recruitment, care and ethics, methodology, Indigenous involvement, accounting for Indigenous realities (e.g., inclusion of Indigenous constructs), outputs, outcomes, evaluation, and collaboration (a link to the repository for the Indigenous futures thinking database can be found in the ESM, and see S4 for summary of data sub-categories). By Indigenous constructs, we refer to the ideas or theories held by Indigenous peoples that contain various conceptual elements, which are grounded in local culture and language and often expressed through stories or metaphors (e.g., Kirmayer et al. 2011; see Glossary for the categories of Indigenous constructs identified across the literature and their respective descriptions). These broad categories that we extracted and the variables within each were designed to capture the variation in patterns and processes, and factors that affect innovation.

As this review focused on innovation to include Indigenous perspectives, we categorised innovations according to those identified by Wiles et al. (2011) in their review of innovations in qualitative research methods and built on these with others that emerged from this review (see S5 for the list of innovation types). We also assessed the extent of innovation in each of the publications as 'Incremental', 'Somewhat new', and 'Wholly new'. Each ordinal category was explicitly defined: Incremental levels represented small new changes in commonly published approaches; Wholly new represented approaches not published before or very few times; and Somewhat new represented a level in between the two. These ordinal categories were assessed in relation to the whole body of literature that we reviewed ($n = 64$ publications). The authorship team used these definitions when making their assessments of the extent of innovation in the publications, to help minimise assessor subjectivity. The extent of research reflexivity on their Positionality, and identification of its likely influence on the research, were also

included in the evaluation category as an indicator of a decolonial approach (Hird et al. 2023).

Crotty (1998) argues that theoretical perspectives are an important determinant in the diversity in patterns, processes, and the potential for innovation in social research. We thus extracted data on the underlying implicit or explicit theoretical perspective of the futures thinking processes when reviewing the literature. "Strengths-based" approaches, as an example, recognise people's strengths in capacities, visions, values, aspirations, social relations, collective identities, and practices, rather than a deficit model that focuses on problems and what is lacking (Bryant et al. 2021). These approaches have proven highly effective in Australian Indigenous well-being, education, land management, and health research (Bryant et al. 2021; Saleebey 1996; Taylor-Bragge et al. 2021). We thus collected data on the extent and content of incorporating this approach in processes (see Indigenous futures thinking database, ESM). We collected the same data for "trauma-informed" approaches, which consider the impacts of negative individual and community life events, as well as systemic and sociopolitical conditions and how these manifest traumatic stress in people (Goodman 2015). This is especially relevant as thinking about the future can create anxieties in the context of a dystopian colonial past and present (Whyte 2018). Data on other underpinning Western or Indigenous theoretical perspectives in use was also collected.

We analysed the extracted data to understand patterns and processes in futures thinking with, by, and for Indigenous people, and how these processes produce innovation, and represent Indigenous knowledge, worldviews, and voices. This involved qualitative and quantitative analyses, using NVivo (Version 14.23.1) and R (Version 4.3.1), respectively. We imported qualitative data in NVivo for auto-coding of our pre-set categories, and a range of new codes auto-identified from the data. We used N-Vivo pattern analysis tools, including word frequency and cross-code comparison, to identify papers that clustered into meaningful groups, and to select quotations that illustrated key characteristics. We used R to visualise descriptive statistics across all publications and to gain insights into some of the factors that support innovation, representation of participant voice, and inclusion of Indigenous constructs in the futures thinking approaches used. To understand some of these factors we applied a multiple correspondence analysis (MCA) on a subset of the data columns (i.e., variables) of the literature database (see S2 for details on performing the MCA and how variables were selected). Using MCAs (R packages, *factoextra;* Kassambara and Mundt 2020 and *FactoMineR*; Lê et al. 2008) enabled us to gain insight into the different factors that relate to the attributes we were interested in exploring further (e.g., level of innovation, inclusion of Indigenous constructs).

Results

Overview of Indigenous futures thinking as an emerging field

The use of, and interest in, Indigenous futures thinking has been growing, with the numbers of publications in this field increasing each year at an average rate of 37% in the last 5 years, far exceeding the 5% average increase of academic articles published globally (WordsRated 2023). This area of research has primarily been led by non-Indigenous researchers, but Indigenous groups and researchers have increasingly led research in this area since 2019 (Fig. 2a).

Indigenous groups were categorised in our literature database as including community organisations, corporations, and government bodies identified as Indigenous; Indigenous researchers were categorised as such if the individuals were associated with academic institutions and self-identified as Indigenous. Co-led research in this field has also become more commonplace since 2018 (Fig. 2a). We found the majority of publications were skewed to a small number of countries, primarily Canada, the United States, and Australia, with a clear geographical gap in the majority of African and Asian countries (Fig. 2b). There was a diversity of terrestrial biomes that were covered across the publications (Fig. 2c); most of the publications focused on terrestrial environments (51.6%), followed by environmental foci of multiple environments (18.8%), and marine (9.4%) and freshwater (4.7%) environments. The environment was not the focus of the futures thinking processes in 15.6% of publications.

A great diversity of Indigenous and Western science methods was evident across the literature, with methodological overlap between the two in terms of storytelling and creative methods (Fig. 3; see also S6). Methods were identified as Indigenous where they had been identified as so by Indigenous people. There were a greater number of Western futures thinking methods used as compared to Indigenous methods (27 and 20, respectively); however, almost all uses of Western methods involved some level of adaptation of the approach to suit the specific contexts. We found that the different methods identified (both Indigenous and Western) were often applied in various combinations of multiple approaches in the futures thinking processes (i.e., processes often blended different methods together). By far the most dominant futures thinking method used involved the development of future stories or scenarios, irrespective of Indigenous or Western science approaches (Fig. 3). We collated all relevant and sector-specific terminology that emerged from reviewing the literature (see Glossary).

A common approach in scenario development is the identification of major drivers of system change, as a

