Circular Economy and Sustainability (2024) 4:23–42
https://doi.org/10.1007/s43615-023-00272-3

OPINION PAPER

Transition to a Sustainable Circular Society: More than Just Resource Efficiency

Martin Calisto Friant[1,2] · **Walter J. V. Vermeulen**[1] · **Roberta Salomone**[3]

Received: 21 October 2022 / Accepted: 7 May 2023 / Published online: 25 May 2023

Abstract
While the conceptual underpinnings of the circular economy (CE) date back to the 1970s, the concept has recently become a major discourse in contemporary sustainability debates. The idea of CE, as it is now understood, is thus rather new and remains in conceptual development. Moreover, it is a contested concept with many different circular visions competing in the discursive sphere. Many researchers have evidenced that dominant CE propositions focus on technocentric solutions and do not address crucial social, political, and ecological implications. This opinion paper seeks to help address this gap by going to the root of the CE metaphor and asking: What do circles, cycles, and flows mean for an economy and a society? To answer this question, this article unpacks the idea of cycles, loops, and flows by analysing what socio-ecological cycles are most relevant for sustainability and circularity. It thus finds a set of seven cycles that are key to better understanding CE and its relation to human and planetary well-being (biogeochemical, ecosystem, resource, power, wealth, knowledge, and care cycles). This article then analyses how and whether dominant CE discourses currently address these cycles. This paper proposes the idea of a circular society as an umbrella concept that can help us better address the critical ecological, social, and political implications of a circularity transition. Moreover, this article develops a set of interrelated strategies to operationalise the circular society concept. This paper thus hopes to contribute to expanding the imaginary regarding the concept of circularity that can help the cross-pollination of ideas, solutions, and approaches to face the manyfold socio-ecological challenges of the twenty-first century.

Keywords Circular economy · Circular society · Sustainability · Socio-ecological cycles · Degrowth

Introduction

The concept of a circular economy (CE) has been proposed as a solution to the multifaceted socio-ecological crises that humanity faces in the twenty-first century by various academics (e.g. Stahel [1]), public institutions (e.g. European Commission [2]), and private organisations (e.g. Ellen MacArthur Foundation [3]). These proponents expect many benefits from the implementation of CE practices, such as reduced resource scarcity and

Extended author information available on the last page of the article

environmental pollution, as well as economic revitalisation and "green jobs" in recovery sectors [1, 4, 5]. However, the CE concept is facing many challenges and limitations to reach those ambitions [6–8].

The use of the CE concept grew exponentially in academic, policy, and business sectors in the last decade, but it is still very much in construction and evolution [5, 9, 10]. There is hence much divergence between different circular economy and society perspectives. Researchers have found 120 different definitions [11] and 38 different Rs (value retention options such as reduce, reduce, recycle) in the literature [12].[1] The mix of widespread support and enthusiasm for the CE with the lack of conceptual clarity and consistency has led some academics to call it an "essentially contested concept" [13]. As with other essentially contested concepts, various actors compete to influence the discourse on the CE for their specific objectives and promote an interpretation of the CE which fits with their political, social, and economic agendas [13, 14].

It has also been argued that many of these actors have chosen to use a "deliberately vague, but uncontroversial" discourse on the CE as a strategy to gain widespread support in the short term (Lazarevic and Valve [15], p60). Mainstream CE propositions are often depoliticised and do not address crucial sustainability implications of CE, such as how the benefits and costs of a CE transition are distributed, who controls CE technologies and patents, who decides on the shape, form, and policies for a CE transition, and what are the overall social and environmental impacts of CE proposals. Dominant CE visions thus often neglect key issues and cycles related to wealth, power, care, race, gender, class, planetary boundaries, ecosystem limits, and democracy.

This opinion paper seeks to help address those gaps by going to the root of the CE metaphor and asking: what do circles, cycles, and flows mean for an economy and a society? To answer this question, this opinion piece is based on a collection of thoughts, insights, and ideas from 4 years of research, case study analysis, and critical literature review on sustainability and CE carried out within the CRESTING project.[2] This allowed us to unpack the idea of cycles, loops, or flows and analyse the many cycles, loops, and flows that are relevant to a circular society transition.[3] This paper then analyses which of these cycles are currently addressed or disregarded by dominant CE discourses. This article proposes the idea of a circular society as an umbrella concept that can help us better address crucial ecological, social, and political implications of a circularity transition. Moreover, it develops a set of interrelated strategies to operationalise the circular society concept. This opinion paper concludes by proposing new avenues for research on circularity to better address the full complexity of the manyfold socio-ecological challenges of the twenty-first century. This opinion piece thus hopes to contribute to an expansion of the imaginary regarding the concept of circularity that

[1] This paper follows the value-retention options (also called R-hierarchy, R-imperatives or simply R's) established by Reike, Vermeulen, and Witjes (2018): R0 refuse, R1 reduce, R2 reuse/resell, R3 repair, R4 refurbish, R5 remanufacture, R6 re-purpose, R7 recycle materials, R8 recover energy, R9 re-mine.

