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TOPICAL REVIEW

Transforming towards what? A review of futures-thinking applied in the quest for navigating sustainability transformations

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Abstract

There is a growing call for transformations to remain within safe and just Earth system boundaries. Coherent visions of desired futures can help motivate and orient such transformations towards Sustainability, but the nature of these transformed futures is not well understood. This gap has inspired a growing body of research on 'preferable' or 'desirable' futures, which can help to unpack what endpoints such transformations to sustainability could entail and what is needed to get there. In this paper, we adopt a mixed methods approach to review the research literature focused on transformative futures so as to gain a general overview of the field and then undertake two qualitative analyses: (i) unpacking the methods, terms and types of outputs produced; and (ii) capturing emergent themes, commonalities and divergences in what is deemed to be a sustainable transformation in the future based on normative visions from either North, South or Global perspectives. Our findings show that the literature landscape on explorative scenarios has significantly increased in the past ten years with most publications led by authors in the Global North. From the fraction of studies that describe desirable futures, visions highlight social, environmental and equity dimensions, but nuances were found between North and South. The visions that suggest the most transformative potential seek a more harmonious human-nature relationship and consider outcomes holistically, but only a fraction offer actual 'alternatives' to the *status quo*. We find that several gaps remain at the interface of biodiversity/ecosystems and justice, or the integration and impact of diverse knowledges and cultures. Addressing these in participatory, just and creative ways seems of utmost urgency. We hope this review can offer a glimpse of how futures-thinking can contribute to research and action on sustainability transformations, and the insights can inform and inspire future research.

1. Introduction

There is a growing call for transformative change or transformations to remain within safe and just Earth System boundaries (Muiderman *et al* 2022, Gupta *et al* 2023). However, what these transformed futures look like, or towards where this transformation is oriented, is less well understood. Conceptualizations of what transformations to sustainability mean vary depending on different disciplinary traditions, frameworks and theories of change (Scoones *et al* 2018, Scoones and Stirling 2020), and accordingly, so do the mechanisms for identifying and moving towards different types and degrees of change (Cork *et al* 2023). Generally, however, they encompass fundamental changes in structural, functional, relational,

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and cognitive aspects of socio-technical-ecological systems that lead to new patterns of interactions and outcomes (Patterson *et al* 2017). From a normative perspective rooted in Sustainability Science (Clark 2007, Miller *et al* 2014, Schneider *et al* 2019), we start with the premise that current sustainability challenges demand transformative and deliberate change (O'Brien 2011). This entails proactively moving beyond mere incremental improvements to our social-ecological systems (Miller *et al* 2014, Olsson *et al* 2014, Bennett *et al* 2016, Patterson *et al* 2017, IPBES 2019, Claudet *et al* 2021). This type of change implies a normative choice and therefore a collective agreement on endpoints–i.e. coherent future visions.

In this context, futures-thinking approaches have become a popular means to understand and use the future to plan for transformative change (Miller *et al* 2014, Sharpe *et al* 2016, Hebinck *et al* 2018, Cork *et al* 2023). They help embrace deep uncertainty and allow us to anticipate discontinuities, enhance agency and coordinate efforts to drive positive change (Inayatullah 2008, Tengö *et al* 2021). By futures-thinking, we refer to the diverse ways in which we can: (i) structurally think about a range of alternative futures–drawing on the deeper explanations of Inayatullah (2008) and Sardar (2010); and (ii) explore pathways to these (Leach *et al* 2010).

While many approaches and tools to enhance futures-thinking exist (Pereira *et al* 2020a), scenarios represent the paradigmatic tool and all-encompassing term characterising how alternative futures can be developed in practice (Bishop *et al* 2007, Inayatullah 2008). The term scenario, however, does not necessarily describe the operationalization of a truly transformative agenda within futures-thinking, with scenarios that may serve to preserve rather than reconfigure the *status quo* towards justice and sustainability (Lauer *et al* 2024). A transformative approach to futures-thinking, however, is grounded in defying the *status quo* of established challenges, assumptions and extrapolations (Pereira *et al* 2018a). This means that scenarios themselves cannot be mere linear extrapolations or predictions, rather, they need to propose radically different futures (Pereira *et al* 2018a).

1.1. Current gaps in this emerging field

Amongst a general popularity and uptake of terms like transformations and scenarios there is a growing interest in understanding the role that transformative futures-thinking and its related methodologies can offer to truly advance towards sustainable change while achieving a more harmonious relationship with the biosphere (Kuiper *et al* 2024). Recently published reviews (McPhearson *et al* 2016, Moore and Milkoreit 2020, Muiderman *et al* 2022, Riedy and Waddock 2022, Cork *et al* 2023, Lauer *et al* 2024) evidence this interest and report a distinct increase in futures publications in the last two decades. However, they lack attention and detail to the range of methods and approaches that are used, or the description of the visions that are put forward in the studies. In addition, these studies rely on publications in the peer-reviewed literature and in English, which can reproduce epistemic injustices and miss the opportunity to capture the diversity of perspectives, values and worldviews that is advocated to be needed in the field (Pereira *et al* 2021, Tengö *et al* 2021, Chibwe *et al* 2024).

To date, there is limited understanding about the totality or partial images of the world that the studies envisage, where or from whom they come, or the degree of difference from the current *status quo* they propose (for one exception see Lauer *et al* 2024). This creates a narrow, and compartmentalised view of the state of the art in this emergent field and forecloses the opportunity to compare and problematize scenarios, or leverage them to accelerate planning and action. This study seeks to fill this gap by addressing the following questions: (i) what is the research literature landscape on transformative futures like? This includes an understanding of where scenarios studies are produced from and published (e.g. geographic distribution, main journals); (ii) what are the main methods and outputs produced? This includes aspects of the study design involving types of scenarios developed, scenario methods, type of participants, format of the outputs and scope of geographical relevance; and (iii) what are the contents of transformative scenarios? This spans from identifying main topics addressed, synthesising the features (similarities and differences between the visions) and identifying how transformative the visions suggest to be. The answer to these questions can offer a glimpse of how futures-thinking is being used to contribute to research and action on sustainability transformations by describing emerging literature published in three languages (English, Spanish and French), tracing the desired future imaginaries that are being developed and highlighting where the gaps or biases remain. Before introducing our methodology, we start by developing a conceptual framework that informs our analysis and underpin the rationale behind our insights.

1.2. A framework of scenarios and their transformative potential

Scenarios are described in different ways in the literature, usually with terms such as 'possible', 'probable' and 'preferable' (Voros 2003, Börjeson *et al* 2006). Much of the scholarly work has focused on determining typologies for scenarios and ways to categorise future visions (van Notten *et al* 2003, Börjeson *et al* 2006, Hunt *et al* 2012). Typologies of scenarios

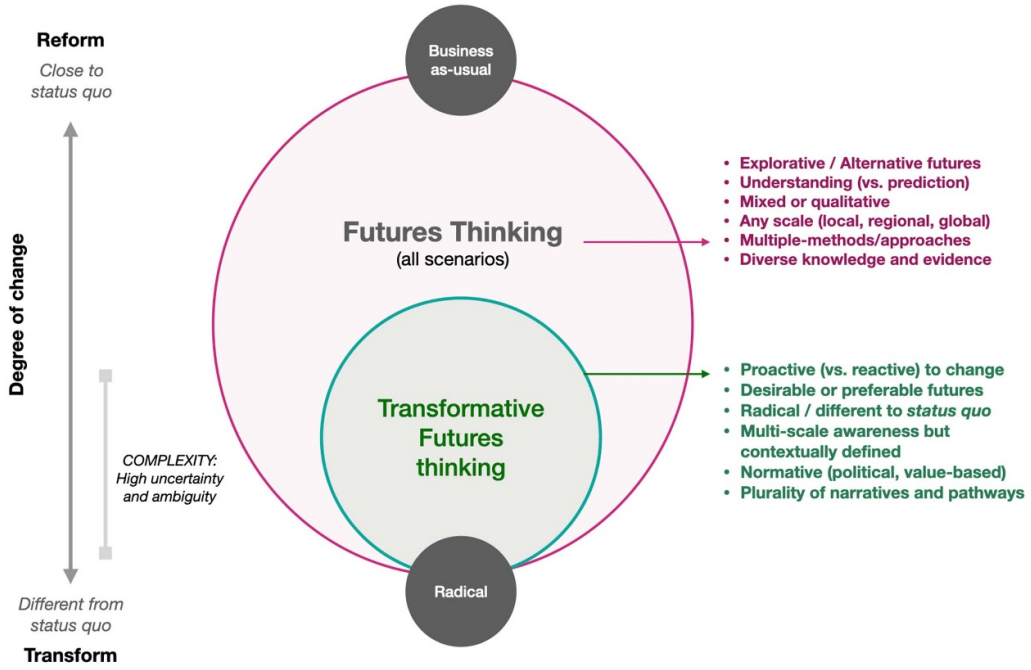


Figure 1. Visual representation of the conceptual framework adopted in this work, positioning scenarios in their diversity, and situating transformative futures-thinking as a subset, typically aligned with normative scenarios that depart from the *status quo*.