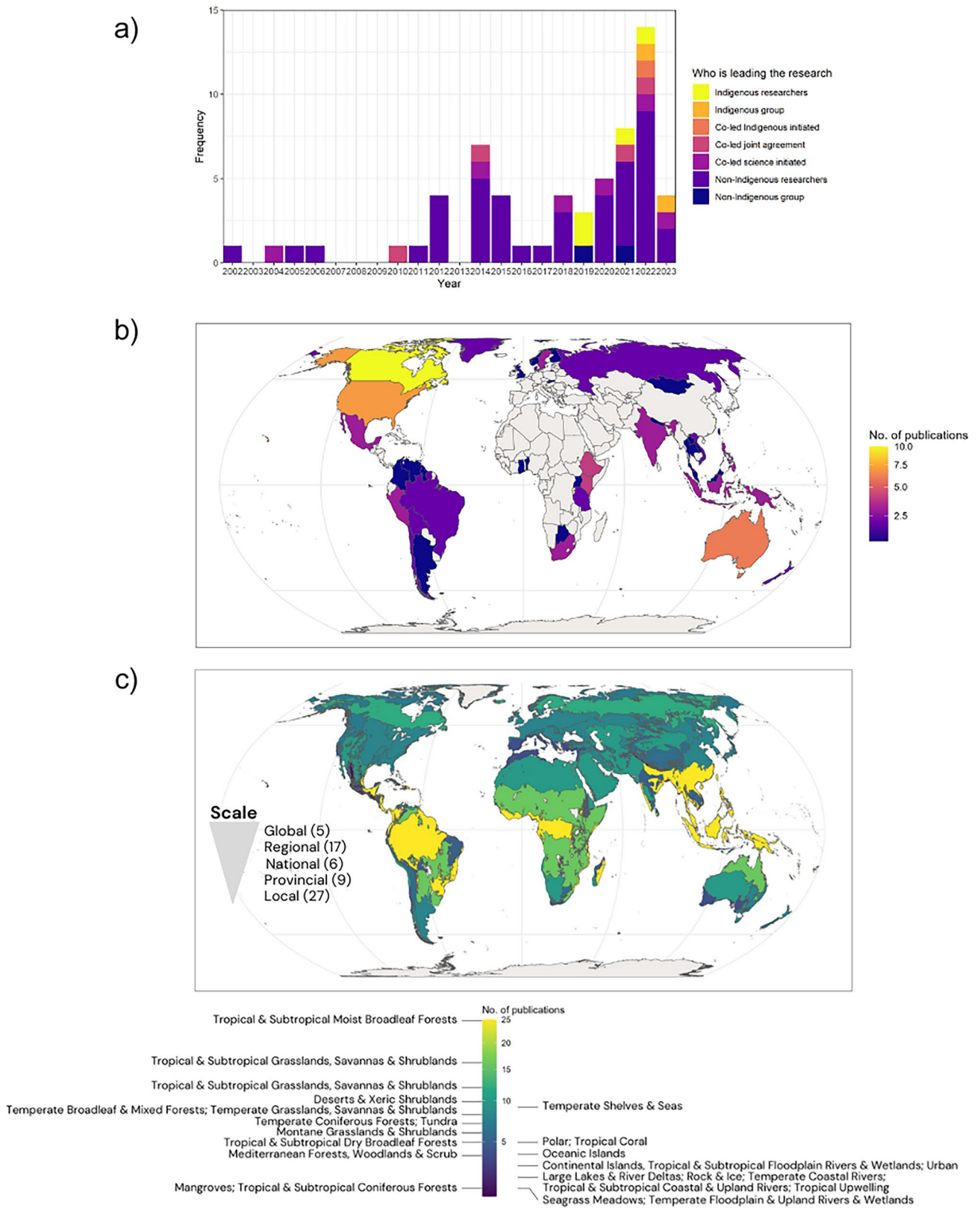

Fig. 2 (**a**) Distribution of who is leading the research in Indigenous futures thinking over time across all publications found since 2002 ($n=64$). Distribution of Indigenous futures thinking publications identified in this review by (**b**) countries and (**c**) environmental biomes, with inset showing frequency of processes at each geographical scale. Note that most publications focused on more than one biome, resulting in the differences in geographical bias evident between (**b**) and (**c**)

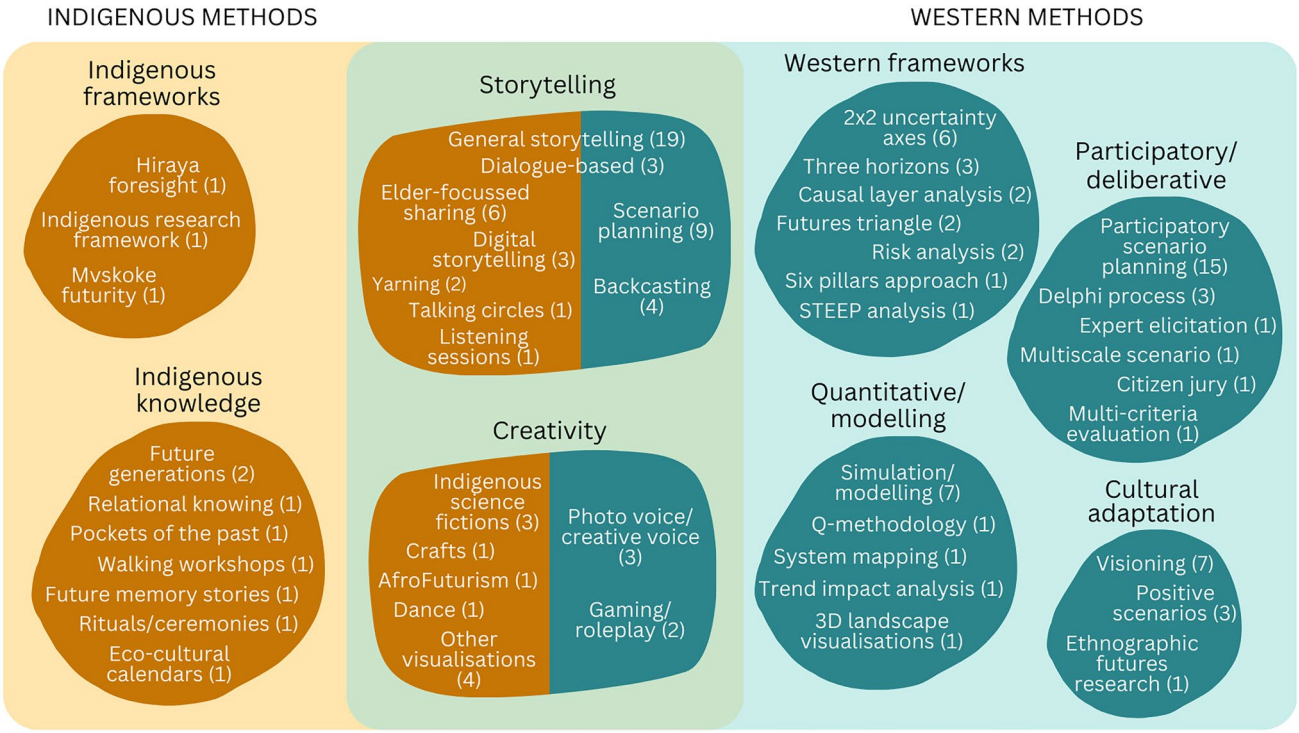

Fig. 3 Overview of Indigenous and Western science methods used in futures thinking with, by, or for Indigenous peoples, highlighting methodological areas of overlap (storytelling, creativity). Numbers in brackets represent the number of publications that used the method in their futures thinking process. Note that 'other visualisations' include drawings, collages, photo stories, video, and media

means of creating a framework around which to build the future scenarios or narratives (e.g., extent of climate change, economic markets, political or governance landscape; Star et al. 2016). Most of the publications involving scenario development (69%) identified and used drivers of change (see S7 for details of uses in story and scenario development). We coded all drivers of change where reported ($n = 39$; Indigenous futures thinking database) and identified eight broad categories used in Indigenous futures thinking scenario development. Economy and resources (34 drivers), governance (26 drivers), and environment (22 drivers) were the most common, followed by social well-being and infrastructure (including culture and health; 16), technology and information (7), physical infrastructure (5), education (4), and population growth (4).