[2] The CRESTING project seeks to analyse the sustainability implications of a CE transition in a broad range of different geographic and economic settings (see https://cresting.hull.ac.uk/): It received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 765198.

[3] The 7-cycle framework described in this article was also presented at 10 conferences and workshops in various countries and regions (including Italy, Germany, Netherlands, Spain, Japan, Quebec, and Peru). This allowed us to share, discuss, and validate the framework with many academics and practitioners working on CE and sustainability.

can help the cross-pollination of ideas, solutions, and approaches to face our most pressing sustainability challenges.

The Importance of Seven Socio-ecological Cycles to Understand Circularity

Human societies and our planet function through a wide diversity of cycles and flows. While there are countless socio-ecological cycles and flows, the literature on sustainability can help us find the most relevant ones in relation to the manyfold CE challenges identified in the introduction. By critically reviewing and reflecting on decades of literature on CE and sustainability, we have found seven socio-ecological cycles, which can help us understand what circularity means in relation to human and planetary well-being:

1. Biogeochemical cycles of the Earth
2. Ecosystem cycles
3. Resource cycles of materials and energy
4. Political cycles of power
5. Economic cycles of wealth, capital, and money
6. Knowledge cycle of technology, information, and education
7. Social cycles of care

It is worth noting that these seven cycles are deeply interrelated, interconnected, and interdependent and are thus best understood as a holistic and integrated framework rather than as seven separate and segmented elements (see Fig. 1). The following section will briefly describe and examine the current state of each of these cycles to better understand their relevance for CE and sustainability research and practice.

Biogeochemical Cycles of the Earth

The Earth functions through many complex biogeochemical cycles such as the water, carbon, nitrogen, oxygen, hydrogen, iron, sulphur, and phosphorus cycles [16]. These cycles lead to the circulation and transformation of matter and energy on planet Earth through various biological and geological processes, such as transpiration, erosion, wind circulation, ocean currents, and the movement of continental plates [17]. By doing so, they ensure that energy and materials are available to different ecosystems and organisms throughout the Earth. These cycles also ensure the stability of global weather patterns and maintain the integrity of the Earth's atmosphere and ozone layer [17]. Life on Earth thus depends on these cycles, and maintaining their effective circulation is thereby imperative. Yet, our societal system is seriously disrupting all of the above cycles, especially the carbon cycle, which is one of the leading causes of climate change, but also the water, phosphorus, and nitrogen cycles, which are affecting key ecosystems and reducing our ability to produce sufficient food [18–20].

Ecosystem Cycles

Biodiversity and natural ecosystems also work through cycles that allow for the continuous reproduction and regeneration of life [6]. Energy flows through ecosystems, entering