vary depending on the analytical units chosen and can offer information about the types of questions raised, main purposes or goals, themes of focus and processes adopted (Pereira *et al* 2021). Within transformative sustainability research, we can broadly distinguish scenario work mainly aimed at (i) exploring a range of possibilities (or alternatives); (ii) identifying what is 'probable'; or (iii) explicitly aiming to determine the preferable (Voros 2003). We see scenarios as a tool to explore the possibility space (rather than predicting endpoints) and to inform action in the context of deep uncertainty (Bai *et al* 2016). In this review, we differentiate between two main types of scenarios: explorative and normative futures (Börjeson *et al* 2006). Explorative (or descriptive *sensu* van Notten *et al* (2003) and Shearer (2005)) scenarios are focused on exploring possible situations or developments, and attempt to answer the question of 'what can or might happen if…?'. Here, we group futures described as 'possible', 'plausible', 'feasible' and 'probable'.

On the other hand, normative futures are those that define specific goals or aspirations, therefore concerned with the question of 'what do we want in the future?'. Here, we group futures described as 'preferable', 'target-seeking', 'desirable' or 'normative'. While these futures could also be placed in different locations along the probable to plausible range of the futures cone (Hancock and Bezold 1994, Voros 2003, Shearer 2005, Gall *et al* 2022), the normative aspect explicitly integrates the values, interests or priorities of the scenario developers themselves (van Notten *et al* 2003). These scenarios or visions depict desired end states and can sometimes have significant transformative potential because they help inspire, align and advance thinking towards futures that–to be sustainable–need to depart significantly from the *status quo* (Bai *et al* 2016, Sharpe *et al* 2016, Pereira *et al* 2018b, Hölscher *et al* 2022), even becoming 'preposterous' (*sensu* Voros 2003). While all scenarios (normative or not) unavoidably include value-based assumptions, we propose that normative scenarios–characterised as 'preferred' or 'proactive' (Shearer 2005, Inayatullah 2008)–offer the most transformative potential as they are meant to be used as plans for action–i.e. deliberate change. Transformative futures-thinking resides mainly in these normative scenarios that describe and offer roadmaps for action that steer away from unsustainable trajectories for societies (see figure 1 for the visualization of this framework).

2. Methods

2.1. Sources and search strings

We conducted a semi-systematic review (Snyder 2019) focused on research papers published in the scholarly literature, intersecting futures-thinking and sustainability transformations within the last twenty years (2003–2023 span). This type of review helps to capture the general state and evolution of knowledge in a particular field, offering an overview of its main themes, and generating insights from quantitative and qualitative analysis of key (albeit not all) publications. While our approach was systematic, there are

limitations within the tools and choices made, which we outline and discuss in the Discussion section. Results reflect–to the best of our abilities–the most prominent scholarly literature landscape. To compensate for a common language bias found in literature reviews, we included two databases to capture results in Spanish and French. We believe this is particularly needed to account for more plural conceptualizations and thus diversity in how the future is being envisaged across the globe.

All in all, four databases were used: for literature in English, Scopus and Web of Science, and, Isidore and Scielo for French and Spanish literature respectively. The keywords used to search these databases included 'sustainability', 'transformation', 'normative/preferable/desirable', 'visions' or 'scenarios', among others (see table 1 in Supplementary data I) in the publication titles, abstracts and keywords. We prioritised the term 'futures' in plural, especially in keywords, to narrow results to those that explicitly adopt futures-thinking approaches that understand that the future cannot be singular (Rowland and Spaniol 2015). This also excludes irrelevant results that frequently conflate the term future with sustainability without connections to futures-thinking. The main search string used in Scopus is shown below. Search strings were replicated and adjusted by language across the four databases (refer to the full list in table 2 in Supplementary data I).

> Scopus: (TITLE-ABS ("transformat*" AND "sustainab*" OR "vision*" OR "scenario*" OR "imaginat*" OR "foresight" OR "anticipat*" OR "normative" OR "desir*" OR "prefer*") AND KEY ("future*") AND KEY ("vision*" OR "scenario*" OR "imaginat*" OR "foresight" OR "anticipat*" OR "normative" OR "desir*" OR "prefer*") AND (LIMIT-TO (LANGUAGE, "English") OR LIMIT-TO (LANGUAGE, "French") OR LIMIT-TO (LANGUAGE, "Spanish")) AND (LIMIT-TO (SRCTYPE, "j")) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "re")) AND (LIMIT-TO (PUBSTAGE, "final"))

The process of moving from the initial records ($n = 653$) to the final dataset ($n = 66$) was informed by the PRISMA protocol for systematic reviews (Page *et al* 2021). Our screening process yielded 49 records, to which we manually added a set of 16 after cross-checking records against known publications and studies referenced in the Biosphere Futures database (Kuiper *et al* 2024). This process was replicated a second time to confirm the methodology was sound and no relevant records were missing (see figure 2). Two rounds of screening were performed for results retrieved from the bibliography databases. The first round applied inclusion and exclusion criteria to titles, abstracts, keywords, journals and publication types. This screening was performed in two steps, with records assessed by two researchers, and a third one when there were discrepancies. A second round screened full articles to make sure that publications referred to sustainability transformations, applied futures-thinking methodologies, contained visions/scenarios and reported methods adopted. During screening, we excluded publications that were either only theoretical (e.g. frameworks, reviews, syntheses), or methodological without explicit scenarios (e.g. new method or approach); and those that examined existing imaginaries without proposing new (future) visions. Further methodological details and information on search terms, strings, and the inclusion and exclusion criteria can be found in Supplementary data I.

2.2. Data analysis

We conducted a quantitative and qualitative analysis of the literature in two degrees of depth: (i) for the dataset of all scenarios ($n = 66$) (see section 3.1), and (ii) for a sub-set of those focused on normative ones ($n = 17$) (see section 3.2). The first set addresses the first research question about the literature landscape and the second question on methods and outputs. We carried out a quantitative bibliometric analysis using the software R Studio (R Core Team 2022) to help illustrate publication trends. We also analysed the geographic spread of leading institutions for these studies based on the affiliations of the main authors (either first author or corresponding author) (section 3.1.1). We further qualitatively coded the studies to identify the types of scenarios and terms adopted, and plotted them manually using the futures cone visual heuristic *(sensu* Voros 2017) (section 3.1.2). To address the second question on methods, we coded the scenario development methods described, the format of outputs produced (e.g. textual narratives or stories, images like paintings, illustrations, etc) and the geographic scope of relevance of the scenarios (section 3.1.3). This was determined based on whether authors mentioned scenarios to be locally, regionally or globally relevant. When not explicitly described, we assumed authors refer to scenarios as globally applicable.

