Ecological Economics 252 (2027) 109264

Contents lists available at ScienceDirect

Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon

Surveys

An agenda for plastics crisis research in the synthetic age

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ARTICLE INFO

Keywords:
Plastics
Ecological economics
Rebound effects
Ecologically unequal exchange
Environmental justice
Data opacity
Degrowth

ABSTRACT

This survey synthesizes insights from environmental social sciences to recast the plastics crisis as a structural feature of growth-dependent economies instead of a problem solvable by consumer choice or incremental technologies. Rather than a within-field review of ecological economics, it maps adjacent literatures to specify what this field could study and how, clarifying researchable questions, suitable methods, and tractable indicators. The synthesis foregrounds connections between expansionary political-economic dynamics, globally uneven socio-ecological burdens across the plastics life cycle, and the power and knowledge relations that shape what is produced, measured, and governed. It calls for comparative, mixed-methods, multi-scalar work and for open, standardized data on plastics flows to strengthen causal inference and comparability. Shifting attention upstream—from end-of-pipe fixes to the transformation of provisioning systems—the paper charts lines of inquiry capable of aligning social metabolism with biophysical limits and human needs, providing a roadmap for ecological economics to organize and accelerate research beyond consumer or techno-managerial framings.

1. Introduction

The plastics crisis is now recognized as a direct challenge to human and planetary health (Karbalaei et al., 2018; Landrigan et al., 2025; Persson et al., 2022). The recent efforts to establish a UN-backed global plastics treaty speak to the growing urgency with which researchers, social movements, environmental governance institutions, and some national governments increasingly see the plastics problem (Aanesen et al., 2024). A growing environmental social science literature has examined plastics empirically across multiple sites and scales (Nielsen et al., 2020). Studies have begun to analyze international plastic waste trade and ecologically unequal exchange (Bai and Givens, 2021), global plastics governance and policy instruments (Dauvergne, 2018; Barrowclough and Deere Birkbeck, 2022), anti-plastics activism in the Global South and organizing alternatives to plastics (Dauvergne, 2023; Dauvergne and Islam, 2023; Chertkovskaya et al., 2024), petrochemical expansion and carbon lock-in (Bauer and Fontenit, 2021; Holmberg et al., 2024; Tilsted et al., 2023), corporate circular economy and transition narratives (Mah, 2021; Tilsted et al., 2022; Vandenberg, 2024), public opinion and responsibility attribution (Holmberg and Persson, 2023; Mayer and Kohl, 2024), and household disposal labor and gendered responsibility (Holmes and Holmes, 2025; Lindsay et al., 2024; Shakuto et al., 2024).

This survey addresses a narrower gap: the absence of a firmly situated ecological economics (EE) agenda on plastics, despite the growth of research on plastics governance, pollution, waste, activism, public perception, and petrochemical political economy. For example, a bibliometric review of manuscripts concerned with plastics in *Ecological Economics* reveals that only 36 of 7864 articles published in the journal between 1995 and June 2026 substantively discuss plastics. Nevertheless, as can be seen in Fig. 1, the number of articles concerned with plastics published in *Ecological Economics* is trending upward, reflecting a general recognition of the importance of the problem across fields.[1] Accordingly, rather than conducting a conventional within-field review,

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[1] To produce Fig. 1 data was drawn from the Web of Science Core Collection on June 11th, 2026 using the search term: "plastic* NOT "plasticity" for all records in the journal *Ecological Economics*. The query was performed on the "Topic" field, which is inclusive of the fields "Title", "Abstract", "Keyword Plus", and "Author Keywords".

https://doi.org/10.1016/j.ecolecon.2026.109264
Received 6 November 2025; Received in revised form 8 August 2026; Accepted 29 September 2026
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we draw on adjacent literatures to specify how EE can study plastics as a socio-metabolic expression of what had been termed the 'Synthetic Age' (Hedlund and Longo, 2024).