Four framings in Indigenous futures thinking

Our analysis identified four framings in Indigenous futures thinking commencing shortly after 2000, each with distinctive characteristics and time periods where each framing appears in the literature and grows in frequency of applications (Fig. 4; S8). Many lessons from earlier publications have been taken up by subsequent researchers, meaning these framings are overlapping, and aspects from each are present today. However, differences in relation to keywords, who was leading the research, the types of Indigenous constructs included, the application of strengths-based and trauma-informed theories, and other distinctively different variables were identified (see S9–S13). Some variables were fairly constant across all four framings, such as the dominant method of scenario development and storytelling, identified drivers of change (see S14), relatively short timeframes (median of 20 years), and the targeted, non-random sample approach to participant selection. In the following descriptions of each framing, we outline some distinctions and similarities between the frames with respect to who leads the research, underpinning theoretical orientations, Indigenous involvement in the research stages, methodological approaches, outputs, and outcomes.

Adaptation oriented frame

The Adaptation oriented frame (15 papers in total) focuses attention on working with scenarios and other tools to support communities to consider, understand, respond to, and better manage future changes. Environmental sustainability is commonly central with attention directed to climate change, management of terrestrial environments, agricultural or marine resources, and Indigenous economic development. Diverse geographical foci were identified in the projects, in both high- and low-income countries

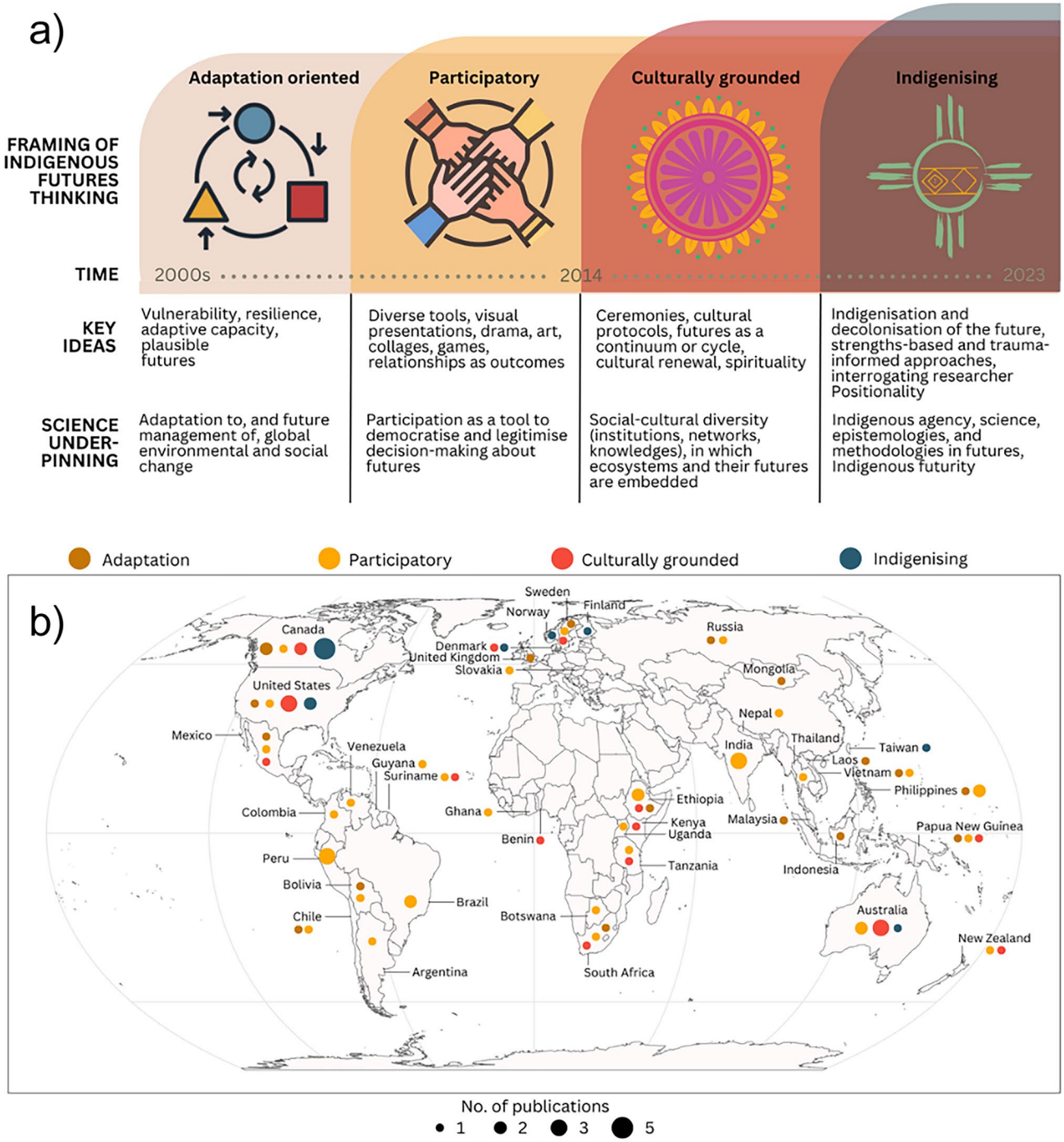

Fig. 4 (**a**) Four framings of Indigenous futures thinking evident from the literature (Adaptation oriented, Participatory, Culturally grounded, and Indigenising), and the key ideas and science underpinning each frame. Each new framing builds upon and includes elements of the previous framing(s), leading to some conceptual overlap between frames. (**b**) Geographic distribution of the four framings in this review, and numbers of publications in each country

(Fig. 4b). Geographical scales of projects range from local community to national scales (S11).

The main reason for using futures thinking in adaptation is decision support and social learning:

"aim to actively involve local actors in identifying and discussing plausible future priorities" (Ruiz-Mallén et al. 2015, p. 401).

Adaptation oriented projects in this analysis were overwhelmingly led by non-Indigenous researchers partnering with Indigenous people as the primary stakeholder (or rightsholder, where this was distinguished), frequently in partnerships continued from previous project work and based on relationships of trust. Rightsholders in the Indigenous context differ from stakeholders in the sovereign rights they have to their traditional land, territories, and resources under international law (Feiring 2013). Indigenous involvement in the research team, co-design, data collection, and authorship was almost entirely absent. Theoretical orientation was towards ideas about the capacity of ecosystems to provide for human wellbeing and life on Earth, including vulnerability, ecosystem services, increasing adaptive capacity, and societal transformations. Social capital was identified in one project as the most important aspect of adaptive capacity.

Several powerful modelling approaches were applied to interrogate future trajectories, including hydrological, agent-based, Bayesian belief networks, simulation, gaming, and integrated models (see S15 in the ESM for examples of technological sophistication in methods and a potential limitation, as well as dominant outcomes from processes).

Although diverse Indigenous languages and the use of language interpretation were reported, few Indigenous constructs were included in the futures thinking. Most projects in this frame do not report the use of cultural protocols or Indigenous methodologies. Nevertheless, movement towards greater Indigenous agency can be identified. For example, Kruse et al. (2003) report on an annual project meeting where the community met by themselves, and:

> *"Upon returning to the meeting room, community representatives presented researchers with 15 pages of flip chart sheets, listing constructive criticisms and recommendations"* (Kruse et al. 2003, p. 15).

A lot of learning was generated from this work with methods taken up and adapted in numerous subsequent publications (see *Collaboration_publication_details* column in Indigenous futures thinking database, ESM).

