*Global Sustainability*

**cambridge.org/sus**

# Sustainability dialogues in Brazil: implications for boundary-spanning science and education

Fabio R. Scarano[1,2,3], Ebba Brink[4], Beatriz L. R. Carneiro[1,2], Luciane Coutinho[5,6], Clemir Fernandes[7], Vitória L. Holz[1,2,8], Moema Salgado[7], Ana C. P. Aguiar[3,9], Agnieszka E. Latawiec[3,10,11,12], Renata Pardini[13], Michelle C. Sampaio[14], Anna C. F. Aguiar[1,2,3], Paulo D. Branco[3,10], Laísa Freire[2], Maíra C. G. Padgurschi[15], Aliny P. F. Pires[16], Isadora M. M. Soares[3] and Alexandro Solórzano[3]

[1]UNESCO Chair on Planetary Wellbeing and Regenerative Anticipation, Museu do Amanhã, IDG, Rio de Janeiro, Brazil; [2]Department of Ecology, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil; [3]Professional Masters in Sustainability Science, Pontifícia Universidade Católica, Rio de Janeiro, Brazil; [4]Lund University Center for Sustainability Studies, Lund, Sweden; [5]Instituto LivMundi, Rio de Janeiro, Brazil; [6]Teachers College, Columbia University, New York, NY, USA; [7]Instituto de Estudos da Religião, Rio de Janeiro, Brazil; [8]Cicli, Rio de Janeiro, Brazil; [9]Fundação Getúlio Vargas, Escola de Administração de Empresas de São Paulo, São Paulo, Brazil; [10]Instituto Internacional para Sustentabilidade, Rio de Janeiro, Brazil; [11]Faculty of Mechanical Engineering, Opole University of Technology, Opole, Poland; [12]School of Environmental Science, University of East Anglia, Norwich, UK; [13]Department of Zoology, Universidade de São Paulo, São Paulo, Brazil; [14]Department of Botany, Universidade Federal do Estado do Rio de Janeiro, Rio de Janeiro, Brazil; [15]Brazilian Research Center for Energy and Materials, Universidade Estadual de Campinas, Campinas, Brazil and [16]Department of Ecology, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil

**Research Article**

**Cite this article:** Scarano FR *et al*. (2024). Sustainability dialogues in Brazil: implications for boundary-spanning science and education. *Global Sustainability* **7**, e30, 1–12. https://doi.org/10.1017/sus.2024.25

Received: 31 March 2023
Revised: 12 May 2024
Accepted: 19 June 2024

**Keywords:**
decolonization; Global South; SDG; sustainability education; sustainability science

**Corresponding authors:**
Fabio R. Scarano;
Email: fscarano@gmail.com;
Ebba Brink;
Email: ebba.brink@lucsus.lu.se

## Abstract

**Non-technical summary.** Brazil – one of the world's largest biocultural diversities – faces high rates of habitat loss, social inequality, and land conflicts impacting indigenous and local peoples. To challenge that, Brazilian sustainability science and education needs to be strengthened. We searched for elements in ongoing bottom-up sustainability social movements that can help serve that purpose. We found values, contents, and attitudes that, if incorporated into Brazilian sustainability science and education, can assist its transformative potential by reflecting local voices and critically engaging with (often-hegemonic) northern concepts.

**Technical summary.** In Brazil, a strong sustainability science and education is required to confront 'glocal' issues such as zoonotic pandemics and climate change, which are worsened by rampant ecosystem loss and social vulnerability. However, a largely disciplinary university system has been slow to meet these urgent needs. To address if and how dialogical processes with non-academics can prompt integration between distinct types of knowledge, we analyze four bottom-up sustainability initiatives that promote dialogues between science, the arts, religion, youth, and indigenous and local knowledge, and reflect on lessons learnt with movement organizers, scientists, and educators – the authors of this paper. Although sustainability science produced in dialogue with other forms of knowledge is still emerging in Brazil, we find that bottom-up initiatives outside academia can inspire science and education to approach sustainability as wholeness – a state of balance to be fulfilled when reached individually, collectively, and cosmically. We discuss how to approach a transdisciplinary and reflexive attitude in Brazilian sustainability science and education, and highlight its unique contribution to frontier topics in global sustainability debates.

**Social media summary.** Social movements' values, contents, and attitudes can inspire transformative Brazilian sustainability science and education.

## 1. Introduction

This paper sets out to construct a new paradigm for Brazilian sustainability science and education, with relevance for the global scientific community. There is increasing recognition that two (Kates et al., 2001) to three (Bettencourt & Kaur, 2011) decades of sustainability science have not contributed enough to a global transition to sustainability (Shrivastava et al., 2020). Although sustainability is often defined as equitably meeting and balancing current and future needs within the planet's boundaries, the *science* of sustainability investigates interactions between human societies and the natural environment, and aims to transform this relationship (Nagatsu et al., 2020). Failure to transform is often attributed to gaps in the science–policy dialogue (Schneider et al., 2019) that call for new forms of science–society collaboration (Bergmann et al., 2019).

However, the interlinked social and natural worlds that such science strives to absolve differ vastly from one another across the planet. The modern view of human–nature relationships, which permeates most environmental policymaking, is strongly influenced by Enlightenment and Judeo-Christian views. It tends to emphasize dualism and separateness, oscillating between a 'romantic devotion' to nature and attempts to master and conquer it (Uggla, 2010, p. 2). However, the hegemonic modern, capitalist, Eurocentric perspective is only one of many co-existing worldviews – actually, the very same one that led the planet (other societies included) into the Anthropocene (Folke et al., 2021). *Hegemony* entails the production of knowledge, be it in politics or academia, that corroborates the worldview of those in power (Gramsci, 1932/2001). Such power relations within knowledge production exist both between countries (e.g. Global North *vs.* Global South) and inside countries and sub-national units (Gaillard, 2019). Sustainability emerges as an antidote to the planetary socioecological decay (Scarano, 2019), and the transition toward a sustainable state, as agreed upon by modern diplomacy, takes place through Agenda 2030 and its sustainable development goals (SDGs). Paradoxically, although SDGs project a transition from the current development paradigm, this agenda is mainly framed within the modern worldview – again, the same one responsible for the present turmoil. It projects seventeen 'fair' goals from a modern perspective, but a common critique is that economic growth (SDG 8) has an obvious and historical trade-off with biosphere-oriented (e.g. SDGs 6, 13–15) and social-equity goals (e.g. SDGs 5, 10) (Pires et al., 2021; Pradhan, 2019). More recently, in face of the COVID-19 pandemic and its causes and consequences, there are calls for a revision of SDGs (Nature Editorial, 2020).