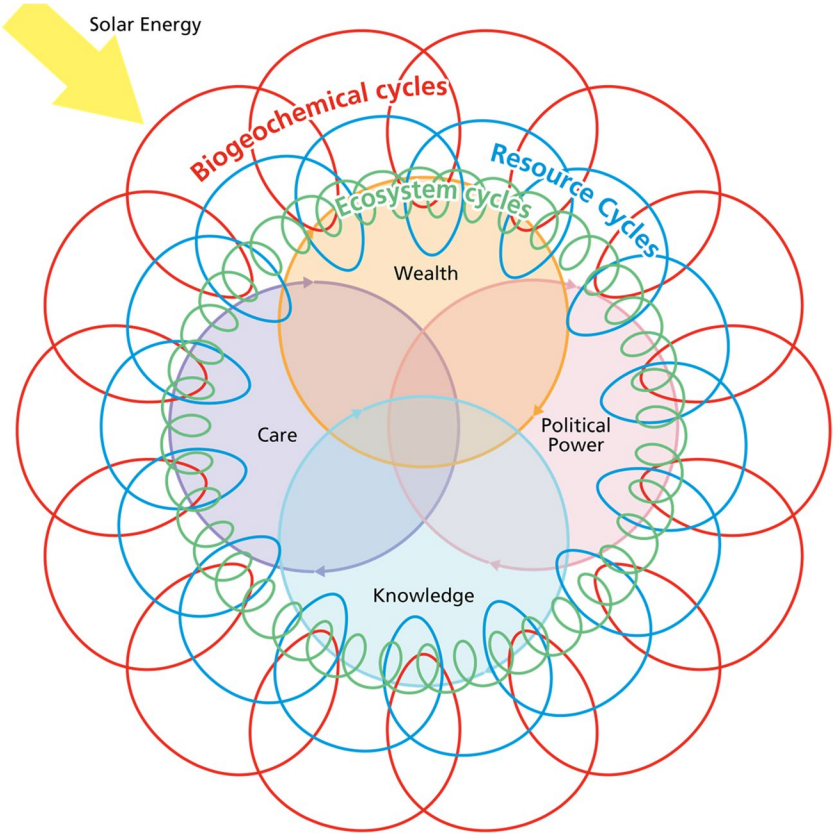

Fig. 1 Seven key socio-ecological cycles (the red, blue, and green loops around the figure represent biophysical cycles, while the four circles in the middle represent social cycles. All the cycles intersect one another to reflect their multiple interconnections, interdependencies, and interactions)

first as sunlight via photosynthetic organisms such as plants, algae, and phytoplankton and succeeding through the different trophic levels of the food web [21].[4] Nutrients are thereby continuously cycled in natural ecosystems in a regenerative manner as the waste of one specie is food for another[5] [22].

These ecosystem cycles provide vital functions and services that enable the existence and reproduction of life and human societies, such as plant pollination, flood regulation, water purification, soil formation, disaster risk reduction, climate adaptation, and carbon sequestration [17, 23]. The health and balance of ecosystem cycles thereby fosters socio-ecological resilience and flourishing [17]. However, there is currently a severe weakening and collapse of biodiversity and ecosystem functions due to human over-extraction of

[4] It is worth noting that ecosystems in the deep sea, where no sunlight can penetrate, obtain energy from hydrogen sulfide near hydrothermal vents rather than from sunlight.

[5] However, it is worth noting that natural ecosystems are not perfectly circular because available energy dissipates in each trophic level (typically 90% is thus "lost"). Thus, biological system cannot continuously cycle energy and materials without the continuous inflow of additional energy from the sun 6.

natural resources, habitat destruction, industrial pollution, deforestation, climate change, the introduction of invasive species and genetically modified organisms, etc. [20, 24, 25]. The current rate of species extinction is 100 to 1000 times the baseline rate [16], and only about 50% of the Earth's terrestrial natural ecosystems remain in relatively healthy conditions [26]. We are thus in the midst of what many scientists have called the "sixth mass extinction event" [27, 28].

Resource Cycles of Materials and Energy

Resource cycles bring materials and energy into human economies. After being extracted, processed, and consumed, resources are cycled through various recovery loops such as repair, reuse, remanufacture, and recycle [10, 29]. At their end-of-use, resources are cycled back to nature either by being burnt and dissipated into the atmosphere, by being placed into landfills, or by being thrown into the environment [30–32].

Waste that is not sustainably cycled can accumulate in natural ecosystems and cause a degradation of human and planetary health [33]. This occurs when there is a lack of effective solid and liquid waste treatment and recovery or an excess of pollution (i.e. when pollution exceeds the ability of the biosphere to assimilate it or exceeds safe emission levels for human health) [34, 35]. These cycles can also be disrupted by the over-extraction of renewable resources beyond their replenishing rates, such as the overfishing of marine resources, the overdrafting of water resources, the unsustainable management of forests, or the over-tilling of agricultural soils [36–38]. Similarly, sustainability problems can arise when non-renewable resources like ores (iron, copper, nickel, aluminium, etc.) and non-metallic minerals (marble, gravel, sand, etc.) are over-extracted and not recycled back into the economy [1, 35, 39]. Finally, unsustainable resource flows can arise when resources are lost due to mismanagement. This happens when resources are wasted before they are used due to losses in storage and transportation [40]. Accounting for all of the above, the global economy currently sustainably cycles only about 8% of its total resource use [24, 41]; humanity could thereby run into critical resource shortages and overshoot key ecosystem boundaries in the coming decades [42–44].

Political Cycles of Power

Laws and institutions shape and determine how power circulates through human societies. Decisions and authority can thus flow from the top down or bottom up depending on the established governance models [45]. Different institutions maintain a balanced flow in the distribution of power between the different branches of government (executive, legislative, and judiciary) and between the different scales of government (municipalities, regional governments, national states, intergovernmental organizations etc.). A balance of power is also maintained in the cycles of power that occur during elections for local, regional, and national representatives. Power also flows between the public and private sectors beyond elections, with various lobbying mechanisms, multi-stakeholder platforms, participatory bodies, and public–private partnerships shaping how policies are developed and implemented [46].