Participatory frame

Strengthening participation of communities, as a tool to democratise and legitimise decision-making in futures thinking, comes into focus in this frame (25 papers in total). Non-Indigenous researchers generally led the projects, with a few co-led, and Indigenous people often participating as one of many stakeholders (as opposed to rightsholders). Similar to the Adaptation oriented frame, projects here were carried out at scales ranging from local community to multiple countries (S11). Formal researcher-initiated partnerships were common, with relationships often viewed as a project output rather than input:

> *"We have all grown, matured, developed trust, and relationships across the stakeholder community in the basin. We have developed a better understand [sic] of each other's realities"* (Gerlak et al. 2021, p. 27).

However, most projects had little involvement of Indigenous people in co-design, data collection, or as co-authors in papers but nevertheless captured a rich diversity of Indigenous constructs, including identity, medicinal plants, rights, law, spirituality, renewal, and connections. For example:

> *"participants mentioned the existence of "cultural institutions", a force defined as the involvement, roles, and practices … that enhance forest tenure security, not only for communities in general but also for women and youth"* (Larson et al. 2023, p. 9).

Diverse theoretical orientations emerged in these projects, ranging across social–ecological systems theory, deliberative and inclusive processes, governance systems, tenure as a determinant of livelihood security, taboo trade-offs, and environmental justice. Projects are again diverse geographically, including both low- and high-income countries, mostly at the sub-national scale (Fig. 4b).

In these projects, as in the Adaptation oriented frame, environmental sustainability is commonly central with attention directed to aspects of environmental management and Indigenous futures. The difference lies in the incorporation of diverse participatory tools such as role-playing, theatre, and games, together with visioning, citizen jury, moonshot thinking, archetypes, Delphi enquiry, graphic facilitation, simulation modelling, futures triangle, collages, drawings, LEGO, trend impact analysis, and the six pillars approach into scenario development. One quarter of projects in this frame used some form of modelling. Details on modelling approaches and examples, frequent outcomes and typical recommendations from projects under this frame are outlined in S15. Projects within this frame also produced a broad array of communication products such as videos, artworks, photo stories, leaflets, fact sheets, water management strategies, and reports targeted to community audiences, in addition to scientific papers, indicating increased emphasis on the shared nature of these futures.

Culturally grounded frame

This frame focuses attention on grounding in the cultural context, embedding futures thinking in customary institutions, networks, and knowledges, thereby strengthening Indigenous agency (18 papers in total). Community and Indigenous development are key foci, with a minor focus on environmental sustainability compared to other frames, across diverse geographies (Fig. 4b). Projects under this frame were carried out at all scales, ranging from Indigenous

nation area (local) through to global; however, there was a clear bias of projects towards the local community scale (S11). Non-Indigenous people led most projects, with Indigenous people as the only or primary stakeholder or rightsholder, through time-deep partnerships underpinned by respect for traditional authorities:

> *"Participants were selected based on self-determination principles, which is a sign of respect toward the Saamaka community" (*Best et al. 2021*, p. 697).*

Projects in this frame primarily used futures thinking for decision-support and Indigenous nation building/revitalisation:

> *"to identify a desirable future for the Nunatsiavut commercial fishing industry … whether scenario planning that is led by, and focused on, Inuit futures is a useful and appropriate approach for developing Inuit self-determination" (*Cadman et al. 2023*, p. 7).*

Tengö et al. (2021) typify how projects in this frame note the benefits of grounding in cultural protocols:

> *"the role and importance of ceremonies and rituals became clear … ceremonies brought people together and built legitimacy and strength to the dialogues" (*Tengö et al. 2021*, p. 31).*

Diverse tools were used in this frame (see S15 for methodological descriptions, process outputs and outcomes, and examples). Most projects followed ethical procedures informed by high standards of Indigenous inclusion, involving Indigenous people in co-design, data collection, and as researchers in some projects, although few projects included Indigenous co-authors in papers. Numerous Indigenous constructs were included across the projects: connections, arts, lore, rights, knowledge systems, worldviews, cultural renewal, spirituality, and time. Time constructs emphasised the connections between past, present, and future:

> *"By addressing multitemporality and people's relationships with time, and through a fluid engagement with the temporal more broadly, I seek to resist singular narratives about a clearly demarcated past, present, or future, instead utilising a multitude of narratives, both converging and diverging, to recognize how people make sense of their societies" (*Chahine 2022*, p. 7).*

Trauma-informed and strengths-based theoretical orientations underpinned empowering outcomes from methodological innovations:

> *"Throughout the design and implementation of the study, we have wrestled with trying to provide a social learning process for young people in the [Northwest Arctic Borough] without limiting Indigenous youth to colonial or settler expectations of their future. … We strongly argue that social learning cannot limit the imagination or reduce concepts like self-determination to desirable but impossible.* (emphasis in original, Cost and Lovecraft 2021, p. 119).

Recommendations focused on broader application of the methods, capacity building, and policy changes towards Indigenous self-determination. Several papers were highly influential in terms of informing the work of other futures thinking publications (e.g., Falardeau et al. 2019; Lempert 2014; Melbourne-Thomas et al. 2023), while some had little to no influence. A minority of papers had explicit statements locating the researchers culturally.

Indigenising frame

This frame emerged through Indigenous leadership with a focus on decolonisation of research (9 papers in total), strengthening Indigenous agency, and advancing self-determined futurity:

> *"A Mvskoke futurity praxis is a set of methodologies and methodological tools that are theorized and strategized with aspirations of reconstituting the Mvskoke worlds and modes of futurity within which Mvskoke people wish to live"* (Harjo 2019, p. 213).

Indigenous and community development were the main sectors, together with a strong focus on environmental sustainability. Projects are overwhelmingly situated in high-income countries (Fig. 4b). Interestingly, we found that most of projects in this frame were conducted at either the local scale of Indigenous nation areas or the global scale (S11), likely reflecting the scales at which Indigenous agency is strongest. Participants were all Indigenous people as the only or primary stakeholder or rightsholder, selected by, or in collaboration with, the Indigenous community.

Community and culture are regarded as the foundation of Indigenous futurity:

> *"collaborating with the community at every stage, and adapting the research to best meet the needs of the participants, but also the Nation's agenda toward self-determination"* (Matters 2019, p. 15).

Methodological examples and most common outcomes are detailed in S15. Indigenous methods were common under this frame, including elder-focused sharing, yarning, talking circles, listening sessions, digital storytelling, science fiction, and art.

> *"Yarning circles are … a safe space for discussions amongst a group of people, that is informally facilitated … so all voices and positions are heard … for many Indigenous and Traditional People this is a*

familiar style of conversation, it allows for relationship building and knowledge sharing in a respectful manner" (Fischer et al. 2022, p. 278).

The Sámi Márkomeannu festival typifies the newness of innovation in this frame—Sámi were invited to present through drama and installations a 100-year future where they succeeded in enclaves, while the rest of the world is suffering the impacts of environmental degradation and social dysfunction. Another innovation at the festival focused on decolonising the imagination:

"Kitti's drawings depict two different contexts: six images focus on colonial violence and Sámi attempts to escape from it; and four focus on Sámi thriving in colonial-free Sápmi" (De Vivo 2022, p. 237).