In Brazil – a bio-culturally megadiverse country with the world's largest biodiversity and nearly 300 different languages spoken (Scarano et al., 2024) – surrendering to any pervasive hegemonic thought seems at odds with sustainability. As of 2015, in parallel to and after the announcement of SDGs and the Paris Agreement of the Climate Convention, several bottom-up sustainability initiatives took off in Brazil, largely based on dialogues between different world visions and perspectives. However, the following year, 2016, arrived with setbacks for both the global and the Brazilian sustainability agenda. While climate-change denier Donald Trump took office in the United States, Brazil faced a political crisis with the corruption accusations of the elected Labour government, its subsequent impeachment, and succession by a non-elected government. Despite this, bottom-up sustainability movements in Brazil thrived. Even when the extreme right-wing and denialist government of President Jair Bolsonaro came to power from 2019 through to the end of 2022, movements continued to stage events, promote debates, publish books, and engage people.

By the time that the COVID-19 pandemic hit Brazil in early 2020, our perspective as sustainability academics and/or practitioners engaged in some of these bottom-up sustainability movements was further challenged: would ongoing initiatives survive the toll of the pandemic and its social distancing? That year, Brazil (along with Venezuela and Tuvalu) had the world's largest setbacks in SDGs, according to the Sustainable Development Report (Sachs et al., 2021). By 2021, Brazil had among the world's highest rates of habitat loss and social inequality, a recently re-enacted history of land conflicts between farmers and indigenous and local peoples, and the second highest fatality rate per 100,000 people among the countries affected by COVID-19 (John Hopkins Coronavirus Resource Center, 2021; The Economist, 2021). Despite all the grief and pain caused – and perhaps to some extent because of it – COVID-19 opened a window of opportunities for reflection and engagement with sustainability.

In this paper, we provide a reflection on how Brazilian sustainability science and education can better contribute to change this game by confronting 'glocal' issues such as present and potential future pandemics and climate change (Devine-Wright, 2013). Inspired by the sustainability dialogues promoted by civil-society initiatives, we attempt to leave behind the linear problem/solution dichotomy to address sustainability and, instead, place our focus on these dialogical processes. The concept of dialogue has a long history in Latin American thought. For instance, Brazilian educational philosopher Paulo Freire found dialogic interaction to be a central practice of social learning processes (Freire, 1970/2013), which can lead to critical scrutiny of, and transformation of, existential conditions (Souza et al., 2020). In this spirit, we examined a set of sustainability dialogues happening in civil-society initiatives that gather scientists, artists, religious people, the youth, indigenous peoples, and local actors. We ask: *how can such dialogical processes with non-academics help prompt inter- and transdisciplinary knowledge integration?* We argue that they offer insights on how to decolonize Brazilian sustainability science and education, by reflecting local conditions and voices, and provoking critical and reflexive engagement with concepts from the Global South and the Global North.

## 2. Conceptual framework

### 2.1 Brazilian sustainability science and education

Although Brazil has historically been a strong international voice on science and policy related to climate change, environment, and biodiversity conservation (Gupta & Singh, 2023; Lobo-Moreira et al., 2023), Brazilian academia has so far made a more modest contribution to the international conversation on sustainability science and the related methodological development on interdisciplinarity (knowledge integration between scientific disciplines) and transdisciplinarity (between academia and society) (exceptions include Scarano, 2024, and references cited next). In fact, the Brazilian sustainability discussion has been fraught by tensions between environmentalism and development both at the level of science and at the level of social movements (Scarano, 2019). Indeed, Brazil is in the top-four countries with the strongest specialization of scientific profiles (Abramo et al., 2022). This has led to a separation between scholars and activists focusing on 'societal' issues, problems, and rights and those focusing on the country's environmental challenges. In our review of the English-speaking literature, we found few papers that focus on defining an agenda for a sustainability science emerging from Brazil (Athayde et al., 2017; Hipólito et al., 2021; Lahsen & Nobre, 2007). Of those, even fewer address the relevance (and provide examples) of dialogue and exchange between science and indigenous knowledge (Athayde et al., 2017; Lahsen & Nobre, 2007), science and local knowledge in the urban context (Souza et al., 2020), and science and the arts (Athayde et al., 2017). Some addressed the potential interplay of methods, such as Rosendahl et al. (2015), who propose that transdisciplinary research, a mainstay of sustainability science, could greatly benefit from the feminist scientific tradition of self-reflexivity, by employing concepts such as situated knowledge and strong objectivity (Ribeiro, 2016).

https://doi.org/10.1017/sus.2024.25 Published online by Cambridge University Press

In the education front, there is a similar gap. In Brazil, environmental education for up to secondary school level is framed within governmental guidelines, whereas the debate on sustainability in schools is fostered by the 2030 Agenda. The training of teachers who work with education for sustainability in schools provides elements related to the critical and transformative perspective of education; however, the professional practice of the teacher does not always correspond to a transformative one, according to a recent review (Freire et al., 2022). One of the criticisms is that the training of science teachers is often based on hegemonic and conciliatory discourses configured by moderate, rather than radical, environmentalism (Jatobá et al., 2009). Moreover, teachers' lack of contact with certain sustainability themes and their interdisciplinary nature, including gendered and racialized dimensions of the environment, is also part of the challenge (Freire et al., 2022). In terms of higher education in Brazil, peer-reviewed research has tended to focus on implementing sustainable *policies* in university campuses (e.g. concerning energy, waste, water, and transportation), rather than on teaching the *subject* of sustainability. Although the former might offer valuable opportunities for students to connect theory to practice through engaging with concepts such as living labs and green campuses (Benevides et al., 2021; Berchin et al., 2020), there is clearly more scope for discussing how a Brazilian outlook on local and global sustainability challenges – and the knowledge(s) required for addressing them – should be framed in the country's undergraduate and graduate education. For instance, some argue that the epistemology and multicultural vision of sustainability should be more intensively incorporated into higher education to help drive transformations (Leal et al., 2018), including in Brazil (Rampasso et al., 2019). The country also lacks specific graduate training courses on sustainability science, the exception being the now 4-year-old professional Master's program at Pontifical Catholic University (PUC), in which some of the authors in this paper are either professors or students.