The second dataset was used to answer the third question on the contents of transformative scenarios. We conducted an in-depth qualitative analysis on the subset of 17 publications that specifically focussed on generating normative or desirable future visions. We zoomed in on these as a proxy to capture the main efforts and examples of transformative future thinking in action. From 51 single visions identified, 49 were kept after removing duplicates (see

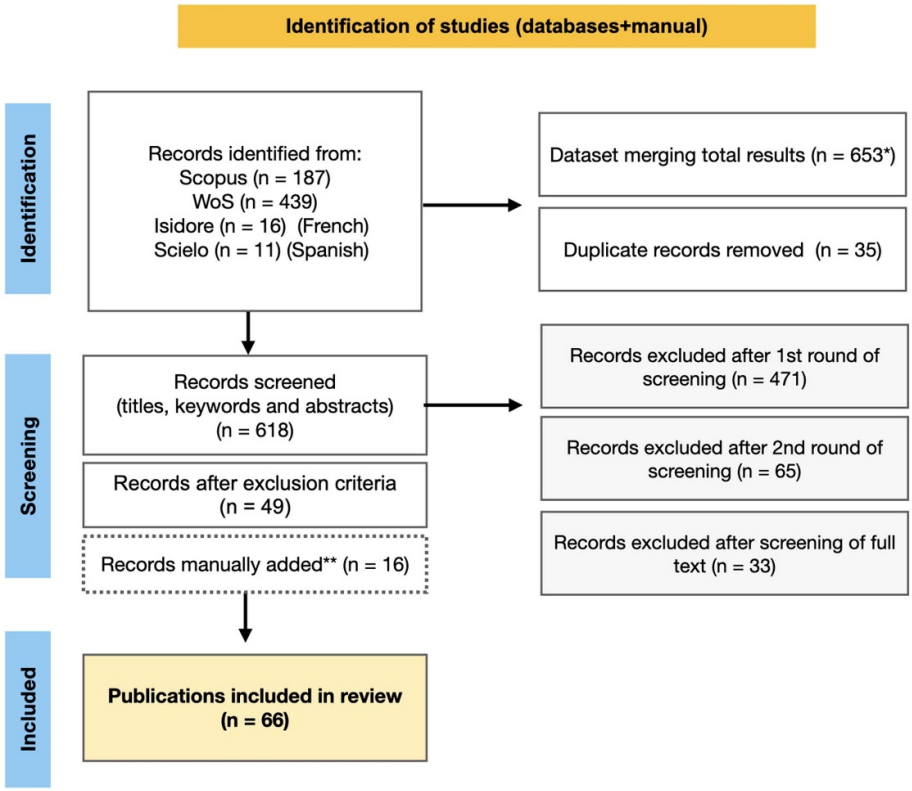


Figure 2. Flowchart of the systematic process (informed by the PRISMA protocol). Adapted from Page *et al* (2021) CC BY 4.0.

Supplementary data I). For this sub-set, we aimed to identify: (i) What are the main focus areas of the preferred futures?; (ii) What do these futures prioritize?; and (iii) How transformative are these visions? We carried out a qualitative content analysis (Saldaña 2011) of the visions described, and generated themes to synthesise the most important features of their contents. Comparison of the frequency of themes helped capture similarities and differences across visions produced with either Global North, Global South or Global (mixed) participants (section 3.2).

The thematic analysis was structured around STEEP-E dimensions: adapting the STEEP model by Schultz (2015) (i.e. Social, Technological, Economic, Environmental, Political) with the addition of an Equity/Justice dimension as a way to capture nuances reflected in the just transformations discourse (Bennett *et al* 2019, Moore and Milkoreit 2020). This is also relevant when considering Global North/South perspectives and differences. To define the themes, we randomly selected three papers and conducted content analysis of the visions to identify emergent themes. Two researchers then moved iteratively between the STEEP-E structure, the emerging themes, and the visions until all visions were coded. The lead author then merged and validated the final set of themes. Each vision was then coded considering how substantially they differ from the *status quo* of the present. We situated single visions along this transformative continuum categorising them as: Stagnant (rooted, clinging to the *status quo*); Progressive (alternative but safe, forward movement); Transformative (challenging the *status quo*, innovative); and Radical (detached, unrooted, totally alternative world).

Given the subjective nature of this analysis, we complemented it by cross-checking results against two additional dimensions: human-nature connections, and systemic outcomes. The first rests on the understanding that rebuilding the connection between people and the biosphere is at the core of the sustainability agenda and thus central for a paradigm change (Pascual *et al* 2023). We developed *a-priori* themes to classify the relationship between humans and nature in the visions as: 'Human-nature connections not a priority' (when this feature was absent), 'Human-nature harmony', and 'Nature as instrumental'. 'Human-nature harmony' refers to descriptions that highlight the intrinsic value of nature for people, or a relational understanding (i.e. mutual interdependence), whereas 'nature as instrumental' refers to views that highlight an anthropocentric view of the value of nature for its contributions to people alone (Pascual *et al* 2017, Rosa *et al* 2017, Pereira *et al* 2020b). Secondly, we assessed how systemic the visions were, based on whether they simultaneously prioritised outcomes for: people, ecosystems and biodiversity, climate, governance, culture or knowledge, and justice (Vasiliev 2022). This helped

highlight whether the visions were comprehensive in their understanding of transformations as encompassing multidimensional changes that result in new patterns of interactions and outcomes for people and nature (Patterson *et al* 2017). Further details including a description of codes and themes adopted can be found in Supplementary data I.

3. Results

3.1. Overall literature landscape: terms, methods and reach

3.1.1. Literature and geographic spread

Our results demonstrate a trend of increasing representation of transformative futures-thinking in the peer-reviewed literature over the past 20 years (figure 3(a)), especially in the last decade (2014–2023). The most prolific years for our search terms were 2020 and 2022 (11 publications each). Our search yielded only six publications from the first decade of our time scope (2003–2013), illustrating a nascent field that is now becoming more established, building on the broader field of sustainability futures more generally. The most prominent journals featuring transformative futures research were Ecology and Society (12 articles) and Futures (6 articles) (figure 3(b) and full list in table 1, Supplementary data II).

Most publications (90%) were led by authors from institutions in Global North countries. The United States was most represented (10 studies), followed by Sweden (7), the United Kingdom (5), France (5), and Australia (4). Very few publications (10%) were led by institutions from the Global South. Representation in this group was led by South Africa (5), followed by Zimbabwe, Brazil and Chile with 1 study each (figure 4). We note that our dataset only includes 3 publications in French (out of 16 initial records), and no publications in Spanish (out of 11 initial). Most of the non-English publications were excluded after applying our criteria, mainly because they did not adopt a transformative approach or include descriptions of newly developed visions (e.g. they analysed existent/past imaginaries).

3.1.2. Types of scenarios and terms used

To compare the normative and explorative studies in our dataset, we investigated the terms adopted to describe futures and visually mapped them using the futures cone model (figure 5). The publications that develop explorative scenarios exclusively, adopt terms like: 'possible', 'plausible', 'probable' (25 studies). When terms like 'alternative', 'dreamed' or 'speculative' futures were used (4 studies), these were marked as 'preposterous'. While these terms reflect normative stances, they are often deemed by the authors as speculative, imaginative and explorative exercises, thus not reflecting common agreements on preferability. Explicitly normative studies adopt terms like: 'desirable', 'preferable' or 'normative'.

Of the publications reviewed ($n = 66$), the majority (47 publications or 71%) do not focus on normative futures alone. Another 18 publications develop a mix of normative and explorative scenarios (e.g. one 'business as usual' and one 'dreamed' future). Thus, developing normative scenarios within exploratory studies is a relatively frequent practice. Only 19 publications (29%) focus on normative futures exclusively. All in all, this identifies a trend towards exploring the possibility space rather than promoting a particular future vision.

3.1.3. Methods adopted and scope of applicability

Most publications adopted a combination of methods to develop scenarios. The most popular method was the participatory scenario workshop (roughly half of the studies). This is followed by literature reviews or other forms of data analysis and by expert consultation through surveys, interviews or Delphi (16 and 15 publications respectively). Creative or speculative methods (i.e. science fiction prototyping, theatre, etc) and different forms of modelling, simulation or mapping are the least mentioned methods (11 and 7 studies), but are most prominent in explorative scenarios. Figure 6 shows a visual correlation between method groups, type of scenarios developed with them, and scope of relevance of the resulting visions. This further highlight that participatory scenario workshops (i.e. qualitative data/co-creation sessions) are the most prominent method to develop explorative and normative scenarios, especially those with local scopes. The adoption of quantitative analyses or expert-based data is more popular in explorative rather than normative scenarios.

Assessing the geographic scope of the scenarios, we found that a majority of the studies (52%) focus on local scenarios, followed by 26% portraying regional ones (e.g. that apply to Europe as a whole) and global-scale scenarios accounting for 21% of the studies. This demonstrates a tendency to prioritise localised (or place-based) over globalised futures.