In this research agenda, we treat plastics not as the inevitable outcome of technological progress or consumer demand, but as a historically specific material foundation of monopoly capital (Hedlund and Longo, 2024). We organize this agenda around three interconnected lines of inquiry: (1) socio-ecological paradoxes, including displacement and rebound effects that expand material throughput under growth imperatives; (2) corporate power, delay, and data opacity, which influence what is produced, what is measured, and what is politically possible; (3) ecologically unequal exchange, environmental justice, and degrowth, tracing the uneven distribution of plastics' socio-environmental burdens while exploring ways for a fundamental reorganization of social metabolism that allows a move beyond mitigation and toward transformation of the systems driving plastics overproduction and pollution. There are other related important topics in EE, such as circular economy, extended producer responsibility (EPR), design-for-longevity, and behavioral approaches. However, we point to the three specific areas listed above as essential for expanding the *critical* research in ecological economics and in line with advancing ecological economics contributions to critical sustainability science (Longo et al., 2025).

Ecological economics contains internal tensions between more technocratic and reform-oriented approaches centered on efficiency, circularity, and environmental management, and more critical traditions that emphasize political economy, unequal exchange, capitalist growth dynamics, and socio-ecological transformation (Pirgmaier, 2017; Spash, 2020). Our emphasis here is on a research agenda on plastics consistent with the latter. As such, we approach the plastics crisis through a social-metabolism framework that examines plastics not as isolated waste objects, but as material flows embedded in historically specific systems of production, circulation, consumption, and disposal (Fischer-Kowalski, 1998; Foster, 2022; Giampietro et al., 2011; Hedlund et al., 2025). Even within the social metabolism research there are some differences in traditions and emphases. Our social metabolic approach, based in an ecological Marxist critical political economy, links the expansion of petrochemical production to broader dynamics of capital accumulation, growth, fossil-fuel dependence, and ecologically unequal exchange. As such, plastic production systems are understood as a crucial part of monopoly capitalism in the age of synthetics (Hedlund and Longo, 2024).

1.1. The unbridled petrochemical growth and the plastics crisis

During the Second World War, state investment, fossil-feedstock infrastructures, and petrochemical capacity made plastics a dominant (synthetic) material force in the social metabolism of monopoly capitalism (Hedlund and Longo, 2024; Hedlund et al., 2025). Plastic production underwent exponential growth, rising from negligible amounts in 1950 to over 500 million tons annually by 2022 (Geyer et al., 2017; Villarrubia-Gómez et al., 2024). The figure continues to climb, illustrating what environmental sociologists term the "treadmill dynamic"—a perpetual cycle of industrial expansion tied to economic growth (Schnaiberg and Gould, 2000). Contrary to showing signs of saturation, the plastics sector foresees substantial future growth. Researchers forecast that under current trends, plastic production and waste will double by 2050 (Geyer et al., 2017; Lau et al., 2020), accompanied by a decrease in the proportion of recycled plastic and a doubling of plastic pollution (Pottinger et al., 2024). This trajectory makes plastics an essential case for studying economy-wide material throughput.

Recent interdisciplinary research suggests that understanding the plastics crisis demands a deeper engagement with its political-economic and socio-metabolic foundations (Hedlund et al., 2025; Uehara et al., 2023; Villarrubia-Gómez et al., 2022). Plastic pollution is now pervasive across ecosystems and human bodies, with mounting evidence of