### 2.2 Worldviews and bottom-up movements in sustainability science

Although still an incipient discussion in Brazil, there is an expansion in the international sustainability science literature about inner dimensions as leverage points for sustainability, including beliefs, values, and worldviews (Ives et al., 2018; Ives & Kidwell, 2019; Nilsson & Stålhammar, 2024; Wamsler et al., 2021). This reflects how the modern human–nature separation is at the heart of the planetary multicrises we currently face (Scarano, 2024), which calls for treating all entities alike, that is, flattening ontologies (Latour, 2004). It is also coherent with the increasing demands to decolonize ecology, biodiversity, and sustainability debates (e.g. Baker et al., 2019; Büscher and Fletcher, 2020; Schultz, 2017; Trisos et al., 2021), pointing, for instance, to the conflictual history between indigenous peoples and conservation, and 'fortress conservation' that entails closing off supposedly wild and 'pristine' nature while business-as-usual continues on the rest of the planet. These emerging scholarly debates inspired three premises of our study.

Our first premise is that the planet is inhabited by different 'worlds' or worldviews. They include the hegemonic modern, capitalist, Eurocentric world, and alternative worlds based on different local cosmologies and worldviews (Hedlund-de Witt, 2013). Even the hegemonic modern world houses asymmetries and differences: between distinct humans depending on gender, social class, and ethnicities; between humans and non-humans; between nature and culture; and between science, the arts, and religion as forms of interpretation of reality (Pretty et al., 2009; Stålhammar & Brink, 2021). For sustainability to prevail, we posit that the global society must embrace the notion of 'pluriverse' (Escobar, 2015), that is, different worlds that coexist and, in some cases, eventually, hybridize (Benessia et al., 2012). In short, it must have complementarity as a principle (Rigolot, 2018). Transformative change demands new responses that are, at once, 'reflexive, strategic, inclusive, and diverse' (O'Brien, 2021, p. 1796) and that consider interlinkages between micro and macro levels. In this context, leading climate researcher Karen O'Brien defends that our understanding of Earth system processes needs to consider human thought and ideas as a separate 'sphere' (O'Brien, 2021). This argument valorizes older literature on the *Noosphere*, the collective planetary intelligence and an emergent property of the biosphere after Vladimir Vernadsky (Russian geochemist; 1863–1945) and Teilhard de Chardin (French Jesuit priest and philosopher; 1881–1955) (Guillaume, 2014), and (while little translated to English) the *Psychosphere* (Santos, 1997), the realm of ideas and production of meaning, after Brazilian geographer Milton Santos (1926–2001).

Our second premise is that the innovation space created by bottom-up sustainability initiatives driven by civil society can provide a rich learning ground for sustainability scientists and educators. This resonates with existing literature on social movements, collaborative governance, and social learning in sustainability science (Brink & Wamsler, 2018; Isgren et al., 2019; Mitlin, 2018). Among several types of transformative actions and tools, movements focused on sustainability and democracy have been described as 'seeds of a good Anthropocene' (Bennett et al., 2016). By definition, these seeds are replicable, and they can have transformative impacts beyond initial localities as they spread or transform existing values. They contribute situated descriptive, normative, and transformative knowledge needed to address fair and sustainable futures, and – unlike many of the dystopian scenarios currently projected – they can generate or inspire bottom-up visions and pathways toward more hopeful and positive futures (Pretty et al., 2009; Rana et al., 2020).

Our third premise is a consequence of the previous two and concerns how we perceive and (re)define sustainability. Sustainability for us is a value related to living in harmony with oneself, with other humans, and with non-human components of nature. It exists as a practice, an aspiration and a utopia for many of the different 'worlds' that inhabit the planet, and is therefore a point of convergence (Scarano, 2019). This value re-emerged in the modern world as an antidote to the malaises brought about by the Anthropocene (see Scarano, 2024, for a review). New or re-emerged values demand new ethics, new practices, new policies, and a new science. This pressing demand is driving convergences of separate modules in all these fronts (e.g. human ethics and environmental ethics; development policies and environmental policies; social and natural sciences, etc.; Scarano, 2019). In short, differently from some other scholars (Clark & Harley, 2020), our definition of sustainability is somewhat more radical and at the same time more pluralistic than the strictly modern concept of sustainable development.

## 3. Methods

Our data collection and analysis were performed in three (overlapping) steps to address the momentum of institutionalized

https://doi.org/10.1017/sus.2024.25 Published online by Cambridge University Press

Brazilian sustainability science and education, as compared to the momentum of what we call 'sustainability dialogues', or bottom-up, spontaneous, non-academic civil-society initiatives that address sustainability from a broader Brazilian perspective.

First, to assess the status of Brazilian sustainability science and education in the international sustainability debate, on issues ranging from the Brazilian context to global matters, and methodological and pedagogical development, we performed a search in Scopus for 'TITLE-ABS-KEY(brazil + (sustainability science))' in May 2021. Our first Scopus search on mentions of Brazil and sustainability science in the English-speaking literature yielded only 13 hits in May 2021. We then reviewed the resulting papers to examine how inclusive the science they report on is of non-academic visions and perspectives. Among the hits, we looked for papers that were explicitly constructed in co-production with the arts, indigenous, and local knowledge, or other types of knowledge. A Scopus search for TITLE-ABS-KEY(sustainability + 'higher education' + brazil) yielded 84 results, for which 20 highest cited and the 20 newest publications were scanned for relevance to this article. In addition, we reviewed Brazilian literature and websites regarding how sustainability is incorporated into distinct layers of formal education, and we drew on scientific work conducted in parallel that reviewed sustainability in science teacher education (Freire et al., 2022).