Unsustainable cycles of power can arise when citizens lose the ability to democratically control their state due to the power of wealthy economic "elites" or of entrenched political elites (or a mixture of both, as political and economic elites, are often hard to distinguish from one another due to the many "revolving doors" between high level public and private institutions) [47, 48]. Many academics have argued that the balance of political power is

currently under threat due to the large inequalities that have risen both locally and globally and due to the lack of meaningful citizen participation in decision-making through democratic institutions and processes [49–51]. A broad range of mechanisms exist to maintain a democratic flow of power that benefits all citizens, such as participatory budgeting systems, referendums, citizen assemblies, citizen juries, deliberative polling, and elections [52–55]. These and other policies, such as the respect of political and socio-economic human rights, the creation of fair and independent judicial systems, and the promotion of free and plural media, help in the development of pluralist and inclusive institutions that ensure a fair, democratic, and balanced flow of power within human societies [56].

Economic Cycles of Wealth, Capital, and Money

Wealth, capital, and money flow and cycle through an economy, continuously shifting hands between governments, firms, NGOs, individuals, etc. This flow is an essential element of an economy's provisioning and distribution system [57, 58]. When monetary wealth accumulates too much in certain hands, it can generate unsustainable inequalities that prevent the economy from running for the benefit of society as a whole [47, 50, 59]. The same is true for wealth in the form of private property, especially private property in the means of production (ownership of companies, technologies, tools, and natural resources), as well as the private property of land and housing. [60]

The fields of Marxist political economy and political ecology have contributed significantly to the study of the circulation of capital. They have pointed out fundamental contradictions in capitalist societies, which lead wealth and capital to over-accumulate in a few hands and to destroy the natural ecosystems on which they depend [61–63]. Many communist, socialist, and anarchist scholars have thus argued that any level of private accumulation and ownership of means of production inherently leads to the exploitation of people and natural ecosystems [51, 61, 63–65]. In fact, the accumulation of capital, money, and private property in a few private hands not only generates unsustainable inequalities in the use of essential resources but also threatens the political and economic stability of a society and the freedom of its citizens [56, 66, 67].

Our economies are currently faced with a highly unsustainable accumulation of capital as the top 10% of the global population own 76% of global wealth while the bottom 50% own just 2% [68]. Various policy mechanisms can be used to counteract this inequality and ensure that wealth is fairly and sustainably circulated throughout the economy. These policies include property taxes, inheritance taxes, and taxes on financial transactions as well as redistributive policies such as universal basic incomes, job guarantee programmes, and the provision of free and quality public goods and services like housing, healthcare, education, water, energy, and social security [50, 69, 70]. In addition to this, democratic worker control over companies and workplaces through unions, cooperatives, and community-owned enterprises can help better distribute wealth within the Economy [60, 64, 71, 72].

Knowledge Flows of Technology, Information, and Education

Modern civilisations are built upon the knowledge and technologies of over 300,000 years of human history. Our societies rest upon centuries of technical inventions, from the wheel, and the printing press, to the windmill and the internet. We also rely on spiritual, artistic, and social inventions such as philosophy, music, schools, and democratic institutions. The flow of human knowledge and technology through writing, education, travel, research, and

storytelling can be a significant fuel for the emancipation and flourishing of humankind through history [73].

Yet, overly stringent patent and intellectual property laws and the privatisation and commodification of research, knowledge, and technology can limit the ability of all humans to share and equally benefit from new technical and societal innovations [48, 74, 75]. The accumulation of patents and technologies in certain countries, companies, universities, or individuals can threaten the free and open sharing of ideas, which prevents the fair and democratic balance of power between different peoples.

Policies and practices that encourage open-source and transparent sharing of information and technologies as well as free quality public education, from pre-school to university, can help circulate knowledge in more sustainable and inclusive manners [76, 77]. Transdisciplinary teaching and research approaches such as participatory action research can also help democratise knowledge flows by empowering marginalised and vulnerable people in the creation, ownership, and dissemination of knowledge [78–80]. This democratisation of knowledge cycles can also be achieved through pluriversal approaches to science that break the ivory tower of western academic disciplines and embrace other forms of knowledge-making and world-making such as indigenous education, technological, and spiritual traditions [81, 82].

Social Cycles of Care

Essential cycles of care occur every day as people share love, affection, energy, and time with their family, friends, communities, and ecosystems. These cycles of care are often invisible and un-valued in current societies and are typically performed by women, racialized people, ethnic minorities, and other historically marginalized groups [83–85]. Yet care is a fundamental cornerstone of human civilisation that ensures the health and reproduction of life. Care cycles are responsible for the well-being and education of children, the feeding and nourishing of most of humanity, the regeneration of vital ecosystems, the protection of biodiversity, the maintenance of people's physical and mental health, etc. [86–88].

Human societies can face major crises of socio-ecological health and well-being when these cycles of care stop by being commoditised, by neglect, by lack of free time, or by lack of funding for social services, safety nets, and environmental regeneration [83, 89, 90]. Moreover, care is vital for societal resilience towards disasters. Strengthening social and community relations of care can thus be a crucial strategy to face the manyfold socio-ecological impacts of climate change and biodiversity loss, such as hurricanes, floods, mass migration, sea-level rise, and heat waves [91].