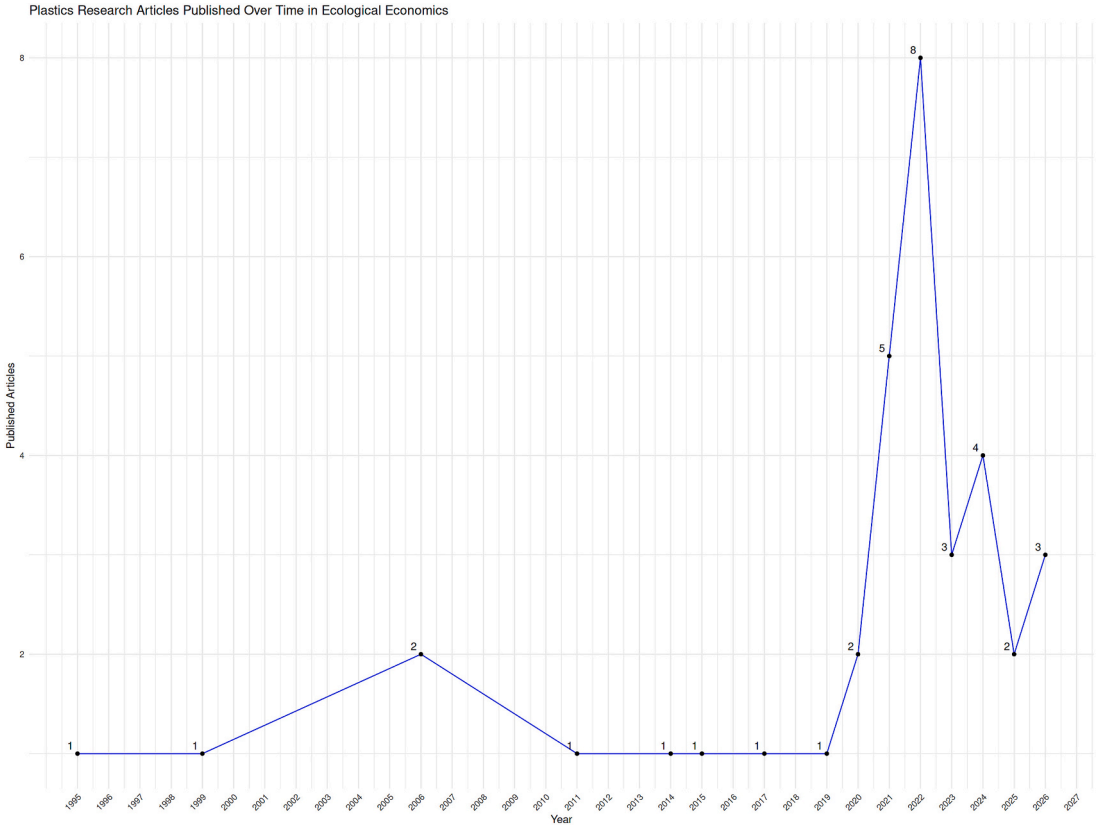

Fig. 1. Articles published in ecological economics that examine plastics.

ecological, climatic, and health consequences (Landrigan et al., 2025; MacLeod et al., 2021; Villarrubia-Gómez et al., 2024). Plastics' climate footprint, in particular, runs through the entire life cycle — from fossil feedstock extraction and energy-intensive polymerization to incineration and degradation — and tightens the analytical link between plastics and the broader fossil-based throughput system (Bauer et al., 2022; Ford et al., 2022; Zheng and Suh, 2019). Plastics are therefore better understood as an economy-wide throughput problem linking fossil extraction, petrochemical production, product design, trade, consumption, waste management, leakage, and emissions.

Plastics are the defining materials of the Synthetic Age: a historically specific period in which petrochemistry, fossil-fuel by-product management, wartime state investment, corporate concentration, and post-war sales efforts converted synthetic materials into a foundation of accumulation (Hedlund and Longo, 2024). Operationalized, this accumulation strategy works through by-product management in integrated petrochemical production: virgin polymer expansion is a supply-side condition of fossil-fuel processing as much as a demand-side response to consumer markets (Hedlund and Longo, 2024; Tilsted and Newell, 2025), locked in by financialized investment cycles in infrastructural capacity and by the lead-firm ownership ties in the global petrochemical industry (Christophers, 2022; Tilsted and Bauer, 2024).

Empirically, this means treating plastics also as a stock-flow system rather than only as waste or pollution. Existing material-flow studies have begun to quantify plastics production, use, trade, and end-of-life fate, while critical reviews identify persistent gaps in stock-flow data, polymer classifications, product categories, recycling yields, and country coverage (Geyer et al., 2017; Wang et al., 2021; Houssini et al., 2025). Ecological economists can therefore operationalize plastics' social metabolism through indicators such as tons of virgin polymer production, polymer-specific trade flows, plastic intensity of GDP or sectoral output, in-use plastic stocks, waste generation per capita, recycling yield rather than collection rate, waste exports, incineration and landfill shares, environmental extended multiregional input–output models, leakage estimates, petrochemical capacity additions, and ownership concentration in polymer production. These indicators register what Hedlund and Longo (2024) describe as plastics' distinctive socio-ecological position — the synthetic 'fourth kingdom' that seeks to insulate production from the cycles of natural metabolism, and that the planetary-boundaries framework now classifies as a novel-entity transgression (Bijker, 1995; Persson et al., 2022).