Second, we selected and examined four distinct 'seeds', that is, bottom-up, spontaneous, ongoing sustainability dialogue processes in Brazil. 'Fé no Clima' (*Faith in Climate*; an interfaith-science dialogue on climate change); 'Selvagem' (*Wild*; a dialogue about life involving indigenous peoples, philosophers, practitioners, artists, and scientists); 'Livmundi' (a sustainability festival); and 'Cicli' (an initiative of cyclists to pedal to the Brazilian countryside and to listen to local inhabitants and their perceptions about climate change and sustainability). For each of these processes, we assessed how they grew in outreach and social adherence during the COVID-19 pandemic, and which elements they address that are less present, or totally absent, from Brazilian sustainability science and education. The latter was performed through participant observation in movement spaces and events, review of their online and offline publications, and triangulation with the other two methodological steps outlined here.

Lastly, by gathering organizers and participants of the movements in the co-authorship of this paper, together with sustainability science teachers and academics who participate in one or more of these movements, we dealt with the data by using the transdisciplinary mode of knowledge production. Following Michael Gibbons, this includes five components: (1) multiple interactions between a larger number of experts and sites of expertise; (2) different forms of knowledge and actors representing them; (3) science leaving the academic field and 'meeting the public'; (4) allowing this exercise to speak back to science, with peoples' interests, concerns, and perspectives entering science; and (5) providing essential data for every aspect of the research process (Gibbons, 2000; Rosendahl et al., 2015). We approached these components by establishing a reflexive conversation among ourselves, looking for consents and dissents, based on the evidence gathered in steps one and two of our methodology (Lang et al., 2012). In practice, this conversation took place through an iterative process of interviewing and surveying among the team members, synthesizing any new inputs, and team members' review of the resulting text (ending after five rounds of review, when no significant new points were added). Authors–interviewees belonged to five groups: (a) four movement leaders (interviewed individually); (b) four people involved with education/science at Pontifical Catholic University (PUC-Rio), engaged in a proposal to create a new undergraduate course in sustainability in Brazil, the first of its kind; (c) four people involved with education/science at other local universities: Federal University of Rio de Janeiro, State University of Rio de Janeiro, and State University of Campinas; (d) three 'external' colleagues (this group was set in the format of a board of referees, who were not involved in the interviews, or with research partnerships with personnel in groups a, b, and c) who work with dialogue processes at São Paulo University, Getúlio Vargas Foundation, Federal University of the State of Rio de Janeiro; (e) three coordinating authors, who conducted interviews and synthesized the answers between each iterative round.

Three questions guided the conversation: (1) why, if at all, should Brazilian sustainability science and education pay attention to these bottom-up movements? (2) what can Brazilian sustainability science and education learn from these movements?; and (3) how can Brazilian sustainability science and education incorporate the lessons learnt by dialoguing with these movements?

## 4. Results

The four distinct bottom-up, spontaneous, ongoing sustainability dialogue processes in Brazil studied here all emerged after 2015, from the need to promote dialogues that inspire transformation, as felt by local actors with distinct worldviews but similar concerns and aspirations in relation to life, the country, and the planet. As seen in Table 1, they all had boundary-crossing or transgressive objectives, including democratizing sustainability (Livmundi), articulating diverse human and non-human species (Selvagem), documenting and spreading the stories of those who are on the frontline of climate change while breaking with fossil-fueled transportation (Cicli), and building new climate narratives that combine scientific and sacred dimensions (Fé no Clima). Our analysis also shows how the COVID-19 pandemic forced the movements to create new capabilities and take advantage of disruptive opportunities. 'Selvagem' and 'Livmundi' were events originally based in the city of Rio de Janeiro, and open and free to public participation. 'Cicli' and 'Fé no Clima' aimed for a national outreach and took place by subscription (the former) or by invitation (the latter) and were therefore less public in terms of their audiences. With the onset of the social distancing imposed by the pandemic, all movements adapted to the format of digital conversation arenas on the internet. As a result, participation increased by factors ranging from 10 to 1000 (Table 1). In addition to the audio-visual material, the various initiatives published books (e.g. 'Selvagem'), guides (e.g. 'Fé no Clima'), recruited volunteers (e.g. 'Selvagem', 'Cicli'), and opened new institutions (e.g. 'Livmundi').

### 4.1 Converging views: worldviews, subjectivity, and actions

There was generally a converging view among co-authors that sustainability science and education in Brazil have much to learn from the four selected processes because, individually and collectively, they engage worldviews and perspectives often absent from or marginal to knowledge construction within the sustainability-oriented natural and social sciences in the country (Table 2). Aspects such as conviviality, transparency, and respect for different views are elements that most team members used to justify why science and education professionals should take

https://doi.org/10.1017/sus.2024.25 Published online by Cambridge University Press