3.2. Normative future visions: key features, process and outputs

In this section, we synthesise the main insights from our thematic qualitative analysis of 49 individual and distinct visions found across 17 publications focused exclusively on normative futures (see table 3 in Supplementary data I for a detailed list).

3.2.1. Perspectives captured and scope of relevance

Study designs for normative futures tend to be quite participatory and engage diverse participants other than the researchers or expert groups leading the studies. The most popular method was the visioning

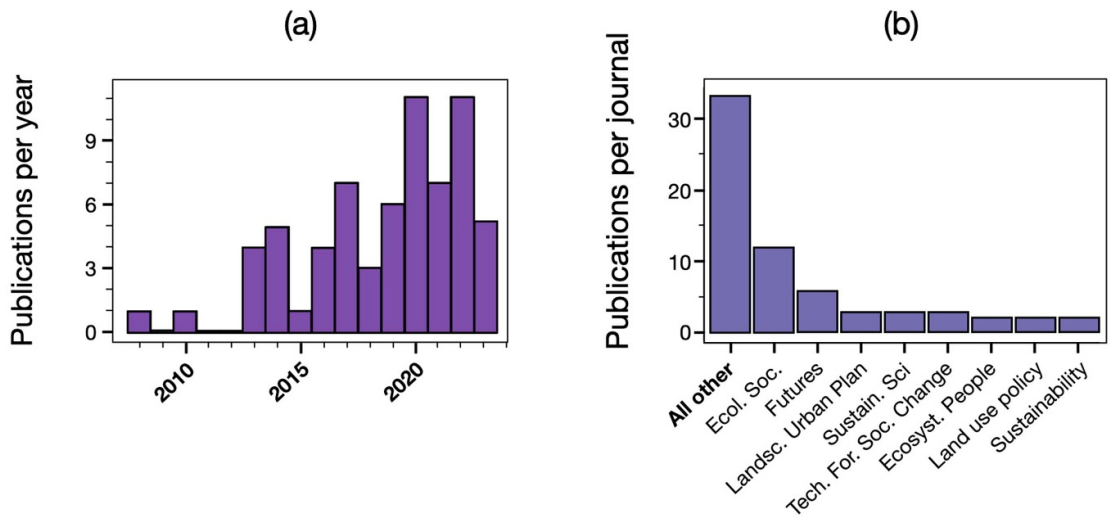


Figure 3. Distribution of the literature landscape across time and across journals. (a) Displays the timeline of publications per year over the last two decades (2003–2023) ($n = 66$). (b) Shows the number of publications per journal. The category 'other' captures all journals with only one publication.

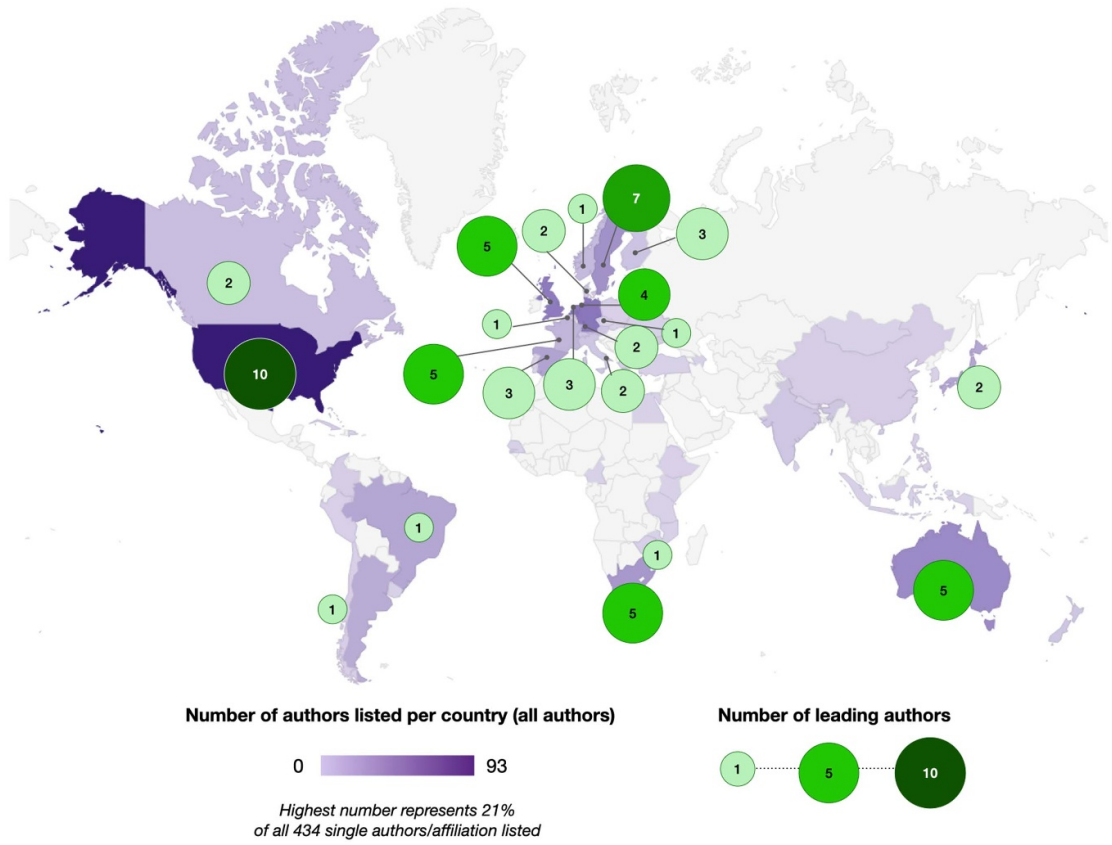


Figure 4. Geographical distribution of authorship. The map highlights the number of authors per country represented in the authorship list for all publications (in purple). We juxtapose green bubbles to highlight the number of leading authors per country. Countries coloured but without bubbles represent that no leading author is based in such a country. We note that authorship here represents countries of affiliation registered, where some authors include more than one country. Not all studies included affiliation information for all authors.

workshop, used to develop 67% of all visions. These workshops described structured approaches to engage participants in co-creation processes while adopting various methods and frameworks. Several of them relied on creative methods and outputs. Refer to table 2 in Supplementary data II for further details on each study.

To understand who produced the visions, and capture their distribution and scope or relevance for comparative purposes, we mapped the location of

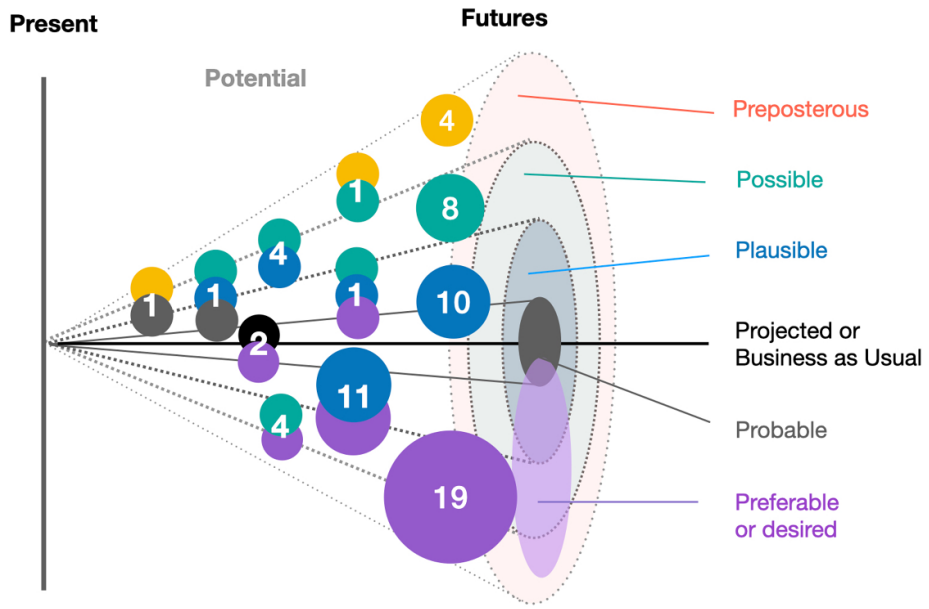


Figure 5. The image depicts how the studies are plotted along the futures cone (*sensu* Voros 2003), adopting a well-known visual heuristic. Numbers indicate the total number of publications (more publications equal larger bubble sizes) and the colours correlate with the type of future scenarios developed (Purple: Preferable, Black: Projected, Blue: Plausible, Green: Possible, Yellow: Preposterous). The placement of bubbles along the *x*-axis does not suggest a timeline, nor does it suggest that studies are more or less anticipatory (distant to the present). Combined colour bubbles refer to studies that develop more than one type of scenario. The publications marked in yellow adopt other terms (speculative, alternative, dreamed or radical) that make them explorative and potentially closer to preposterous futures although not stated explicitly. Adapted with permission from Voros (2003). Copyright © 2003, Emerald Publishing Limited.