Political economy research complements these approaches by showing how petrochemical infrastructure, fossil feedstocks, industrial policy, and corporate strategies create lock-ins that sustain the expansion of virgin polymer production (Bauer and Fontenit, 2021; Tilsted et al., 2023; Tilsted and Newell, 2025; Holmberg et al., 2024). Building on these insights, the following sections turn to three key debates within EE—on displacement and rebound effects, corporate power/data opacity, ecologically unequal exchange, environmental justice, and degrowth—to articulate a research agenda for understanding and confronting the plastics crisis at its systemic roots. We suggest that emphasizing and expanding these areas of research in EE is needed to advance fundamental insights into the current environmental and social concerns associated with plastics production, consumption, and pollution.

2. Engaging key debates in ecological economics

2.1. Displacement paradox and rebound effects

An important question in research on energy systems is whether the development of non-fossil fuel energy technologies helps to suppress fossil fuel production and consumption. A number of studies have suggested that new energy sources have often been used, to a large extent, to expand energy production rather than replace established energy sources, so that the growth in renewable and nuclear energy at the global level, and in many nations, has not substantially suppressed fossil fuel use (Apergis et al., 2010; Fressoz, 2024; Greiner et al., 2022; Liddle and Sadorsky, 2017; Shafiei and Salim, 2014; Thombs, 2025; York, 2012; York and Bell, 2019). This phenomenon, where a potential substitute for an established resource or technology does not substantially replace the established resource or technology, has been called the "displacement paradox" (York, 2017). Research indicates this may be a rather general phenomenon, and displacement paradoxes have been identified (or suggested) for aquaculture vs. wild fisheries (Longo et al., 2019; Longo and York, 2024), one type of meat vs. another (e.g., poultry vs. beef) (York, 2021), organic food vs. conventional food (McGee, 2015), plant-based meat-substitutes vs. meat (Briscoe, 2022), electronic storage vs. paper (York, 2006), petroleum vs. whale oil (York, 2017) and plastics recycling (York et al., 2026). Although there are numerous reasons why the displacement paradox occurs, a central force behind it is likely connected to growth dynamics, where the development of new technologies and materials serves to spur the expansion of production and consumption.

Is there a displacement paradox for plastics, and if so, at what scales and in which contexts? Given the prevalence of the displacement paradox with respect to other resources, one key question is whether plastics have helped suppress use of other resources for which it can potentially serve as a substitute. The growth dynamics of plastics suggest that plastics may have allowed for dramatic expansion of material use, helping create disposable products of all types, and therefore may not only have failed to replace other materials but may have led to the increased consumption of other resources. Available methods (e.g. York, 2012, 2021), such as panel and time-series models using national-level (or other macro-level) data could test whether rising plastic use is positively or negatively associated with paper, glass, metals, textiles, rubber, and other materials for which plastic is a potential substitute. Although there are limitations in data availability for plastics relative to data on energy (which we discuss more in a subsequent section), there are sources that provide data that could be used for this purpose, including UN Comtrade, OECD/Eurostat, Geyer et al. (2017), Wang et al. (2021), and Houssini et al. (2025). Other sources, such as the World Development Indicators (https://databank.worldbank.org/source/world-development-indicators), provide data on appropriate control variables, such as GDP, population, urbanization, trade openness, and sectoral composition. Although we do not know of publicly available sources tailored for the purpose, similar analyses could potentially be performed using household, business, or industry level data.

Existing plastics research provides concrete cases through which displacement dynamics can be studied. Chakori et al. (2021), for example, show that single-use food packaging is driven by interlinked changes in globalization, supermarket expansion, and household time constraints, suggesting that plastic packaging is not simply substituting for older materials but enabling new food-system configurations. Ralston et al. (2026) sharpen this analysis by identifying ultra-processed foods specifically—engineered for shelf stability, portability, and standardized portioning, and produced through globalized food-corporation supply chains—as a structural driver of the plastics pollution crisis, implying that any serious upstream plastics-reduction strategy must engage the political economy of food-system transformation alongside that of packaging itself. These cases suggest that plastics may expand total material throughput by making new forms of convenience, portability, disposability, and retail logistics economically viable. Thus, these examples suggest that plastics have contributed to the reconfiguration of food production and distribution systems, thereby serving to expand existing or stimulate new demand for products, illustrating one of the potential explanations for the occurrence of the displacement paradox.