**Table 1.** Selected sustainability dialogues in Brazil and their increased outreach during the COVID-19 pandemic

| Start | Process | Dialogue | Objective, website, and host | Before and after the onset of the pandemic |
|---|---|---|---|---|
| 2015 | Fé no Clima (*Faith in Climate*) | Religion–science | Objective: 'To build and disseminate new narratives about climate change that combine scientific and sacred dimensions'. https://www.iser.org.br/projeto/fe-no-clima/ Host: Instituto de Estudos da Religião (ISER, Institute for Religious Studies, an NGO) | (1) Before: annual events and meetings between scientists and religious leaders, and between scientists and various faith communities. It was one of the inspirations for the Interfaith Rainforest Initiative, the United Nations multifaith alliance to fight tropical deforestation, launched in 2017. Dialogues were only rarely open to the public, and the use of the internet to broadcast content was shy. (2) After: YouTube channel was launched 7 years ago, but movement increased markedly since the pandemic. It now has >1000 followers and 78 videos with nearly 30,000 views. Although these numbers have plenty of room for improvement, it is fair to say that during 1 year of pandemic the visibility and adherence to Fé no Clima multiplied by at least a factor of 10, as compared to its first 5 years. |
| 2016 | Livmundi | Individual– collective–territory | Objective: 'To democratize sustainability as a theme to the wide public in order to promote behavior change in individual, society and organization.' https://livmundi.com/ Host: LivMundi Institute (since 2021) | (1) Before: three annual editions (2016, 2018, 2019) free of charge, offered multiple views of sustainability by immersive experiences. Each festival edition gathered ~10,000 people. Satellite hands-on initiatives also occurred, such as a crowdfunding campaign to promote improvements in the school, with volunteer's support community people to join efforts to realize. (2) After: first digital edition broadcasted by YouTube (2020) had 50 activities. The event attracted >65,000 unique users and >200,000 views. Social media also increased during the pandemic: >19,900 subscribers on YouTube and >15,400 on Instagram. LivMundi Institute was created (2021) to foster other initiatives related to non-traditional learning processes, aiming to expand the movement's impact. |
| 2018 | Selvagem (*Wild*) | Indigenous–art–science–practice | Objective: 'To articulate different types of human (indigenous, academic, scientific, traditional, artistic) and non-human species.' http://selvagemciclo.com.br/sobre/ Host: Dantes Editora (a publishing co.) | (1) Before: two annual presential meetings (2018, 2019) free of charge. Meetings consisted of a series of conversations between three people belonging to different knowledge systems, chaired by Brazilian indigenous leader Ailton Krenak. Meetings gathered an audience of >1000 in the course of 3 days. The YouTube channel was launched a few months prior to the onset of the pandemics. (2) After: YouTube channel now has six years and >60,000 followers, 285 videos, and >1,700,000 views. In Instagram, it has >67,900 followers. Moreover, 'Selvagem' has also developed a web portal that includes links to the YouTube channel, but also publications, books, a book-club, and short animation movies – all of which convey the concern of the movement with dialogues. |
| 2019 | Cicli – Pedalando pelo Clima (Cicli – *Cycling for Climate*) | Youth–local–practice | Objective: 'To raise awareness about the climate crisis by telling the stories of those who are on the front lines of climate change, by bikepacking'. https://www.instagram.com/ocicli/?hl=pt-br Self-organized | (1) Before: Bikepacking and documenting inspiring stories collected with local people along the way, in order to produce audio-visual material to raise awareness of the climate crisis. More than 1000 km cycled and 122 stories heard in three regions of Brazil. Instagram was used to disseminate the stories, and engagement was low. (2) After: Cicli temporarily stopped traveling to safeguard the health of all involved and began producing more online content about the climate crisis, including courses, live streams, and texts for websites and magazines. Partnerships and engagements increased, and it now has ~3000 followers on Instagram since then. |

**Table 2.** Seven keywords and expression that frequently appeared during interviews with the co-authors for each of the three questions: (1) why should Brazilian sustainability science and education pay attention to ongoing dialogue processes? ('why?'); (2) what can Brazilian sustainability science and education learn from these processes? ('what?'); (3) how can Brazilian sustainability science and education incorporate lessons learnt into practice? ('how?')

| Why? | What? | How? |
|---|---|---|
| Multiple worldviews | Dialogue processes | To listen |
| Conviviality | Participatory processes | To open and to be open |
| Democracy | Network building | To transgress |
| Transparency | Language (jargon-free) | To co-produce |
| Respect | Fluidity | To be present and to empathize |
| Convergence | Permeability | To perceive sacredness |
| Reflexivity | Care with body and spirit | To transcend |

a closer look at these initiatives. Among the take-home lessons for scientific and education practice, team members frequently indicated the different dialogue formats and content matters, the importance of participation over observation only, and the importance of subjectivity over objectivity only. Thus, sustainability for our diverse group of activists and scientists is more than an external phenomenon to be objectively observed and described. This reinforces our premise that sustainability is a value related to living in harmony with oneself, with other humans, and with non-human components of nature. This perspective, which is largely present in indigenous, religious, and local/traditional discourses in practice, is often absent from (natural) science in the name of objectivity. Most answers to how Brazilian sustainability science and education could incorporate the lessons learnt from these and other equivalent movements (see Supplementary material, Table S1) were related to a change in attitudes and in actions. Important attitudes include to listen actively and emphatically to others (one participant said that 'there should be no time limit to listen'), and to transgress some of the rigid academic institutions and pigeonholes ('science locks us up in boxes of rationality and methods'; 'in science and education anything should be possible'). Practical actions involve co-producing knowledge with non-academic actors present in Brazilian nature and culture. An educational practice that incorporates and conveys other lay and extra-scientific forms of interpretation of reality is, therefore, a prerequisite – from schools to graduate programs.

Presence, fluidity, and permeability were recurring terms used by our participants to describe feelings and emotions that emerge while in contact with the initiatives (Table 3). The statement 'to be really present in the activities, be it in the classroom or in the field', made by one of the educators in the team, harmonizes with words and expressions ('empathy', 'to participate', 'to actively listen') commonly used across participants as notions of best practices to be incorporated in science and education for sustainability. The word 'fluidity' was used in three senses, as in 'the fluidity of spirituality and faith is not in contradiction with scientific practice', and in 'the fluidity of our [post-modern] times, when agreed-upon modern values seem to be diluting', and, finally, 'to be fluid and honest with oneself to embark on transformations'. Despite variations in context, fluidity suggests flexibility, plasticity, and openness to change. 'Permeability' statements include 'individuals are multidimensional and permeable to the outside world', and 'we must be permeable to nature to regain humanity and sensibility'. In this context, there were many references to 'multiple layers of reality', 'complex realities', 'listen to other worldviews', 'to be connected to nature', and to the need to 'avoid following science and education models that are inadequate to our [Brazilian] reality'.