Methods	By scope of relevance			By scenario type			Studies
	LOCAL	REGIONAL	GLOBAL	NORMATIVE	EXPLORATIVE	MIXED	w/method
Delphi, surveys, interviews	10	4	1	3	9	3	**15**
Literature based, analysis, data mining	11	4	1	3	9	3	**16**
Modelling, simulation, mapping	3	3	1	0	4	3	**7**
Backcasting	2	1	1	3	1	0	**4**
Participatory workshops	29	9	11	17	20	12	**49**
Speculative / Creative	4	2	5	3	7	1	**11**

Figure 6. Heat map displaying the main types of methods adopted in the studies and the relationship to the scope of applicability of the visions (either local, regional or global) and the type of scenarios developed with them (either normative, explorative or mixed). Numbers reflect the studies that mention a type of method. Total number of studies exceeds the number of publications because most studies combine methods.

visions. Location (or rootedness) is defined based on where studies were conducted and on participants' backgrounds (not on the studies' authorship as was done in 3.1.1). Most studies (13 out of 17) adopt a place-based approach seeking insights relevant to a particular area, thus engaging local or regional participants. For example, Hölscher *et al* (2022), Raudsepp-Hearne *et al* (2020) and Reidsma *et al* (2023) focused on different European regions; Bourgeois *et al* (2017) on three Asian countries, and Lembi *et al* (2020) on a specific forest region in Brazil. However, a few studies engaged participants from around the globe, thus mixing South and North perspectives (e.g. Rana *et al* 2020, Durán *et al* 2023, Pereira *et al* 2023). We categorized these as Global (mixed) studies.

All in all, we were able to identify 51% of the visions rooted in the Global North, 27% as Global,

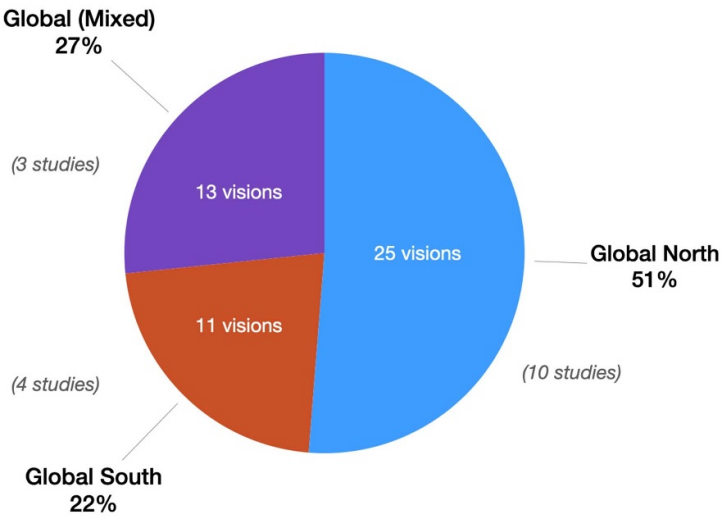


Figure 7. Distribution of the 49 visions across global North, South or mixed (global). This data is based on the details described by the authors. Three publications had global scopes and engaged international participants from both global North and South.

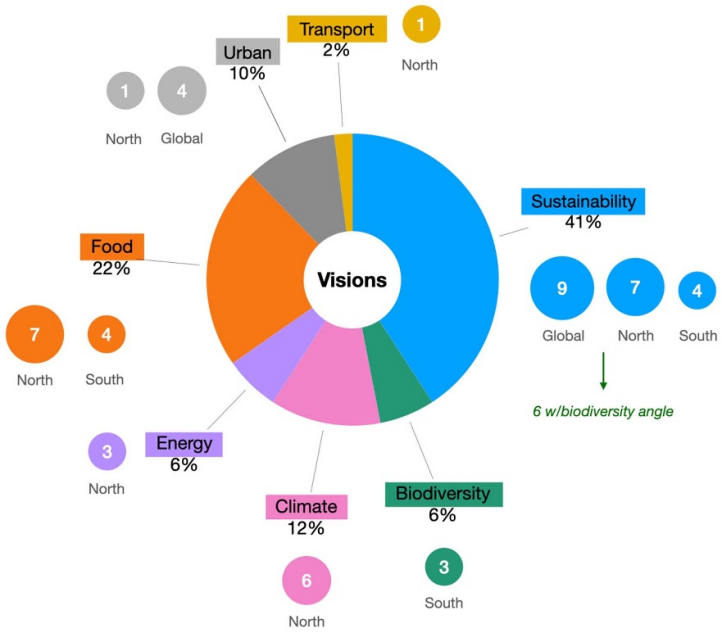


Figure 8. Overview of main topics addressed by the visions (bubbles indicate number of visions) and their distribution in terms of location: global (mixed) visions, and those developed from either global North or South perspectives.

and finally 22% from the Global South (figure 7). We note that while the vision location tends to correlate with their scope, authors are not always explicit about whether visions are locally, regionally or globally relevant.

3.2.2. Visions insights: content overlaps, differences and gaps

An overview of the topics addressed in the scenarios shed light on the priorities, differences and gaps that the research literature on transformative futures addresses. Figure 8 illustrates the main topics addressed in the visions and how they are distributed according to their rootedness. Most visions are concerned with sustainability goals in general, followed by food systems and climate. There are differences across locations: for example, Energy, Climate and Transport are prominent in North visions, while biodiversity emerges more strongly in the South (while also prominent to some North and Global sustainability-oriented studies).

To highlight the core components (i.e. the content) of the visions we report the main themes across all 49 visions following the STEEP-E categories. Refer to table 1 for a detailed description of each theme and the most prominent differences across the North/South or Global perspectives. Figure 9

Table 1. Overview of the main themes across STEEP-E dimensions. We highlight the central features (overlaps across all visions) and major differences when comparing prominence of themes in either global North or South. Themes are expanded to offer a clearer view of what these features mean in practice.

STEEP-E dimensions	Main themes and what they describe (full list of themes in Supplementary data I)	Notes on nuances and differences
Social	**1. Collective or co-operative societies.** These themes included, for example, societies living in communities where sharing, a sense of belonging, and self-governance were key features. **2. More empowered communities.**This theme refers to enhanced agency, consciousness or transparency (via information, technology, education) for daily lifestyles and overall decision-making and action. It includes community-based power and governance.	**Equity and equality i**s central for almost half of the visions in the Global South and not nearly as prominent for the North (20% of visions). This refers to embracing social and environmental issues equally, valuing all opinions, ensuring food security and access to good quality products, or indigenous access to land and its resources. Mixed/global visions strongly highlight inclusivity/diversity.
Environmental	**1. Reduced impact from resource intensive systems, and Urban transformations.** This referred to innovative agricultural models for sustainable food, reduced waste, food forests, intergenerational and traditional food practices. It also included revising energy, water, and transport systems to more sustainable solutions. Urban transformations referred to nature-based solutions, greening and wilding of cities, and new visions for cities where there would be smaller local communities. **2. Healthier human-nature relationships.** This theme included, for example, having more time to spend in and conserve nature, increased harmony between humans and nature through changed values, stewardship, ethical use of ecosystem services, and nature as having value and rights (e.g. sentient species other than humans).	All in all, Environmental themes are less prominent in the South than in the North. **Urban Transformation** (e.g. green cities, nature-based solutions) emerged as priorities in the Global North for over half of the visions, while **Conservation/Restoration** (e.g. bioregions, restoring biodiversity) are strongly stressed for the majority of the Global (77%) and also South visions (55%). **Healthier human-nature relationships** (e.g. harmony, ethical production, more time in nature) is central for almost all Global visions (85%).
Justice and equity	**1. More inclusion and participation.** This theme included, for example, inclusive decision-making regardless of demographic variances, and acknowledgement that nature has rights and needs to be considered. **2. Fair access and distribution, and embrace diversity and difference.** These themes included, for example, a decrease in wealth inequality, subsidies for the purchase of new energy or for rural development, decrease in electricity prices, and equitable access to open data. It also refers to acceptance/inclusivity of traditional and indigenous knowledge, intergenerational and traditional food practices, preservation of indigenous governance and leadership systems.	**Embracing diversity and difference** is a particularly strong theme in the South (73% of visions), also highlighted in under half of the Global visions, but contrastingly less relevant in the North (20%). **Fair access and distribution** is quite central for Global and South visions, but not North visions.