What Do These Seven Socio-ecological Cycles Tell Us About Circularity and sustainability?

This section will first discuss the importance and interrelated nature of all the above cycles to better understand the full complexity of current socio-ecological challenges. It will then analyse which of these cycles are currently addressed or disregarded by mainstream CE literature and what this entails for the sustainability, scientific validity, social relevance, and political legitimacy of dominant CE policies and practices.

Addressing All Relevant Cycles and Flows with a Holistic View of Circularity

All the above cycles are interrelated and should not be considered in isolation. This is shown in Fig. 1, as all cycles overlap with one another and influence each other in multiple ways. For example, a failure in care cycles due to a lack of support for indigenous forms of land tenure can increase the deforestation of vital ecosystems and weaken ecological and biogeochemical cycles (especially carbon, water, nitrogen, and phosphorus cycles). Similarly, a failure in wealth cycles due to the over-accumulation of capital in the hands of fossil fuel corporations can shape political power cycles, so societal decisions favour the interests of that industry. This can affect the capacity of humanity to develop democratic policies to address critical biogeochemical and ecosystem cycles related to carbon, climate change, and deforestation. Addressing a problem related to any of the seven cycles thus necessitates a broad understanding of the interactions and interrelations between all cycles.

Moreover, it is worth adding that these seven cycles are a simplification of infinitely more complex planetary and societal structures; therefore, not all possible social-ecological cycles were included. Some cycles, such as the hydrogen, copper, lithium, and calcium cycles, were hence not explicitly added but are rather part of broader cycles (the resource and biogeochemical cycles). Other cycles, such as business cycles, Milankovitch orbital cycles, or spiritual cycles (such as the Buddhist rebirth cycles of samsara), were not included because they were not deemed relevant enough to the specific socio-ecological issues related to sustainability and circularity which this article addresses.

All in all, the core value of representing these seven cycles resides in helping us understand what "circularity" and "circular" flows can be about in relation to sustainability and human and planetary well-being. They help expand the imagination regarding what is and what isn't included as a "loop", "cycle", "circle", or "flow" when we talk of a "circular" economy and society. Moreover, these seven cycles are very much aligned with the well-recognised conceptions and principles of sustainability developed by Robèrt [34] and by Herman Daly [39]. Robèrt describes a sustainable society as one where "nature is not subject to systematically increasing: 1. concentrations of substances extracted from the Earth's crust; 2. concentrations of substances produced by society; 3. degradation by physical means; and in that society; 4. human needs are met worldwide" (2002, p246). Similarly, Daly stipulates that sustainable development requires first that renewable resources are harvested at a rate below their regeneration rate; second, that waste emission rates are below the assimilative capacities of the ecosystems; and, third, that the rate of depletion of non-renewable resources, does not exceed the rate of creation of renewable substitutes (1996). Daly adds that "all economic and environmental decision-making should consider the well-being of future generations, and preserve for them the widest possible range of choices" (1996, p15). The first 3 principles in Robert's and Daly's description of sustainability are directly related to this article's biogeochemical, ecosystem, and resource cycles, while the fourth principle that Robert and Daly describe relates to this article's power, wealth, knowledge, and care cycles.

A central point that can be drawn from the seven socio-ecological cycles and their relation to human and planetary well-being is that sustainability crises can arise if any of these cycles are significantly altered or stop flowing in a sustainable and regenerative manner. Excessive accumulation, unsustainable exploitation, lack of effective recovery, lack of sufficient redistribution, or simply neglect can thereby lead to crucial sustainability problems and even a collapse of planetary functions and societal structures.

Moreover, many academics have demonstrated that the current capitalist system is negatively impacting all these flows and cycles [32, 66, 92].

Capitalism can be described as a linear system that continuously generates waste in terms of social injustice, poverty, alienation, exploitation, and conflicts over resources [40, 93, 94] as well as waste in terms of environmental pollution, biodiversity reduction, and disruption of biogeochemical flows and cycles [19, 32, 95].[6] As Martinez-Alier points out, the growth-dependent nature of the global capitalist economy means that it depends on the continuous supply of raw materials and energy from "commodity extraction frontiers" and generates an endless supply of waste that it sends to "waste disposal frontiers" [31]. This has created a global pattern of social and environmental injustice with countless ecological distribution conflicts throughout the world and strong global movements of popular resistance and revolt against the expansion of capitalist frontiers on human and non-human nature [93, 94, 96].[7] Poor communities, indigenous people, people of colour, women, LGBTI + groups, and many more systemically marginalised people are thereby often united in their common struggle against the socio-ecological impacts of this globalised economic system [31, 97]. This conflict costs the lives of over 250 environmental and human rights defenders every year [98], and this tragic figure does not count the thousands more who die of hunger, lack of access to healthcare and sanitation, over-exposure to toxic pollution, and many other so-called "externalities" of the global capitalist economy (every year over 9 million people die of hunger [99], 2 million die due to work-related accidents and diseases [100], and over 8 million die due to air pollution [101]).