**Table 3.** Dimensions to be addressed in the scientific and educational practice of sustainability, according to our definition of 'sustainability as wholeness', which we find applicable to the bioculturally megadiverse Brazil

| 'Sustainability trinities' | Sustainability dimensions | | |
|---|---|---|---|
| Eliade (1957/2019) | Body | House | Cosmos |
| Kumar (2013) | Soul | Soil | Society |
| Principle for Responsible Management Education (PRME) (2020) | Individual | Group | Whole |
| **Our results** | **Sustainability practices and tools** | | |
| Mindset and/or spirit | Presence | Fluidity | Permeability |
| Attitude and action | Silence | Dialogue | Transgression |

### 4.2 Diverging views: legitimacy, fear, and contested 'truth'

In parallel to these convergent perceptions, there were also differences and complementarities. Those were often related to specific groups of authors. The organizers of the initiatives raised concerns about operational challenges ranging from fundraising and networking to being perceived as legitimate brokers, and to effectively mediate dialogues. Their a priori openness to transgress to produce and acquire new knowledge can be contrasted with the concern about academic criticism manifested by some of the scientists. Although the scientists in the group are engaged in transgressing academic and disciplinary walls, several of them do so with fear. Others used words and expressions such as 'rage', 'fatigue', and 'emotional atrophy' in relation to the more conservative academic institution and accepted norms of behavior. The group more engaged with Educating for Sustainability in all scholarly levels, although recognizing the challenges, seemed less intimidated by the academic establishment. 'Reality' and 'truth' were words that appeared among academics and educators on some occasions, which were not present in the other groups. Constraints or opportunities for modifying the spatial settings of classrooms to mimic some of the conversation practices of one or several of the initiatives were also raised as important learnings. Finally, yet importantly, one of the leaders of the initiatives recognized that perhaps we should speak of 'sustainability sciences' rather than 'sustainability science', to be inclusive of other forms of interpretation of reality.

## 5. Discussion and concluding remarks

In this section, we discuss three themes which emerge from our findings. They are related to the scope of what we argue 'sustainability' in Brazil should encompass, the disruptive role of digitalization in forwarding this notion, and the theoretical and methodological development of sustainability science and

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education with a Brazilian imprint. We trust they provide important avenues to decolonize Brazilian sustainability science and education.

### 5.1 Sustainability as wholeness: connecting the sacred and the profane

What can the incipient Brazilian sustainability science and education benefit and learn from these processes? The horizontal dialogues we take part in, where science is only one more voice among other relevant and legitimate voices, teach us that sustainability is wholeness: a state of balance that can only be fulfilled when reached individually, collectively, and cosmically. Most scientists' training to objectively observe external phenomena places the focus on individual behavior or (often to a lesser extent) collective socioecological and political structures, while they generally lack tools to consider their inner self and that of the people they study (Ives et al., 2020). One's own relationship with the cosmos is also neglected from a (traditional) scientific perspective (Woiwode et al., 2021). Emotions, beliefs, cultures, values, spirituality, and identities have often been mobilized for, or played a key role in driving, historical transformations and are no less important when aiming for a transition to sustainability (Ives & Kidwell, 2019). Here, science has a lot to offer beyond the bio-geo-physical foundations of problems such as climate change. For instance, social science can provide strategic insight into political and social systems, the viability or desirability of solution alternatives, and the mechanisms of social change (Isgren et al., 2019). Thus, we argue that Brazilian Sustainability Science should develop methodologies to account for individual, collective, and cosmic dimensions, and their interactions. Scientists, however, are often trained to be more concerned with the parts than with the whole, which is an obstacle to the development of sustainability science as we define it. In fact, no science alone can be a science of wholeness. Therefore, this perception is aligned with our co-author's argument that, in this context, it is probably more appropriate to refer to 'sustainability *sciences*' than to 'sustainability *science*', in reference to the multiple types of knowledge that ought to converge before something new emerges (Latulippe & Klenk, 2019; Trott et al., 2020). Our discussion thereof navigates between two perspectives: (1) that of an emerging Brazilian sustainability science and education with a Brazilian fingerprint; and (2) that of a looser collection of 'sciences' that do not identify with the stricter view of science.

Our emerging view of sustainability as wholeness – a state of balance to be fulfilled when reached individually, collectively, and cosmically – parallels the 1957 'body–house–cosmos' framework of Romanian philosopher Mircea Eliade (1957/2019). Largely drawing on Indian religious thinking (that finds echoes in other Asian, European, and Amerindian philosophies), Eliade applies this framework to what he calls '*Homo religiosus*', whom he defines as anyone 'open to the world' or, in other words, someone who perceives sacredness in nature and in the divine. By his description, it would appear that *Homo religiosus* differs from modern humans, who desacralized and desecrated the world by turning nature and people into commodities, which ultimately led to disenchantment (Agrawal & Gibson, 1999) and alienation from the world, bringing the planet into the Anthropocene. Although sacredness has a spiritual dimension, enchantment has a sensorial dimension (Hoefle, 2009), and the two may merge. Both perceptions of sacredness and feelings of enchantment are forces that inspire affective attachment (Woodyer & Geoghegan, 2013). For our purposes here, we find particularly useful two notions forwarded by Eliade: (1) the human being with the above characteristics reproduces in human scale the rhythms that define a 'world', a 'universe'. We assume that to translate such universal, natural (and, therefore, sacred) rhythms into one individual ('body') or into a collective community ('house'), sustainability should have both an inside-out and an outside-in flow or movement (Ives et al., 2020). Eliade argues that, whenever this occurs, the body is as much a house as it is cosmos, and vice-versa (again, 'wholeness' as our reference for sustainability). (2) These equivalent images of body, house, and cosmos have a passageway to 'another world' on Earth, still according to Eliade. This logic seems a reference as essential to our sustainability science and education endeavor in Brazil, as it is to 'sustainability sciences'. Both are concerned with moving from the current state, one hegemonic world that does not perceive but still impacts other coexisting worlds in this planet, to a new state of planetary oneness, where different worlds coexist and, eventually, hybridize – 'another world'.