(Continued.)

Table 1. (Continued.)

STEEP-E dimensions	Main themes and what they describe (full list of themes in Supplementary data I)	Notes on nuances and differences
Economic	**1. Solidarity/localised economy.** This theme included, for example, there being less of a divide between rich and poor through more sharing and regenerative mechanisms, and economic localisation. **2. Circular economy.** This theme included, for example, closed-loop production, sharing and multiple use products, and circular food systems.	**Circular economy** is not prioritised in the Global South visions but a distinct feature of **improved livelihoods** only appears in this group (e.g. higher yields, job creation through botanical factories). Conversely, **post-materialism** and **alternative paradigms** are featured in the Global North and prominently in almost half of the Global visions (this refers to no longer using GDP or personal wealth, from land ownership to stewardship).
Political	**1. Enhanced governance models.** This theme included, for example, sustainability informed governance, collective decision-making, integrated and community-led platforms, cooperation, solidarity, and a priority placed on human rights. **2. Empowering legal mechanisms and policies.** This theme included, for example, young people can hold environmentally destructive individuals, companies, governments accountable through formal legislative mechanisms, fight for their rights and the rights of future generations, citizen led governance, decisions made with help of situational leaders; land sharing policies, no fights as equal access to land; or strong local institutions that facilitate farmers organisation.	**Enhanced governance models** are not prioritised in visions from the South (27%). Global South visions put emphasis on **empowering legal mechanisms and policies** (45%) and Global visions do so on **transnational/regional instruments/norms** (69%)(e.g. no nation states, international cooperation and collaboration). **Political consciousness** (e.g. non-hierarchical governance system, preservation of indigenous governance and leadership, micro-sovereignty of local groups) features as priority in almost half of the Global visions, and a third of South ones.
Technological	**1. Technology to meet daily needs.** This theme included, for example, using technology as a key mechanism to meet daily human communication needs, travel, delivery of goods, and knowledge exchange. **2. Address production or consumption demands, and Techno-environmental solutions.** These themes included, for example, food innovations like lab grown meat, consumption of insects, exotic superfoods, and enhanced farming efficiency to improve food availability, and energy efficient products. In addition, this also meant innovation for increased sustainable behaviour and development, plastic-eating bacteria, green energy, and resource management.	In the Global South we see a distinct interest in using **technology for human actualisation** (e.g. access to machines to make manual work less tedious, integration of technology with traditional knowledge) not replicated in the North, and **global connectivity** (e.g. data access, easy global travel, cultural exposure). This is not reciprocated in North visions.

offers a complementary visual overview of the weight of each category group across North, South and Global visions–we expand on this in the Discussion. More details on the themes can be found in Supplementary data I.

Across all visions, the **Social** dimension is the most prominent, highlighting an interest in **'more collective or co-operative societies'** (59%), and '**more empowered communities'** (53%). To note is that **'equity and equality'** is prominent in almost half of the South visions, but not nearly as highlighted in the North.

Almost as important, the **Environmental** dimension stresses a '**reduced impact from resource intensive systems'** and **'healthier human-nature relationships'** (53% each). We found that the latter is central for almost all Global visions (85%). Contrastingly, **'conservation and restoration'** is significantly more important in Global (77%) and South (55%) visions, but not in the North (24%).

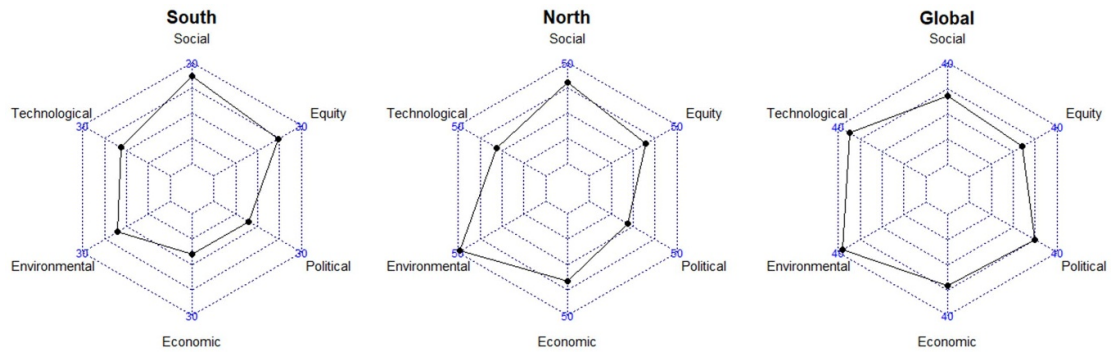


Figure 9. Comparison of the main features across visions themes (per the 6 STEEP-E categories) and their rootedness (either South, North or global visions). The figures illustrate a generalized similarity but also minor nuances depending on the location of visions.

The **Equity** dimension appears represented by a focus on '**inclusion and participation**' (49%), followed by **'fair access and distribution'** and **'embracing diversity and difference'** (37% and 35%). The latter is particularly strong in the South (73% of visions) and less so in the North and Global visions (20% and 38% of visions respectively). Also, '**fair access and distribution**' is stressed in Global and South visions (69% and 45%), but not as prominent for North ones (16%). We point out that **'balancing power'** is not consistently prioritized, appearing in 28% of North and 18% of South visions.

The **Economic** dimension highlights a trend towards a **'solidarity/localised economy'** (49%), followed less prominently by a **'circular economy'** (31% of visions). This is strongly prioritised in the North (36%) but minimally in South (9%) visions. We identified a stronger interest in **'post-materialism'** and **'alternative paradigms'** in half of the Global visions (46% each) but this theme was absent in the South. Instead, an interest in '**improved livelihoods'** only emerged in South visions (18%).

The **Political** dimension points to an overall need for **'enhanced governance models'** (47%), a feature strong in the North (48%) and especially Global visions (62%). This is followed by **'empowering legal mechanisms and policies'** (31%), a priority for roughly half of the South and Global visions. We note that **'transnational/regional instruments or norms'** (69%) and **'political consciousness'** (46%) are strong in Global visions but less so in North (12%) or South (9%) ones.

Technological dimensions are the least prominent overall, emerging mainly for meeting **'daily needs'** (39%), for **'techno-environmental solutions'** (35%) and in addressing **'production and consumption demands'** (33%). However, **'Techno-environmental solutions'** are strongly highlighted in half of Global visions (54%), but less prominent in North and South visions. Technology for **'human actualisation'** (i.e. pursuing people's potential and sense of fulfilment) is highlighted in 62% of Global visions, and 36% of South visions but only 12% of North visions. Finally, **'global connectivity**' is mentioned in the South (27%) and almost half of all Global visions (46%).

3.2.3. Transformative visions

To assess how imaginative and transformative the visions developed were, we attempted to understand the distance between the *status quo* in the present, and the futures proposed. Figure 10 displays the visions across a 'transformative spectrum' (TS). From this, we gather that 57% of the visions move towards the transformative area of the map (TS $\leq$ 1.5), with only 41% of them (20 visions) suggesting significant divergence from the *status quo* (transformative to radical).

We also found that while normative visions tend to highlight positive and desirable features (Pereira *et al* 2020a), two visions describe elements that may worsen (TS $= -1$)compared to the present. Reidsma *et al* (2023) adopt this strategy to explore stakeholder's desirability of certain alternatives when comparing them with *status quo* conditions. We discuss the significance of this finding and its implications in the Discussion section.