Indigenous involvement in co-design, data collection, product creation, and as researchers and co-authors is characteristic, although few gave specific attention to protection of Indigenous Cultural and Intellectual Property (ICIP). Fewer but higher-level Indigenous constructs were included, with attention to concepts of time:

"The encounter … delineates a dialogical narrative between descendants and ancestors at odds with Western linear conceptions of time but perfectly fitting within a spiral understanding of it, characteristic of many Indigenous understandings of time" (De Vivo 2022, p. 236).

Most projects explicitly designed trauma-informed and strengths-based approaches promoting connection, hope for the future, a calm environment, and critical reflection on the colonial context. Few projects had an explicit evaluation component, and recommendations largely focused on the broader application of methods towards Indigenisation and decolonisation of futures thinking. All papers had explicit positionality statements and gave consideration to the influence of the researcher on the research and vice versa.

Contributing factors to innovation

This review sought to highlight innovative approaches to Indigenous futures thinking. We found a diversity of innovations across the literature, particularly in narrative methodology and mixed methods occurring the most frequently (Fig. 5). This potentially reflects the significance of story in Indigenous cultures, a practice that sustains communities, validates experiences and epistemologies, and nurtures relationships and the transmission of knowledge between generations (Iseke 2013). While innovations were mostly 'somewhat innovative', 'wholly new' innovations emerged in narrative methodology, creative methodology, visualisation, and time/spatial scales (Fig. 5). These wholly new innovations arose in processes where art (visual narratives, performances, scenography, science-fiction writing) and activism intersected to imagine and portray futures of Indigenous people or countercultures (De Vivo 2022; Reina-Rozo 2021).

Wholly new innovations have emerged in the last five years in the Indigenous futures thinking literature, highlighting the capacity to learn from, build on, and combine the many new ideas that are being developed to better articulate and diversify Indigenous futures.

Other factors that appear to support innovation in Indigenous futures thinking are having Indigenous researchers lead the research (e.g., De Vivo 2022; Harjo 2019); strong Indigenous involvement in the identity of the research team (e.g., Fischer et al. 2022; Gordon 2021); co-designing the research or other processes (e.g., Bremer et al. 2018; Cadman et al. 2023); shared authorship in publications arising from the work (e.g., Lempert 2014; Lenhardt 2019); as well as reporting cultural protocols (e.g., Barrett et al. 2022; RIDES 2005); using Indigenous methodologies (e.g., Falardeau et al. 2019; Lopez et al. 2018); employing a very strong decolonisation approach (e.g., Adams et al. 2023; Chahine 2022); and explicitly incorporating trauma-informed approaches into the futures thinking process (e.g., Matters 2019; Reina-Rozo 2021) (Fig. 6).

Strengths and weaknesses

Indigenous involvement in Indigenous futures thinking processes is a key factor relating to innovations in this field and there is scope for improvement across many of the research stages we assessed. Strong Indigenous involvement was most often seen in the data collection and product creation stages of the futures thinking processes (45% and 42%, respectively; Fig. 7). Indigenous involvement was comparatively lower in the ethical considerations in and co-design of the futures thinking processes across all publications (28% and 27%, respectively; Fig. 7).

We observed the least amount of Indigenous involvement in the identity of research teams, authorship of publications, and intellectual property (IP) discussions across the literature (16%, 14%, and 13%, respectively; Fig. 7), signalling these areas as needing improvement in future processes. It is also worth noting that ethical considerations and IP were reported the least (approximately only half of publications), highlighting the importance for future publications in this field to transparently report on and call attention to these aspects of the research, and funders to require and fund Indigenous engagement in these activities.

Indigenous leadership and co-leadership are clear strengths where it has emerged, supporting explicit incorporation of a 'decolonial' or 'anti-colonial' approach, the inclusion of important theoretical orientations to the work

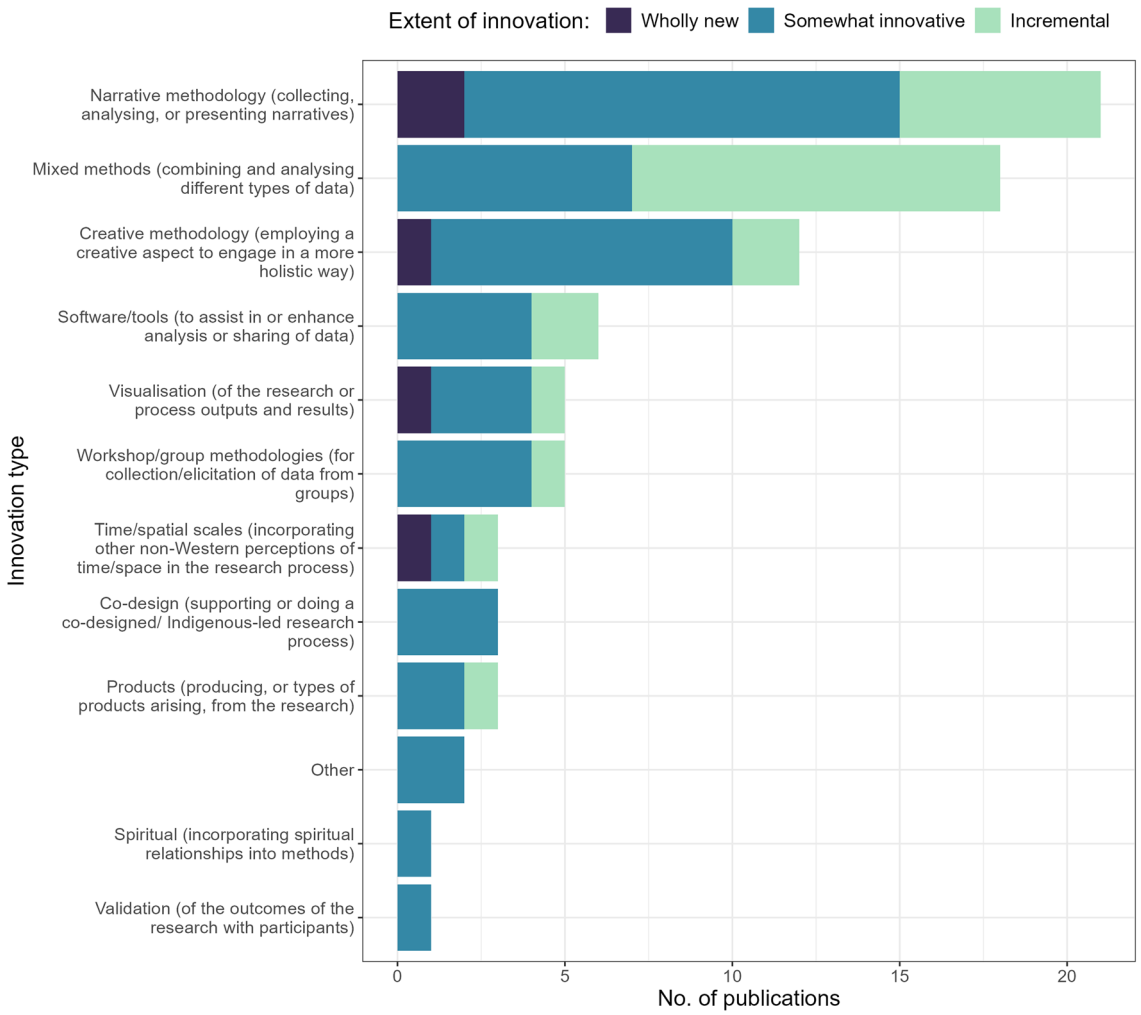

Fig. 5 Extent of innovation across the 12 innovation types identified from the Indigenous futures thinking literature. Incremental levels represent small new changes in commonly published approaches; Wholly new represents approaches not published before or very few times; and Somewhat new represents a level in between the two (see S5 in the electronic supplementary material for full-length descriptions of each innovation type)