In addition to research related to the displacement paradox, there is a vast literature on the "rebound effect," mostly centered on analyses of energy use, examining the degree to which improvements in efficiency can spur consumption so that not all of the potential resource savings

from the efficiency are realized (Gillingham et al., 2016; Stern, 2020; Wallenborn, 2018). Common cases where efficiency gains are associated with rising rather than falling production and consumption are known as the Jevons paradox, after Jevons's (1866) observation of coal use in steam-engines in Britain (Alcott et al., 2012; York and McGee, 2016). Decades of research have established that substantial rebound effects are common at many scales from the household to the global economy (York et al., 2022).

An important question that, to our knowledge, has not been addressed in the scholarly literature is whether and in what contexts we find rebound effects associated with various indicators of the production or economic efficiencies of plastics use. Plastics efficiency should be treated as a family of indicators capturing distinct throughput-to-service ratios: polymer mass per unit GDP or sectoral output, polymer mass per packaged or shipped good, recycled-content share in new polymer, and feedstock or energy used per ton of virgin polymer. The key empirical question is whether improvements in these indicators reduce absolute plastic throughput or instead generate rebounds by expanding plastic-intensive production and consumption. Plastics rebound should be distinguished from broader scale effects. A rebound effect occurs when efficiency improvements, lightweighting, recycling gains, or lower polymer costs expand plastic-intensive production and consumption, offsetting expected material savings. Scale effects refer to growth in plastics use driven by industrial expansion, e-commerce, super-marketization and food-system restructuring.

2.2. *Centering corporate power, delay, opacity, and policy obstruction in the plastics industry*

In what follows we distinguish two registers: documented empirical findings —for example, the composition of delegations at treaty negotiations (Center for International Environmental Law (CIEL), 2024, 2025), the archival record on industry knowledge of recycling limits (Gardiner, 2026; Allen et al., 2024), and survey and experimental evidence on responsibility attribution (Holmberg and Persson, 2023; Mayer and Kohl, 2024) — and the critical framing we use to interpret them, which we advance as interpretive propositions guiding the research agenda rather than settled conclusions. Within the Synthetic Age, we approach corporate power as built into the material organization of plastics: fossil feedstocks, petrochemical production, polymer science, disposable-goods markets, and waste infrastructures are organized through concentrated monopoly-capital relations (De Groot and MacNeil, 2025; Hedlund and Longo, 2024; Mah, 2022; Tilsted and Bauer, 2024; Tilsted and Newell, 2025). Following the monopoly-capital and social-metabolism literatures (Hedlund and Longo, 2024; Hedlund et al., 2025), we treat this power not primarily as the strategic action of individual firms but as a structural feature of how capital reproduces and expands itself through synthetic materials. Lobbying, corporate social responsibility, treaty obstruction, and agnotology are best understood as expressions of this structural power rather than as autonomous corporate tactics. In this reading, plastics industry influence derives not only from, for example, lobbying, but from the sector's structural embeddedness as an essential part of state industrial strategies and global trade regimes, and structurally linked to numerous economic sectors and capital accumulation dynamics (De Groot and MacNeil, 2025; Taggart et al., 2026).

De Groot and MacNeil's (2025) "Big Plastic" framework can be read as the governance-level expression of this Synthetic Age: a heterogeneous but politically coherent plastics bloc maintains influence through structural, instrumental, discursive, and informational power. From this perspective, lobbying is not the source of plastics industry power but one expression of a broader monopoly-capital structure. Historically, this bloc extends the wartime state-capital fusion and the US-based petrochemical oligopoly that Hedlund and Longo (2024) identify as central to the rise of synthetic plastics as an essential input and product in the modern political economy. Structurally, virgin polymer production is embedded in fossil-feedstock infrastructures, petrochemical investment cycles, state industrial strategies, employment relations, and tax revenues, making production limits politically costly (Tilsted and Newell, 2025; Tilsted and Bauer, 2024). Instrumentally, firms and trade associations seek access to national policy processes, treaty negotiations, and regulatory design (Center for International Environmental Law (CIEL), 2024, 2025; Mah, 2022). Discursively, industry actors frame plastics as a problem of litter, recycling, consumer responsibility, and technological innovation rather than overproduction (Mah, 2021; Tilsted et al., 2022; Vandenberg, 2024). Informationally, fragmented and proprietary data on production volumes, additives, recycling yields, and waste flows make upstream regulation and accountability more difficult (Edelson et al., 2021; Wang et al., 2021).