To cross check this categorization, we assessed whether and how the visions addressed the relationship between humans and nature, and how systemic or holistic the outcomes envisaged were (see table 3 in Supplementary data II). We found that 20% of the visions did not strongly address human-nature connections while 80% did so, but in different ways. The majority of the visions that highlight '**human-nature harmony'** correlate with the more '**transformative'** and **'radical'** visions. The visions where '**human-nature connection was not a priority**' were mainly '**stagnant'**.

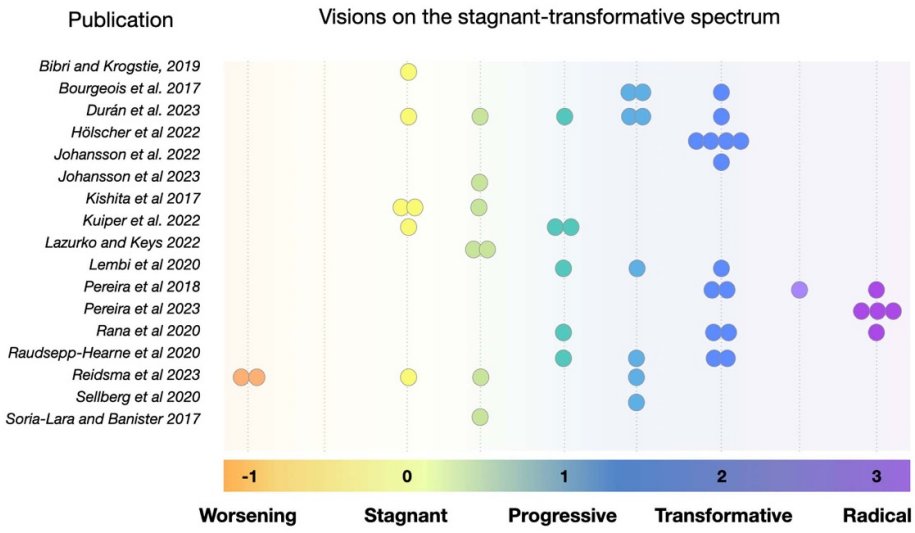


Figure 10. Visions across the transformative spectrum. A heuristic to identify how visions suggest detachment from conservative/reformist/incremental scenario propositions, thus hinting at a gulf between present conditions and the futures envisaged. Six visions are stagnant and 7 move towards progressive, 6 visions are progressive and 8 move towards transformative, 14 are transformative and 1 move beyond transformative, with only 5 deemed radical. Two visions portray conditions as worsening.

When inspecting whether a systemic perspective is adopted (i.e. holistic outcomes for people, ecosystems and biodiversity, climate, governance, culture/knowledge, and justice), we found that the majority of the '**transformative**' visions (TS = 2) engaged all or almost all dimensions, but in '**stagnant**' visions (TS = 0), various dimensions were not addressed simultaneously. The outcomes least prioritized in the '**transformative**' visions refer to culture/knowledge, then followed by biodiversity/ecosystems. We discuss gaps and other implications and limitations of these findings in the next section.

4. Discussion

This section revisits our research questions to discuss how our results are relevant to the community engaged in transformative futures: (i) in relation to the literature landscape, (ii) the study design and methods; and (iii) the content of the transformative scenarios. We structured our insights into six sections to start by highlighting takeaways from surveying the literature and the directions in which it could be expanded. We then discuss the diversity of scenario approaches and the implications of different study designs. Next, we draw attention to the implications of the priorities and gaps that are stressed by the visions, discuss their transformative potential and highlight gaps that could shape a future research agenda. Finally, we acknowledge important limitations and caveats.

4.1. Expansion of the field requires widening perspectives

The findings from this review complement other reviews on sustainability futures, (e.g. Cork *et al* 2023, Lauer *et al* 2024), also highlighting that the literature landscape on transformative futures has increased in the last ten years with a striking rise from 2020 onwards. While we made efforts to scope publications in languages and databases other than English (i.e. Spanish and French), very few publications matched our criteria. This correlated with a strong leadership of publications from authors in Global North institutions (mainly Europe). Results suggest that while scenario work on transformative futures is undertaken in the Global South, there is work that needs to be done to be more fully inclusive.

4.2. Diversity of approaches exploring the possibility space

Within the transformative futures literature that we scoped, we found studies situated across every area of the Futures Cone (figure 5), with visions raging from projected and probable, to possible and preposterous. This highlights the importance of employing a broad range of approaches to the future and its contested and yet open nature (Hancock and Bezold 1994, Voros 2003, Shearer 2005, Gall *et al* 2022). Yet, while normative future visions are developed within multiple studies, we highlight that only a fraction of the publications explicitly aim at opening up the space of preferable futures and explore the projected-plausible-possible-preposterous continuum. This is

necessary to recognise the range of preferable futures that could emerge and what actions need to be taken to get there.

Importantly, while normative visions tend to highlight positive and desirable features, exploring negative or 'worsening conditions' is fruitful and necessary, considering that for a new system to emerge, the current system has to decline and there will be losers (Hebinck *et al* 2022, Pereira *et al* 2024). In the visions reported by Lembi *et al* (2020), the scenarios that prioritised nature over human values presented disparities in access to and benefit from ecosystem services, thus resulting in increasing social inequalities. We stress that the important role of scenarios is to be explicit about what some of these trade-offs could be, as we cannot always optimise for everything.

4.3. Study design and methods can expand to improve outcomes

Our insights complement previous reviews by offering descriptions on envisaged futures, their methods and unpacking some of the main similarities and differences identified across Global North/South contexts. We noticed that the outcomes and relevance of scenario work are largely dependent on the study designs—i.e. the methods used and who undertakes the visioning.

In terms of the participants convened, visioning workshops did not always represent diverse groups. While we recognize that full participation and effective co-design cannot always be possible or desirable (unless required resources and fair processes can be secured) (Pereira *et al* 2020b), participants' diversity of background and the degree to which key stakeholders are involved can sometimes be a critical aspect of a research study, depending on the purpose and thematic focus of each study (Pereira *et al* 2018a). Within the literature scoped, especially on normative futures, two strategies stand out as a way to diversify participation and ensure inclusivity: the adoption of creative methods, and the inclusion of a wide range of perspectives from participants from both the Global North and South. We noticed that interesting outcomes resulted from studies that adopted creative and often interdisciplinary methods seeking to foster a more transformative imagination (Moore and Milkoreit 2020). However, the integration of artists, humanists or the overall adoption of arts-based methods could still be expanded, opening up sustainability science beyond the natural and social sciences. We concur with Ketonen-Oksi and Vigren (2024) and Vervoort (2023) that fostering the imagination of 'previously unimaginable' futures through the development of new methods is necessary for accelerating and enabling action. Methodological innovations and interdisciplinary collaborations–especially between the futures-thinking and sustainability scenarios communities–can only strengthen the portfolio of methods, especially within the transformative futures thinking space.

Finally, we highlight the diversity of geographical scope of the visions, ranging from local- to global-scale focus. Overall, place-based or local scenarios were more common than global ones. Indeed, scenarios that are produced at local or regional scales can be more relatable, action-focused (Brown *et al* 2016) and more likely to be co-produced. This helps leverage local and traditional knowledge and consider alternative ways of conceptualising the future beyond 'Western' or hegemonic paradigms (Oteros-Rozas *et al* 2013, Garteizgogeascoa *et al* 2020, Terry *et al* 2024). But, since these local, bottom-up visions are better at integrating excluded voices, the research community needs to avoid eroding them and rather promote this diversity as it engages top–down or expert-driven Global scenarios (Lauer *et al* 2024). However, caution is needed as scenario development requires an openness to consider trade-offs between contrasting goals, and to embrace the political nature of transformations where what is deemed desirable is context-dependent, and where change is resisted in favour of adaptations rather than transformations (see Reidsma *et al* 2023).

4.4. Priorities and gaps stressed by the visions

In spite of some minor nuances, transformative futures display many overlaps in terms of preferences described. Most desirable visions portray futures that highlight social, environmental and equity dimensions. Interestingly, technological solutions did not receive much interest beyond being deployed to meet daily needs or production demands. This would be achieved by enabling more localised economies and with the support of better legal mechanisms and governance.