Dominant CE Discourses and the Seven Socio-ecological Cycles

The dominant idea of a CE has grown in the discursive sphere to address many of the above global sustainability challenges. Indeed, it is proposed as a new vision to reduce waste and resource scarcity by sustainably cycling materials and energy in our economies thanks to various value retention technologies and strategies such as reduce, reuse, repair, remanufacture, recycle, and re-mine, as well as sustainable business models that close, slow, and narrow resource flows [5, 102, 103]. However, this mainstream vision of a CE only addresses the third of the seven cycles mentioned above ("the resource cycle") and partly addresses the first ("biogeochemical") and second ("ecosystem") cycles. Key social and political elements, such as the democratisation of power, the redistribution of wealth, and the nurturing of caring activities, are thus typically absent from mainstream CE debates [104–107]. Research has found that policies related to CE in the Netherlands [108, 109], in Norway [110, 111], in Australia [112], in China [113], in Quebec [114], in the USA [115], in various European cities [116–121], and at the EU level [14, 15, 122, 123]

[6] Because of these socio-ecological impacts of the linear capitalist system, some scholars call it a social and environmentally entropic system 31,93,96,130. Both social and environmental entropy can be understood as the application of the thermodynamic principle of entropy to our socio-ecological system. Entropy here is thus a measure of chaos, conflict, lack of diversity and disharmony. An increase in environmental entropy is thus a reduction of biodiversity, a reduction of available material and energy resources, greater pollution, lower resilience of ecosystems, and a disruption of biochemical flows and cycles 96,130. An increase of social entropy means an increase of social injustice, unrest, poverty, exploitation, conflicts, violence, and alienation, while a reduction of social entropy entails greater peace, equity, solidarity, reciprocity, harmony, health, democracy, and conviviality 93.

[7] The environmental justice atlas counts over 3500 ecological distribution conflicts to date (see https://ejatlas.org/).

are mainly focused on end-of-pipe approaches such as recycling innovations and recovery technologies, and do not address key social implications, nor seeks to reduce overall ecological footprints.

CE is also often promoted as a vehicle to decouple economic growth from environmental degradation through the many eco-efficiency improvements it hopes to bring about in material and energy resource cycles [15, 124, 125]. Yet, this growth-optimist approach to CE is quite problematic from a scientific perspective, as a significant amount of academic research has demonstrated that decoupling is neither happening nor likely to happen on a sufficient scale to prevent climate breakdown, resource shortages, and biodiversity collapse [126–129]. In fact, research has shown that economic growth is deeply tied to energy and resource use, and it is the main driver for the continuous expansion of the commodity extraction and waste disposal frontiers [31, 38, 40, 130, 131]. Hence, by focusing on economic growth, regardless of actual planetary boundaries and limits, mainstream CE approaches currently lack a full understanding of the biogeochemical, ecosystem, and resource cycles described above.

All in all, mainstream CE discourses often lack a holistic vision of both social and ecological cycles and remain attached to problematic assumptions about economic growth and decoupling. This technocentric discourse on CE could end up replicating current patterns of social and environmental unsustainability and injustice [31, 106, 132]. Addressing those research and conceptual gaps on the topic is a timely endeavour now that the CE concept is still relatively young and remains in conceptual development and construction. It is thus still possible to challenge and enrich the discourse with different visions of what a CE is about and expand the imaginary of what a fair and sustainable circular society can look like.

Discussion and Conclusions: Towards a Circular Society

In its current dominant interpretation, the CE is neither a novel concept nor a particularly socially or environmentally relevant one, as it often fails to address the entangled nature of the seven flows and cycles presented in this article. While most contemporary CE discourses overwhelmingly focus on material and energy flows, this is not a new area of research and action as previous ideas, which focus on those flows, have existed for decades, such as industrial ecology, cleaner production, industrial metabolism, and material efficiency (ideas within CE1.0 and 2.0 according to Reike et al. [12]). The critical value and importance of shrinking, slowing, and closing resource loops was indeed already stressed by academics as far back as the 1970s [133–135], and it is a central element of the 1992 Rio Declaration on Environment and Development and Agenda 21 [136].