(e.g., trauma-informed approaches), and progressing a journey of change:

> *"There is much more work to do to build practices of anti-white supremacy and decolonizing frameworks into our research practice, our professional work and our relationships. … We are committed to an ongoing, step-by-step, day-by-day harm-reducing version of our practice" (*Adams et al. 2023*, p. 12).*

Many papers demonstrate a strong ethics of care around the research process, prioritising inclusivity, accountability, flexibility, and collaboration between Indigenous and non-Indigenous actors (Álvarez-Romero et al. 2021; Best et al. 2021; Bizikova et al. 2011; Bremer et al. 2018; Cruz and Kahn-Parreño 2022; Kruse et al. 2004). These processes enable ways to better consider aspects such as temporal perspectives other than biases toward linear time (Chahine 2022) and address global Indigenous struggles against critical concerns of climate change and environmental justice (De Vivo 2022). We also found that Indigenous futures thinking could be effective in increasing Indigenous leadership (Fischer et al. 2022), enhancing a sense of agency and voice for those involved (Falardeau et al. 2019; Pimbert and Wakeford 2002), capturing plurality of knowledges (Reina-Rozo 2021; Romm 2020), promoting self-governance of First Nations to realise their preferred futures (Matters 2019), and supporting reconciliation, equity, and dialogue (Nikolakis 2020; Wengerd and Gilmore 2022).

Many publications did not appear to evaluate their own process based on details reported in the publications, making it more difficult to learn from failures or limitations for future processes. This is common in many futures exercises

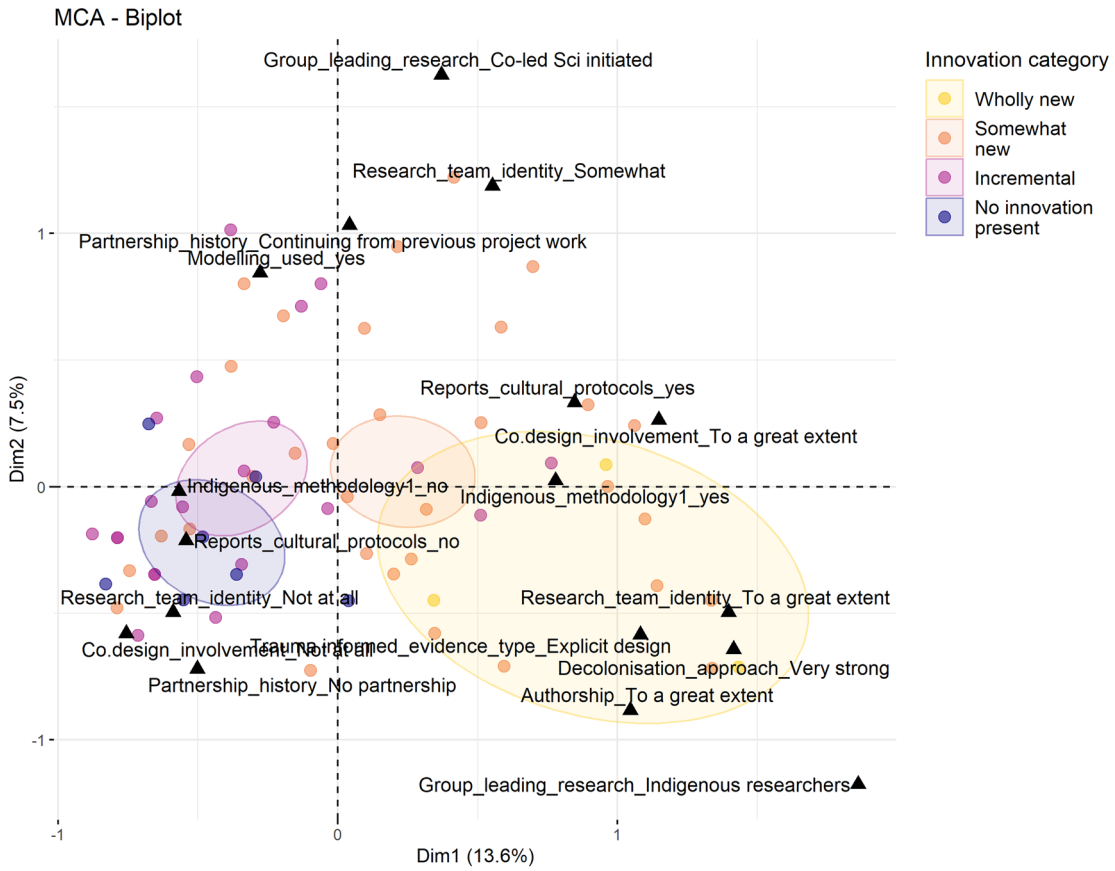

Fig. 6 Similarities between Indigenous futures thinking publications along two principal dimensions of variability identified using a multiple correspondence analysis (MCA). Points represent individual publications ($n = 64$), coloured according to level of innovation apparent; black triangles represent categorical factors that relate to variability seen across the publications. Concentration ellipses are shown for each level of innovation

(Osteros-Rozas et al. 2015), but is a significant weakness as evaluations of how these processes led to successes or desired changes is critical in informing how Indigenous groups undertake futures thinking moving forward. Conducting evaluations requires funding and time, which is frequently lacking (Whitley et al. 2018). Several publications reported the lack of time or time-consuming nature of developing scenarios as a challenge, indicating a need for institutions and funders to allow for this in the design and execution of projects. Time-consuming processes to allow for co-design approaches and trust to develop are essential in this type of research. Where project evaluations do occur, we strongly recommend that these are reported in resulting publications.

Another common challenge was a lack of clarity as to whether and how the identified futures or recommended action steps would be taken up by policy or have on-ground impacts (Bizikova et al. 2011; Chitakira et al. 2012; Lenhardt 2019; Reina-Rozo 2021). It was not uncommon for processes to lack Indigenous leadership and be more focused on grounding in the diversity of community stakeholders, sometimes resulting in the marginalisation of Indigenous voices. There were some limitations raised in some of the futures thinking processes that used modelling methods, such as its ability to model processes in the future (Kruse et al. 2004) or provide the level of detail desired by local managers and limited model validation possible (Steger et al. 2022).