This focus on alternative governance and economic models, and less on technology as the solution, fills an important gap recognised by Lauer *et al* (2024). In their analysis of the ideology underpinning 342 global scenarios, they found that the majority of the global scenarios display a strong bias of extrapolating the *status quo* into the future, with technological progress and economic growth as solutions to sustainability challenges (Lauer *et al* 2024). Whilst they emphasise that post-capitalist and eco-centric scenarios that focus governance models beyond the post-Westphalian ideology are lacking at the global level, our analysis shows that at the local level and mainly in Global visions, these more radical scenarios are being depicted.

Accordingly, whether the scenario was local or more global mattered for features prioritized. This accounts for some of the nuances found across the STEEP-E category groups. For example, North visions prioritized environmental and economic dimensions (e.g. post-materialism) more than equity ones, in contrast with the South where social issues

and matters of equity and justice were stressed more–likely accounting for more unequal societies as well as varying rates of development. Similarly, circular economic models–while trendy and emerged in the North–was not a priority for South visions while improved livelihoods was–based on the need to meet basic daily needs. Global visions were more prone to suggest alternative economic paradigms and transnational legal instruments in stark contrast with local ones–i.e. being easier to imagine larger scale changes and new global dynamics when zooming out of the nuances of place-based problems. This emphasises that defining futures at the Global level could better unpack a range of alternative governance and economic approaches that transformative futures require (Lauer *et al* (2024). Yet, we also find that other aspects like human-nature connections or systems thinking are also important to incorporate (see Durán *et al* 2023, Pereira *et al* 2023). All in all, there is scope for more of these scenarios to be undertaken, especially to fill this ideological gap at the regional and global level.

In relation to the connections between people and nature, our analysis shows that certain characteristics of 'preferable' futures are dependent upon differences in cultural values, context-based priorities and worldviews. Desirable scenarios (co-)created by perspectives from the Global North were less likely to be explicit about connections between people and nature. In contrast, studies from the South addressed human-nature connections more often, but displayed a stronger instrumental valuation of nature, at times, co-existing with a desire for human-nature harmony. This is explained by the fact that people's lives in the Global South may be more dependant and closer to nature (e.g. for their livelihoods) but also that it is vital to recognizes the diversity of ways that people connect to and value nature (IPBES 2022). Still, it was striking to see how few peer-reviewed studies exist focusing on preferable futures for people and nature.

While there are likely a significant number of such studies in the grey literature, addressing this gap in the research community is critical to help guide decision-making, especially around how to meet the Paris Agreement and the Kunming–Montreal Global Biodiversity framework vision of living in harmony with nature by 2050. We also note that while a growing body of studies are exploring frameworks and methods for the creation of value-plural scenarios (e.g. Harmáčková *et al* 2022, Kuiper *et al* 2022, Pereira *et al* 2023), these remain largely undertaken in the Global North. Opening up for more inclusive visioning processes with a wider geographical representation might therefore allow for more diverse values of nature to be recognised and included in target-seeking scenarios, as well as more inclusive and diverse action pathways.

With the importance of scenario diversity is well-recognised, it is also important to recognize that there is a potential trade-off between covering a bigger space of future possibilities and adding redundancy to scenario sets (Carlsen *et al* 2024). In advocating for more diverse target-seeking scenarios to be developed, we do acknowledge that an overwhelming number is not necessarily effective for communicating with stakeholders and so a more coordinated effort across the climate, biodiversity and sustainability communities is needed.

4.5. Transformative futures and future directions

Our study shows that only a fraction of what are deemed to be transformative future scenarios promise such potential offering actual 'alternatives' to the *status quo*–a finding also reached by Lauer *et al* (2024). With under half of the visions could be situated in the transformative to radical range, more effort is needed to overcome the challenge to imagine truly revolutionary change. To ensure visions are transformative, they need to be more systemic (i.e. prioritise holistic outcomes), seek a more harmonious relationship between humans and nature, and further explore creative approaches and methods in inter- and transdisciplinary ways.

The priorities and outcomes that the visions portray, hint at some gaps that can shape a future research agenda. Scenario development work could benefit from addressing impacts for knowledge and culture (the most neglected dimensions across visions). For example, expanding on the role of indigenous knowledge systems (Tengö *et al* 2021, IPBES 2023) or forms of knowledge other than scientific, and how they may relate to the cultural norms that are prioritised or neglected. This could also fit into attempts to 'decolonise' or 'deWesternise' futures praxis (Chibwe *et al* 2024, Terry *et al* 2024) and to strengthen the debate on deeper cultural and social-psychological dimensions of change (i.e. subjective elements) which is generally missing in this field (Stedman 2016).

In turn, a stronger emphasis on biodiversity and ecosystems, as well as intra and inter-species justice, are also needed. Futures work could be expanded by looking more deeply into the trans-species futures (e.g. Pereira *et al* 2023, or Fieuw *et al* 2022). We note that ongoing work operationalizing the Nature Futures framework is likely to go a long way towards addressing this specific gap (Lundquist *et al* 2021).

4.6. Limitations and caveats

While within this semi-systematic review, our approach was systematic. However, there are limitations within the tools and choices that the research team had to make to capture as much of the relevant literature as possible in a pragmatic way. First, we recognize limitations in relation to the process, much of which are due to the reliance on tools available in the databases. The French and Spanish databases have significant technical constraints (e.g. for filtering and exporting data), which limits the reliability of results.

Secondly, there are limitations regarding interpretation and classification of studies during screening and exclusion criteria, as well as during qualitative coding. The thematic analysis has constraints in its application to a large amount of nuanced data such as visions. Finally, a strict classification under limited dimensions (such as STEEP-E) is not fully possible as dimensions and themes are inherently interconnected. We made our best effort at capturing key ideas that would result in a meaningful synthesis relevant to the field.

Mapping visions along the transformative spectrum was a difficult and incomplete task. We defined a vision's radical-ness according to elements that seemed far-fetched, or harder to imagine. However, we acknowledge that transformations may not imply futuristic and totally novel ideas, but may also include elements rooted in the past (Terry *et al* 2024) or that simply challenge dominant power structures (Lauer *et al* 2024). We recognize that the mapping we present in figure 10 represents our own perspective on the radical-ness of these studies.

Despite iterating the search string multiple times in both English databases, key references that we knew about were lost and had to be manually added. There are probably other studies that meet the criteria and could have been included in the analysis, but that the search string might have missed. We apologise for any omissions, as these were not intended.

5. Conclusion

This review highlights our best attempt to synthesise the state of the art of sustainability futures research by analysing preferable and transformed futures, how and who shapes these imaginaries and how they differ or overlap when produced from South, North or Global perspectives. Our contribution complements and expands on other reviews by offering details of the methods and scenarios produced, matching and contrasting the types and contents of scenarios with the scope of relevance of their outputs, and evaluating their transformative potential. We do this by mapping visions along a 'transformative spectrum' of stagnant to radical futures, and by how they engage human-nature connections or capture systemic dimensions.

Our insights also point to gaps in how and where studies are conducted, and the areas that need more attention. More effort is needed to address the interface of biodiversity/ecosystems and justice and the integration and impact of diverse knowledges and cultures. We suggest that although many of the scenarios are participatory, these are not often combined with creative approaches, which might do more to inspire and propose radically different (rather than extrapolated) futures. Ensuring inclusive visions across multiple knowledge systems will require more support and funding for these initiatives, especially in the many countries and regions that are not represented in the literature (much of Africa and Asia) and in local languages. An important next step for the transformations research community is to explore how these critical gaps are addressed, while also making urgent efforts to link these visioning outputs with a strong message for decision-makers offering actionable pathways towards change. Even though this is not an easy feat, as depicted in Pereira *et al* (2023) it is an important work for the research community. Finally, our expanded analysis that starts to describe the priorities and values of desirable futures reveals interesting aspects for determining the range of preferable futures at the global level and what some common features of these futures might be.

Data availability statement

The data that support the findings of this study including datasets and their analyses are openly available at the following URL/DOI: https://doi.org/10.5281/zenodo.11112918.

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