Indeed, Eliade's trinity finds match in others that we find equally applicable to Brazilian sustainability science and education. Satish Kumar's (2013) soil–soul–society refers to the moral imperatives of caring for the natural environment (soil), maintaining personal wellbeing (soul), and living in harmony with other people (society). The principle for responsible management education, likewise, argues for three levels of reflexivity in sustainability education: individual, group, and whole (Cunliffe et al., 2020; Table 3). These trinities bear resemblance to keywords that emerged from our dialogical process between authors, where presence, fluidity, and permeability described feelings and emotions that emerge while in contact with the bottom-up initiatives (Table 3). Curiously, fluidity and permeability were the same words used by Jean Clottes, Paleolithic art specialist, to describe the two main traits that would justify, in his opinion, naming humans *Homo spiritualis* rather than *Homo sapiens* (Cook, 2016). Fluidity, in his terms, is related to the capacity to interact with others – humans, animals, plants (Eliade's 'house') – whereas permeability refers to the human capacity to interact with the unseen, with the spiritual world (Eliade's 'cosmos').

Nevertheless, the emphasis on spirituality, sacredness, and wholeness might, at first impression, contrast with another key theme that emerges through the sustainability initiatives: digitalization.

### 5.2 Technosphere meets the Psychosphere: the emergence of digital spaces of resistance and alternative rationalities

Our results show increased adherence to civil-society sustainability movements and their expanding outreach, not least due to adaptation of these movements to digital formats during the social distancing imposed by COVID-19. Much like the pandemic, digitalization itself represents a disruptive opportunity for change agents wishing to bring about societal transformation as well as for those wishing to preserve the status quo (Sharpe et al., 2016). This is particularly salient for a country like Brazil, where the digitalization of public life, including of government services, ranks among the most advanced in the world (World Bank, 2022). The rapid technological development and social media algorithms continue to give rise to new and emergent forms of mobilization, from large but unorganized groups of urban protesters that can surge in hours, to completely digital resistance repertoires such as through *memes* and online forums (Brink et al., 2023; Giaretta & Di Giulio, 2018). This raises valid

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questions regarding digitalization and digital inclusion for transformations toward sustainability. For instance, what are implications of movements 'going online', given the underlying logic of such information technologies that control and monitor users, and in parallel spreads hate and fake news? Furthermore, how inclusive can these movements be of people with no access to such technologies? Despite these risks, we mostly see symptoms of positive transformation in the studied cases. There is evidence that peasant and indigenous movements in Brazil and Latin America – long associated with rural life, backwardness, and being excluded from modernity – in recent decades have become key actors in internationalized and global struggles (Bringel, 2019). This situation warrants theoretically informed ways to think about the interaction between human consciousness, technology, and social change, which is still incipient in sustainability science.

Here it might be fruitful to draw on Brazilian geographer Milton Santos (Table 4), a pioneer in critical studies of globalization. He described a temporal lag for 'social energy' to include technical objects – in this case, internet and the social media – in the 'movement of life' (Santos, 1997). Our results show that dialogues proposed by civil-society sustainability movements are increasingly becoming a significant part of the 'movement of life' in Brazil. In this way, the related digitalized spaces become an expression of 'alternative rationalities', another topic addressed by Santos in his globalization studies (Albagli, 2017). He argued that the Technosphere (everything made by humans: buildings, streets, computers, clothes; see also Folke et al., 2021) and the Psychosphere (where meaning is produced, the sphere of ideas and intersubjective action; Santos, 1997) introduce both hegemonic rationality and alternative rationalities in a given territory. Alternative rationalities, such as the ones fostered by the movements here examined, are a form of resistance to the hegemonic logic and to the purely instrumental or for-profit use of the Technosphere in the territory. This resistance emerges from areas of the Psychosphere, and their enhancement is of great significance, particularly considering that estimates of the weight of the Technosphere suggest that it might soon exceed the mass of all living things on the planet (Elhacham et al., 2020).

### 5.3 Incorporating lessons learnt: pathos and methodology of a sustainability science emerging from Brazil

The research presented here reveals a plurality of mindsets and attitudes (see Table 3) which can enrich Brazilian sustainability science and education practices. Sustainability in the modern perspective is often used as a synonym to sustainable development, translated into global policy (that percolates to national policies) as SDGs. For Brazilian sustainability academics, teachers, and practitioners to conform to the hegemonic perspective on sustainability is to embrace one 'universe', that of the modern worldview, science, and policy. It means to leave behind the pluriverse that defines Brazilian nature–culture interactions.

A prerequisite to incorporate these practices and transform Brazilian sustainability science and education is to decolonize the minds and attitudes of our students and researchers. Along this pathway, Brazil can benefit from its legacy of border-thinkers (see Table 4), that is, actors who think outside and beyond the colonial walls of modern narratives (Mignolo, 2011), some of whose ideas provided the background rationale for our paper. To incorporate all these approaches in sustainability science and education would be in many ways an 'epistemic disobedience' (Mignolo, 2011), or a 'transgression' – a term used by our team in the interviews, and also by Georges Bataille about the transgressive nature of literature and art, as opposed to the 'interdictive' nature of the social status quo (Bataille, 1957/2020). In Brazil, such a rupture with the status quo of knowledge production seems essential to fulfill a sustainability science and education capable of producing the necessary transformation.