Industry success has consistently employed discursive strategies that frame plastics pollution as a downstream waste-management or consumer-responsibility problem—centered on recycling and litter—rather than a question of upstream production growth and petrochemical expansion (Mah, 2021; Center for International Environmental Law (CIEL), 2017). Instrumental and discursive power are visible when plastics and petrochemical industry lobbying groups steer environmental legislation, promoting circular economy without challenging the perpetual pursuit of growth, endorsing voluntary efforts or recycling campaigns that divert attention from direct production limits (Center for International Environmental Law (CIEL), 2024; Mah, 2021; Tilsted et al., 2023). Classic messaging about "litterbugs" or wrong waste sorting by households exemplifies this deflection, placing blame on consumers while obscuring how industry systematically promotes disposability (Center for International Environmental Law (CIEL), 2017). Contemporary corporate social responsibility initiatives spotlight incremental improvements—like compostable packaging or advanced recycling technologies—that rarely achieve the scale required to disrupt established models. As also noted, recent efforts to establish international treaties to address global plastics pollution have been unsuccessful.

These concerns should be studied in relation to how plastics-producing corporations, trade associations, and petrochemical-state alliances shape treaty negotiations, national policy design, and the inclusion or exclusion of production-control measures. Industry presence at recent treaty negotiations illustrates why lobbying and policy access should be treated as empirical objects of study. For example, at the 2024 global plastics treaty negotiations in South Korea, fossil fuel and chemical industry lobbyists reportedly formed the largest delegation at the meeting, larger than the combined number of all European states (Center for International Environmental Law (CIEL), 2024); their presence increased further at the Geneva negotiations in August 2025 (Center for International Environmental Law (CIEL), 2025). De Groot and MacNeil (2025) document this pattern of coordinated industry presence at international plastics negotiations as evidence that the plastics sector—despite the heterogeneity of its supply chain—operates as a coherent political force in global environmental governance. Taggart et al. (2026) develop a complementary account, theorizing this coherence as a petrochemical historical bloc—an alliance of fossil capital, petrostate governments, industry associations, and aligned scientific and policy networks—and tracing how this bloc has shaped the negotiating space, agenda, and unresolved deadlocks of the UN Global Plastics Treaty. Read together, these accounts suggest that the obstruction of upstream production controls is neither incidental nor reducible to the strategic conduct of individual firms, but is best interpreted as an expression of structural power within the broader monopoly-capital system — a proposition the agenda set out here is designed to examine.

Further, research on agnotology, climate denial, and corporate delay provides a comparative model for studying how industries shape uncertainty, public understanding, and regulatory action (Dunlap and McCright, 2015; Hess, 2016; Oreskes and Conway, 2010). Gardiner, 2026; see also Allen et al., 2024), drawing on industry archives, internal memos, and interviews, traces how plastics producers and trade

associations promoted recycling as the answer to mounting public concern from the 1970s onward, while internal industry documents acknowledged that mechanical recycling could not function at the scale required. The parallel with the tobacco and fossil-fuel agnotology literatures is direct: investment in a publicly visible solution served as a discursive instrument for sustaining production growth rather than as a credible technical pathway. This historical record—together with related work on the recycling paradox (York et al., 2026)—anchors the analytical claim that discursive power in the plastics economy operates not only through framing but through the orchestration of seemingly substantive solutions. A plastics research agenda should therefore develop an analogous analysis of how corporations and aligned organizations shape public opinion, policy design, and scientific interpretation. For plastics, this may operate less through outright denial than through delay: the promotion of recycling, voluntary commitments, and circularity narratives as alternatives to binding production limits (Mah, 2021; Villarrubia-Gómez et al., 2024; Tilsted et al., 2022).