Discussion

Indigenous people consistently express their inherent responsibilities for the past, present, and future of their societies and their traditional territories, with obligations to repair these land and sea areas, connections, political relations, and ensure that future generations carry forward language and other cultural practices (Ko et al. 2022; Smith et al. 2023). Our review shows that Indigenous people's engagement in futures thinking is increasing, but

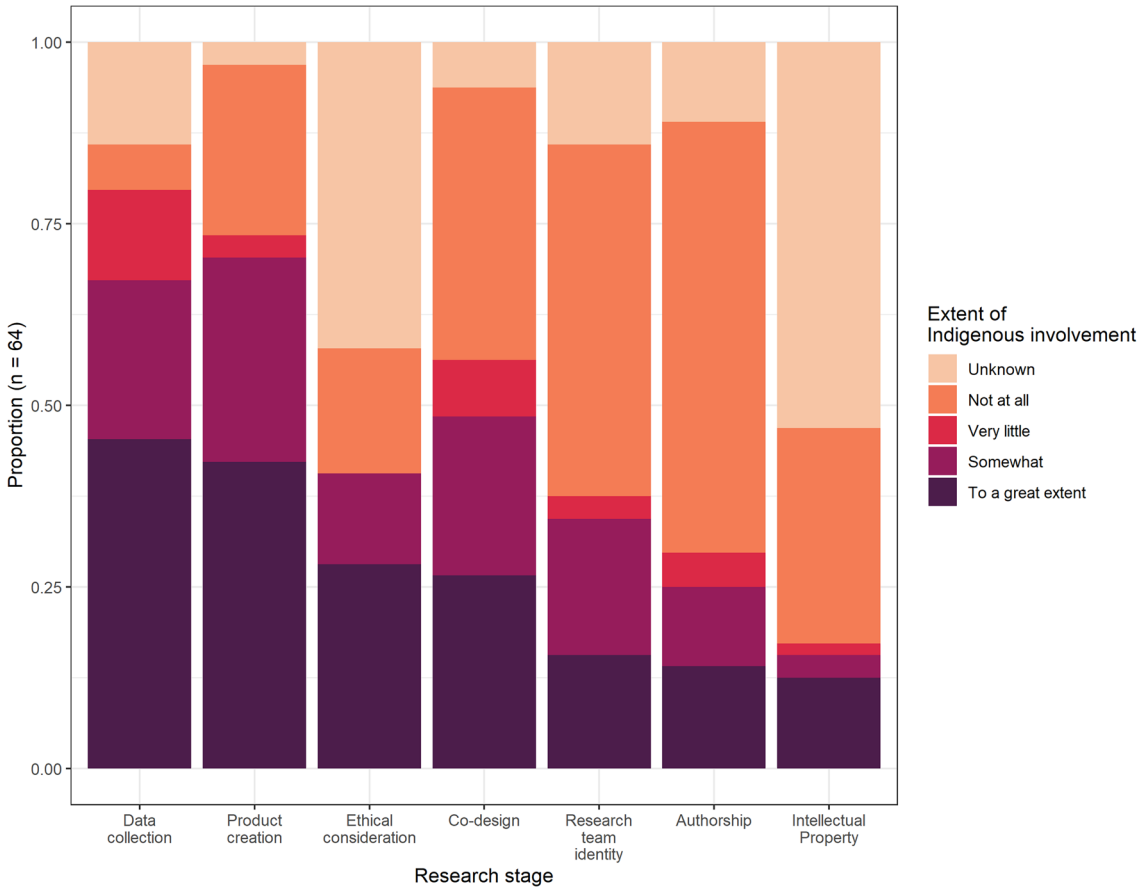

Fig. 7 Extent of involvement (from not at all to a great extent) of Indigenous peoples in various stages of research, as proportions of the selected literature

is still greatest in the data collection and product creation stages, which include the least amount of power and control over the research process. Involvement as researchers and co-authors, and adherence to ethical practices and protection of ICIP is very limited. In high-income nations, Indigenous people are gaining access to the rights and resources to lead and create their own practices of futures thinking, generating significant innovation and hope. Surprisingly however, our review of the literature indicates an apparent lack of Indigenising futures projects in the high-income nation of New Zealand, where there is in fact very strong Indigenous agency and governance (e.g., Fisher and Parsons 2020; Forster 2016). This is likely attributable to the limitations of a systematic review approach in a novel and emerging field (discussed further in the following section).

Our review illustrates the diversity and power of Indigenous futuring methodologies and frameworks, either alone or when used in combination with Western futuring approaches. The four frames identified in this paper provide lenses with which to view innovations and evolutions within the field. However, given the rise in Indigenous-led processes and methods, new frames will likely continue to emerge as the field grows.

A particular area of Indigenous futures thinking that is ripe for innovative advances, relates to Indigenous conceptions of time that differ to Western linear conceptions. One example is by the Ambonwari people of Papua New Guinea, where there exists relational temporality, and time is inextricable in its existence and perception in the context of other events or time periods (Telban 2017). Another relational understanding of time and space is evident across Australian Indigenous cultures, where seasons are demarcated based on the life stages of different plant and animal species (e.g., Woodward 2010). Circular and relational time is also concisely captured by the Australian Indigenous notion of "Everywhen", where past, present, and future co-exist simultaneously and consequently, there are obligations to consider actions across the whole circle of time (McGrath and Rademaker 2023). These notions of time have important implications for the approaches taken to explore alternative 'futures'; for example, reimagining a future that is already emergent today to inform decision-making and acting with inter-generational care (Bates et al. 2023). The 'Entangled

Time Tree' of Terry et al. (2024) identified in this review resonates strongly with the diverse concepts of time as circular, of inter-connected past-present-future, a concurrent dimension of place. Indigenous conceptions of time also have implications for the lengths of time that are anticipated or explored, often along extensive timescales due to their histories that can span multi-millennia (Bates et al. 2023). For example, in our review the longest future timeframe of 200 years was explored in the Native sci-fi film *Future Warrior* (2007), which maps past colonial violence onto technological futures, representing "the Native Apocalypse" that has arguably already taken place (Lempert 2014). Indigenous concepts of time and long-term thinking appear able to enrich and inspire new understandings of diverse futures.

The growing awareness of the need for respectful, reciprocal, and relational co-designing of work and research with Indigenous people, as well as critical developments in Indigenous rights and research suggests that change is underway (Akama et al. 2019; Chilisa 2011; Davis 2010). Moreover, meaningful inclusion of Indigenous methodologies in sustainability and transdisciplinary research practice is growing (Chilisa 2017; Datta 2015; Gould et al. 2019; Reid et al. 2021; Ruwhiu et al. 2021; Zanotti and Palomino-Schalscha 2016). There has been increasing discourse around recognising ICIP since the UNDRIP reaffirmed Indigenous peoples' rights to self-determination (UN General Assembly 2007). For example, Indigenous data sovereignty has recently been developed as a principle (Carroll et al. 2021; Walter et al. 2020), which can provide the institutional scope to support increasing Indigenous involvement and agency in ICIP in Indigenous futures thinking research.

Strengths-based approaches, adopted largely in the Culturally grounded and Indigenising framings, are empowering Indigenous peoples and thereby elevating challenges to colonial structures and associated modes of capitalism, economic growth, and modernity as an ongoing process that urgently needs to shift for a sustainable future. The Participatory framing demonstrates great capacity to mobilise diverse Indigenous constructs, including worldviews, and broad and specific values such as stewardship and connection, also recognised as essential for sustainable futures (Raymond et al. 2023). Researchers can apply all four framings (Adaptation oriented, Participatory, Culturally grounded, and Indigenising) to contribute positively together with Indigenous peoples to think about transformative futures in ways that empower Indigenous societies, their knowledges, cultures, and territories.