Nevertheless, the surveyed attitudes also revealed some interesting contradictions and uncharted possibilities for furthering inter- and transdisciplinarity. Most striking are views that equate 'science' with positivist, natural science, and the fear of one's work being deemed as 'non-scientific' if considering people's values and lives. This neglects a wealth of historical development of

**Table 4.** Some Brazilian border-thinkers and their ideas that can contribute to decolonial sustainability science and education (SSE) in the country

| Border-thinker | Field | Contributions applicable to a decolonial SSE |
|---|---|---|
| Paulo Freire (1921–1997) | Education | Dialogic interaction as a centerpiece of social learning processes; critical thinking about existence and the consequent action to transform those very conditions (Freire, 1970/2013; Wanderley & Bauer, 2020). |
| Lélia Gonzalez (1935–1994) | Feminism Antiracism | Her concept of 'Amefrica Ladina' provides an Afro-Latin-American and Amerindian perspective on the historical, cultural and political direction for the continent (Rios, 2019). Insights to standpoint theory (Ribeiro, 2016). |
| Ailton Krenak | Indigenous peoples | He argues that 'ecology' and 'nature' are colonial concepts and evokes the perception of 'sacredness' and 'oneness' in the territory or 'place': 'the place transcends nature perceived as resource and reaches the dimension of the existence as something sacred' (Krenak, 2018). |
| Clarice Lispector (1920–1977) | Literature Feminism | Foundations of a decolonial view on feminism in Brazilian literature (dos Prazeres & Miglievich-Ribeiro, 2017); poetically broke the silence Brazilian society imposed on women's voices. |
| Cecília Meirelles (1901–1964) | Education Literature | The need for children to occupy the political and educational scene; the need for adults to create strategies to listen actively to the children across the education process (Ferreira & Wiggers, 2018). |
| Darcy Ribeiro (1922–1997) | Anthropology Education | Decolonial interpretation of the civilizational process; Brazil's reality as inseparable from Latin America's reality (Miglievich-Ribeiro & Romera 2018). |
| Milton Santos (1926–2001) | Geography | Wrote about and practiced against the colonial relations that have shaped Brazil. Decolonial interpretation of globalization by highlighting non-hegemonic values and knowledges threatened by capitalism (Melgaço & Prouse, 2017). |
| Anísio Teixeira (1900–1971) | Education | Conceived an educational system to develop autonomous and creative citizens (Fialho & Oliveira, 2022). |

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qualitative methods and reasoning (e.g. regarding sampling, analysis, and potential generalization) in scholarly fields such as sociology, anthropology, human geography, education, and feminism (many represented in Table 4). In other words, by transgressing boundaries we are not advocating for a loosening of academic rigor or 'anything goes' – rather, we see the need to develop novel, innovative, rigorous, and contextually relevant methods to respond to these new demands on science. Such methods must be potent enough to handle the cross-sectoral and complex scalar dynamics inherent to 'glocal' challenges such as climate change, while they might need to consider *additional* quality criteria, such as salience, legitimacy, and credibility (Kunseler et al., 2015; Sarkki et al., 2014), that arise in transdisciplinary co-production with stakeholders. This translates into a research niche and opportunity for Brazil, with its history in participatory methods via Paulo Freire and diverse nature–culture, to contribute to the methodological development of sustainability science. Educational programs for sustainability could incorporate and teach a range of methods and techniques including participatory action research and dialogical processes (Fernández-Aballí Altamirano, 2020; Freire, 1970/2013), living lab methodology (Berchin et al., 2020), futures literacy (Facer & Sriprakash, 2021), collective foresight and intelligence (Wood et al., 2021), and standpoint theory (Gonzalez, 1984). Their deployment would be supported by strategic recruitment of faculty strong in philosophy and history of science, mixed qualitative and quantitative methods, and methods for inter- and transdisciplinary (including Latin American perspectives). This would be essential for nurturing a strong Brazilian sustainability science that reflects local conditions and voices and critically and reflexively engages with (often-hegemonic) concepts from the North.

This discussion, in turn, underscores the importance of sustainability science emerging from the Global South to contribute to global sustainability debates. For instance, in an urbanizing world, cities in the Global South have urgent necessities, and a 'unique but often overlooked capacity, to innovate and experiment for sustainability' (Nagendra et al., 2018, p. 341). Currently, ~14% of the world's urban population lives in informal settlements (https://unstats.un.org/sdgs/report/2023/goal-11/), making it not a marginal phenomenon to the sustainability debate but the reality of housing for many people. Brazilian research is well positioned to contribute on many frontier topics in sustainability science such as decolonization, inequality, informality, environmental racism, more-than-human worlds, inner transformation, artificial intelligence, and urban living labs.

Finally, we stress that our study is less a crusade against hegemonic thought on sustainability than it is a call for Brazilian sustainability scientists and educators to listen, engage in dialogue, and learn from the various and diverse voices and knowledges that exist in the country. Indeed, the rationale for this paper combines the lines of thought of border-thinkers from Brazil (Table 4) and elsewhere (Bataille, Eliade, Gramsci, Mignolo) with well-established and relevant hegemonic sustainability thinking (most citations). The various worldviews expressed in the civil-society initiatives examined here come from actors increasingly interested in what science and policy call 'sustainability', even if they call it by other names. Technology connects these diverse perspectives on sustainability, as the expansion of the initiatives during COVID-19 demonstrates. Scientists and educators, from Brazil and elsewhere, will always be welcome to such dialogues.

**Supplementary material.** The supplementary material for this article can be found at https://doi.org/10.1017/sus.2024.25.

**Data.** Data are available by contacting corresponding authors.

**Acknowledgments.** This paper is a product of the UNESCO Chair on Planetary Wellbeing and Regenerative Anticipation hosted by the Museum of Tomorrow in a partnership with Universidade Federal do Rio de Janeiro, Rio de Janeiro Brazil. The Chair is funded by Instituto de Desenvolvimento e Gestão, Instituto Humanize, Porticus Foundation, EY and Volvo. E. B. acknowledges the Swedish Research Councils VR (2019-00498) and FORMAS (2018-01350). We are thankful for the various graduate programs we are affiliated to and, especially, to various organizers and audiences of the social movements concerned with sustainability dialogues that we address in this paper.

**Author contributions.** F. R. S. and E. B. conceived the paper. F. R. S., E. B., and B. L. R. C. conducted the interviews with all co-authors. A. C. P. A., M. C. S., and R. P. reviewed the whole process. All authors reviewed the submitted and the revised versions.

**Funding statement.** This paper was financially supported by the sponsors of the UNESCO Chair on Planetary Wellbeing and Regenerative Anticipation: Instituto de Desenvolvimento e Gestão, Instituto Humanize, Porticus Foundation, Volvo and EY. E. B. was funded by the Swedish Research Councils VR (2019-00498) and FORMAS (2018-01350).

**Competing interests.** None.

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