If the CE is to bring any substantial innovation and contribution to the sustainability debate, it is by bringing more than just a biophysical perspective and by integrating the full range of cycles and flows relevant for sustainability. The CE concept could thereby help broaden our understanding of the systemic social, material, energy, and biological cycles that shape human and planetary well-being. By highlighting the seven cycles presented in this paper, we hope to contribute to this conceptual development of the CE and improve its social relevance and usefulness for sustainability debates. This particularly calls attention to the need for a circular economy and society that places planetary limits and natural cycles above economic growth; that balances cycles of political power

in democratic manners; that redistributes flows of money and wealth in fair and equitable manners; that maintains the free and open circulation of knowledge and ideas; and that ensures that care is cycled throughout society in a reciprocal and convivial manner.

In line with the above vision, many social movements and academics have started to propose a "social CE" [137], a "circular humansphere" [138], a "careful circularity" [87], a "sustainable circular society" [37], a "permacircular economy" [139], a "social CE" [140], a "convivial CE" [106], a "post-growth CE" [141], or a "circular society" [11, 112, 142–145] as more inclusive, democratic, and eco-centric approaches to circularity. Other academics maintain the use of the CE concept but add key social and environmental dimensions missing from mainstream debates [35, 104, 141, 146, 147]. These approaches address all the seven cycles described above (although they might not explicitly call them cycles, these academics include a wide range of socio-political considerations and acknowledge the biophysical limits of the Earth). However, they remain a relatively marginal part of the academic and societal discourse on the topic.

This article thus calls for more academic research and societal implementation of these inclusive and post-growth CE approaches. The idea of a *circular society* could be used as an umbrella concept that unites all these alternative circularity visions and perspectives. By putting society at the centre, circular society discourses could help break from economy-centric and capital-centric understandings of circularity and expand the imaginary towards key socio-ecological cycles and considerations. The term circular society can thus help us "re-embed" [148] circular and economic activity within a larger socio-ecological context and thereby allow us to consider crucial implications of any circularity strategy in terms of culture, environment, resource scarcity, class, gender, race, health, education, colonialism, power, technology, politics, governance, etc.

As an umbrella concept, there is no single definition or vision of a circular society; rather, it is a concept that includes a wide range of different discourses from the Global North and South alike (including circular humansphere, careful circularities, buen vivir, degrowth, voluntary simplicity, ecological swaraj, steady state economics, and the like). All in all, circular society discourses are united in their objective to create a democratic, fair, and sustainable socio-ecological system that works in harmony with the natural cycles of the biosphere to improve human and planetary well-being for current and future generations.

We propose that a circular society can operate through various interrelated strategies including, but not limited to, the following:

- Shrinking socio-ecological cycles: reducing the absolute size of flows through socio-cultural changes for simpler and more convivial lifestyles as well as design and technical changes that reduce or substitute materials (often with a "low-tech" perspective), and thereby shrink the overall societal resource/economic throughput. [44, 82, 106, 139, 141, 149–153]
- Slowing socio-ecological cycles: maintaining products as long as possible through product life extension, reusing, leasing, servicing, and focusing on functionality, access, and stewardship instead of ownership and overconsumption. [1, 5, 10, 103, 146, 154–156]
- Shortening socio-ecological cycles: repairing, refurbishing, remanufacturing, and repurposing goods following a cascading value retention hierarchy to prevent resources from becoming wastes. [12, 29, 104, 154, 157–161]

- Closing socio-ecological cycles: recovering components, materials, and embodied energy through recycling, bio-digestion, composting, urban-mining, and, as a last resort option, incineration with energy recovery [4, 9, 155, 162–166].
- Smartening socio-ecological cycles: using eco-innovations for optimum eco-efficiency and the provision of renewable energy, such as eco-design for durability, multifunctionality, upgradeability, modularity, reusability, repairability, recyclability, and electrification, as well as ICT innovations such as P2P platforms, blockchain, smart grids, big data, and industry 4.0, when they have proven socio-ecological benefits. [1, 167–174]
- Greening socio-ecological cycles: using safe, organic, and renewable natural resources and nature-based solutions while protecting, conserving, regenerating, and restoring ecosystems and biodiversity through agroecology, biomimicry, permaculture, and environmental stewardship. [20, 154, 166, 174–177]
- Democratising socio-ecological cycles: establishing democratic governance processes to ensure the equal and meaningful participation of all people in the management of resources both in the public sector (local, national and international governments) and in the private sector (enterprises and NGOs) through direct and deliberative democracy methods such as citizen assemblies, participatory budgeting, participatory design, worker unions, and cooperative ownership. [37, 59, 60, 77, 104, 138, 178–181]
- Redistributing socio-ecological cycles: ensuring a fair, equal, and just distribution of resources, wealth, and power, especially considering the unmet needs of the most vulnerable citizens of the Earth, through progressive taxation, comprehensive welfare, communal ownership, and open-source knowledge and technologies, etc. [50, 87, 139, 149, 152, 179, 182–184]
- Re-localising socio-ecological cycles: fostering local autonomy and sovereignty in the provision of essential goods and services, promoting local employment and reducing unnecessary transport costs and industrial delocalisation (and thus preventing competition for low labour and environmental standards) by producing as close to consumption areas as sustainably possible. [35, 44, 106, 174, 179, 181, 185, 186]
- Revaluing socio-ecological cycles: changing what we ascribe value to through socio-cultural and spiritual transformation by shifting away from an anthropocentric, consumerist, nationalist, hypercompetitive, hierarchical, and patriarchal plutocracy to a worldview based on ecocentrism, pluralism, solidarity, reciprocity and care for all forms of life, through a broad re-education of society both on systemic socio-ecological cycles and on planetary values and ethics. [86, 87, 140, 179, [187–190]