We argue that the frames and tools identified in this review can also be leveraged to explore and envision alternatives to non-Indigenous social injustices, such as problems of marginalised urban communities, poor rural farmers, or Indian scheduled castes. Transnational solidarities among Indigenous and other marginalised peoples are increasing in the sustainability domain, suggesting that actions, such as fostering international Indigenous futures thinking networks and conferences, could promote knowledge sharing, mobilisation, and action across multiple relevant contexts. Furthermore, the Indigenising frame has relevance for countries where Indigenous people have maintained or re-established their own governance (e.g., some Pacific Island, African, and Asian nations). In these contexts, the focus may be more on approache2s that centre a resurgence in the local or traditional culture (in line with the Culturally grounded frame), rather than Western-centric approaches.

Models are a particularly useful means of developing futures, by enabling consistent projection of consequences for people, for economies, for nature, and nature's benefits to people (IPBES 2016). Models were most strongly applied in the Adaptation oriented and Participatory frames, where participants appreciated contributions in terms of grounding the futures in realistic data-driven scenarios, and their roles as boundary objects that enabled communication among people with diverse perspectives. Researchers seeking to bring Indigenous peoples together with other stakeholders to generate community cohesion and strengthen anticipatory adaptive capacity (*sensu* Engle 2011), or Indigenous organisations and nations that want to produce model forecasts to plan their own activities, will likely find the Adaptation oriented and Participatory frames most useful.

Our review identified an inverse relationship between the use of models in futures thinking and the inclusion of Indigenous constructs. While discontinuities and dynamisms of global environmental and social change are difficult to capture in models (Cork et al. 2023), progress has been made in translating socio-cultural concepts into models, particularly through agent-based, fuzzy-cognitive mapping, and Bayesian approaches that allow for the incorporation of diverse types of expertise (Ferrier et al. 2016; Rojas et al. 2022). However, we emphasise that a shift towards Indigenous-led modelling approaches is needed in Indigenous futures thinking, where Indigenous worldviews and constructs can be adequately represented in the exploration of alternative futures. Qualitative and semi-quantitative modelling approaches such as signed diagraphs (e.g., Dambacher et al. 2007), fuzzy cognitive maps, or social network analyses, which can use numerical analyses of values that are qualitative or conceptual (Voinov et al. 2018), can bridge many domains and many knowledge types (e.g., Sarmiento et al. 2024). While care needs to be taken when applying quantitative models to more social and cultural contexts, modelling options are usefully expanding there also (Gotts et al. 2019). For example, the use of Bayesian belief networks has helped address First Nations and community concerns around fisheries management and ecosystem health, and to assert their governance authority (Reid et al. 2021; Tulloch et al. 2024). Recent research argues for trans-systemic approaches, which

take seriously the challenges to Western worldviews that underpin most current models and consider Indigenous systems thinking and associated opportunities for tackling issues related to complexity, reconciliation, and dynamic views of time and cosmology (McIntyre et al. 2023). Thus, the use of new types of models in futures thinking is a fruitful area for further research with, for, and by Indigenous peoples.

Related to innovations of perceiving time are the scales at which Indigenous futures thinking is taking place. The scales where Indigenous people have been developing their agency (i.e., at the local Indigenous nation and international policy forum levels) is where Indigenous futures thinking is evolving. Examples of these international-level processes are global assessments of biodiversity and ecosystem services undertaken by the IPBES and the CBD (Forest Peoples Programme 2020; Lyver et al. 2015). This likely reflects the reality that Indigenous people continue to face barriers at national and regional levels, such as the lack of recognition of Indigenous sovereignty by governments in policy and natural resource management (Emanuel and Wilkins 2020; Löf 2013). Indigenising processes of futures thinking at national and regional levels will support the transformative change for sustainable and just futures needed across multiple scales, particularly from national to international levels (Reyes-García et al. 2022). An example of this is the use of forums such as the Arctic Council (arctic-council.org) to lead and support Indigenous cooperation between nations.

Limitations and further research

The systematic review approach used here proved extremely time-consuming in terms of generating many papers for screening, which ultimately led to relatively few that met our criteria, while also missing many. This is supported by the result of finding over one-third of the literature (22 out of 64 publications) through other searching means (i.e., expert notification and citation searches). As noted above, this largely results from the inconsistent terminology used in titles and abstracts. A literature review approach based on bringing together experts in the field to identify relevant papers is likely to have been much more effective and efficient in this case—and also in any newly emerging field of research (Sutton et al. 2019). We note that certain geographical regions are also very likely underrepresented in our review as a result of this.

We would like to encourage further research in this field. Futures research in general is quite fragmented, is published in a wide variety of journals and technical reports, across many fields, and uses a wide variety of concepts and inconsistent terminology (Kuiper et al. 2024). For example, there was not much clarity as to how these processes have been incorporated into policy and planning, or how to evaluate the long-term value and success of futures thinking. Criteria, such as that developed by Wiek et al. (2014), highlight important considerations for applying visioning and futuring processes. Nevertheless, the further development of sets of evaluation criteria specific to individual Indigenous-led processes could be an important step in applying futuring more broadly.

Conclusions

Our review was inspired by the recognition that Indigenous peoples can contribute innovations in futures thinking as a result of holding unique knowledge systems, worldviews, and perspectives on time; and of many of them already living in a post-apocalyptic situation resulting from colonialism (Mazzocchi 2020; Parsons et al. 2017). We discovered an inspiring example that delivered on this potential: the 2018 Sámi Márkomeannu festival set 100 years in the future which foresees the Earth transformed by climate change and social inequalities, where only Indigenous peoples have managed to preserve nature and culture in isolated enclaves framed as Indigenous sanctuaries. Given consistent evidence that humanity is facing major population and resource-use transitions over the next 100 years with high uncertainty around the impacts of future changes, increasing the time frame of futures thinking is urgent (Nebel et al. 2023; Turner 2008).

To deal with the diverse terminology and sector-specific thinking we encountered, we have produced a glossary that includes an array of field-specific terms (see Glossary). Emerging strengths in this field are the clear scope and potential of creative innovations to continue futures exploration, particularly those that prioritise Indigenous leadership and a strong ethics of care in the research, consider other perspectives of time as a construct, address the struggles of Indigenous and other marginalised people, capture plurality of knowledges, promote self-determination and self-governance of Indigenous peoples, and support reconciliation and equity in striving towards better futures. Our review of patterns and processes identified four frames of Indigenous futures thinking: *Adaptation oriented*, which enables communities to consider changes in the future, identify ways to better manage these changes, and build anticipatory adaptive capacity; *Participatory*, which strengthens the contributions of many different peoples and their diverse expertise to thinking about the future; *Culturally grounded*, which deepens the cultural/local context to leverage Indigenous people's agency more centrally; and *Indigenising*, which enables Indigenous futurity as a practice of re-centring to privilege the Indigenous voice and counter Western/modern dominance. Key methods, tools, and outcomes are characteristic of each frame, but strong interaction and learning has occurred across all four, resulting in conceptual overlaps

between the frames. By distinguishing the different key ideas underpinning the frames however, we hope to add some insight and structure to the evolving discourses, as well as highlight commonalities and distinctions between differing approaches in Indigenous futures thinking as an emerging field of research.

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Data availability The Indigenous futures thinking database created that supports the findings of this review article is publicly available through https://data.csiro.au/collection/csiro:62010.

Declarations

Conflict of interest The authors declare that they have no known conflicts of interest in the production of this paper.

Ethical approval Ethics approval was not necessary for conducting this literature review.

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