To create these ten strategies, we focused on building and expanding on CE research with further sustainability and degrowth literature to add elements that are not always considered when implementing CE interventions. We also focused on developing actions and practices that could comprehensively address all the seven socio-ecological cycles presented in this article. Therefore, some strategies are directly related to a specific socio-ecological cycle. Care cycles are directly linked to re-localising and revaluing strategies. Resource and biogeochemical cycles are connected to slowing, shrinking, shortening, and closing strategies. Knowledge cycles are most related to smartening. Ecosystem cycles are linked to greening strategies. Power cycles are directly related to democratising strategies, and wealth cycles are connected to redistributing strategies.

Beyond these specific relationships, which helped us develop these ten strategies, all seven socio-ecological cycles are fundamentally relevant to all ten strategies presented above. When implementing interventions in any of the above strategies, it is thus crucial

to consider their impact on all socio-ecological cycles. For instance, an intervention seeking to slow socio-ecological cycles by improving the reuse and servicing of products and services should also consider aspects related to care, power, and wealth to expand access to these services for the most vulnerable sectors of the population and support local production activities and community-based tool-sharing networks.

Moreover, each of the ten strategies described above is deeply interrelated, as with the seven socio-ecological cycles, interventions in one of these areas can affect the other, and thereby, a comprehensive, fair, and sustainable circularity transition must include actions in all these strategies. For example, shrinking, greening, or smartening socio-ecological cycles without redistributing and democratising could lead to inequalities in access to key tools and resources needed for a sustainable circularity transition.

To conclude, our description of a *circular society* and its core components and operating strategies is best understood as the beginning of an open academic debate on the topic. A debate that could help scholars and practitioners expand their understanding of circularity and embrace a plurality of different discourses and ways of implementing the concept. Although their conceptual underpinnings stretch far back in history, the circular economy and society concepts are still relatively young and remain to be further developed within and beyond academia. Therefore, further research and practice of these concepts is highly encouraged, especially through inter and transdisciplinary approaches that include a wide range of perspectives and societal actors. The different strategies and cycles we propose could thus be further researched, expanded, amended, and criticised to construct a more holistic, comprehensive, and systemic understanding of the topic. We hope this might help circularity discourses and practices become more sustainable, inclusive, socially just, and democratic.

Acknowledgements The authors would like to thank Laura Oers, Kaustubh Thapa, and Piero Morseletto for their helpful comments on earlier versions of this paper as well as Ton Markus for the illustration of the figure. The authors are also grateful for the constructive comments of the anonymous reviewers, which helped improve this piece.

Author Contribution All authors contributed to the study's conception and design. Literature review, data collection, and analysis were performed by Martin Calisto Friant. The first draft of the manuscript was written by Martin Calisto Friant, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript. Supervision and funding acquisition was performed by Walter J.V. Vermeulen and Roberta Salomone.

Funding This article constitutes part of the outcomes of the CRESTING (Circular Economy: Sustainability Implications and Guiding Progress) project, funded by the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 765198.

Data Availability Not applicable.

Declarations

Ethics Approval and Consent to Participate Not applicable.

Consent for Publication Not applicable.

Competing Interests The authors declare no competing interests.

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Authors and Affiliations

Martin Calisto Friant[1,2] · Walter J. V. Vermeulen[1] · Roberta Salomone[3]

✉ Martin Calisto Friant
p.m.calisto@uu.nl

Walter J. V. Vermeulen
W.J.V.Vermeulen@uu.nl

Roberta Salomone
salomoner@unime.it

[1] Copernicus Institute of Sustainable Development, Faculty of Geosciences, Utrecht University, Utrecht, Netherlands

[2] Faculty of Economics and Business Studies, Autonomous University of Barcelona, Barcelona, Spain

[3] Department of Economics, University of Messina, Messina, Italy