These political and discursive dynamics are reinforced by informational asymmetries rooted in the commodification of science. Knowledge about polymers, additives, production volumes, recycling yields, and waste streams is often produced within corporate systems and protected as proprietary information. Existing sources—World Bank waste data, UN Comtrade polymer and waste flows, OECD and Eurostat plastics datasets, and academic stock-flow estimates—remain limited by short time series, inconsistent classifications, incomplete country coverage, uncertain recycling and leakage estimates, and weak reporting on additives and final material fate (Edelson et al., 2021; Geyer, 2020; Geyer et al., 2017; Houssini et al., 2025; Kan et al., 2023; Wang et al., 2021). Reforms to evaluate include mandatory polymer and additive registries, public reporting of production and waste flows, recycling-yield rather than collection-rate disclosure, harmonized product and polymer classifications, and transparency requirements in EPR and treaty design.

A further empirical research agenda concerns how responsibility for plastics is assigned across firms, states, households, and consumers. Public opinion research shows that support for plastics policy is not simply given by the visibility of plastic pollution: it varies by policy type, perceived cost, and regulatory form. Holmberg and Persson's (2023) Swedish panel survey finds relatively high support for a range of plastics policies, with strongest support for softer measures such as information campaigns, recycling initiatives, and extensions of existing regulations, while taxes, bans, and stricter regulations receive comparatively lower but still substantial support. Experimental work by Mayer and Kohl (2024) shows that responsibility framing matters, since consumer-blame and manufacturer-blame frames can shape attitudes and policy preferences. Ethnographic and sociological studies further show that downstream plastics governance often transfers labor to households, women, informal workers, and poor communities through recycling, sorting, disposal, reuse, and waste management practices (Braun and Traore, 2015; Holmes and Holmes, 2025; Lindsay et al., 2024; Shakuto et al., 2024). EE should therefore study how responsibility narratives affect support for upstream production controls, producer accountability, and alternative provisioning systems.

2.3. *Ecologically unequal exchange, environmental justice, and degrowth*

After the Second World War, plastics became emblematic of modern convenience, with governments promoting industrial growth and corporations identifying lucrative opportunities in disposable goods. As neoliberal reforms accelerated, trade liberalization and policy shifts facilitated global flows of petrochemical inputs and finished plastic products (Bai and Givens, 2021; Mah, 2022). Capitalist globalization expanded the treadmill of plastic production worldwide: corporations established facilities in countries offering cheaper labor or lax environmental regulations (Hedlund and Longo, 2024; Mah, 2022). As Hedlund and Longo (2024) document, this globalization of polymer production extended the wartime petrochemical settlement under conditions of capital export and feedstock relocation. At the global scale, the Synthetic Age reorganized imperialist unequal material relations: earlier natural plastics such as rubber and gutta-percha were tied to colonial extraction, while synthetic plastics shifted dependence toward fossil feedstocks, petrochemical infrastructures, and U.S.-centered monopoly capital. Simultaneously, petrochemical giants consolidated control over polymer innovation, cementing single-use plastics as a mainstay of everyday life (Hedlund and Longo, 2024; Skovgaard et al., 2023; Tilsted et al., 2023). By the twenty-first century, plastic was virtually synonymous with economic progress, and steady increases in production rapidly eclipsed any gains from recycling or reduction initiatives.

As noted, EE has had limited engagement with plastics, despite the field's analytical resources being especially well suited to the problem. Two scholarly traditions related to EE stand out as relevant to understanding the unequal dimensions of plastics' social and ecological costs: ecologically unequal exchange (EUE), which operates at the macro-structural scale of world-system flows, and environmental justice (EJ), which generally works at the meso- and local scale of exposures and proximities. Together, they can help explain how plastics' burdens are systematically displaced—across borders, across communities, and across generations—while accumulation continues in core economies, corporate centers, and elite and privileged populations.

It has been argued that there is an ‘ecological debt of the Global North to the Global South, where plastic use is mainly happening in the former while the burdens of plastic waste and production largely affect the latter’ (Chertkovskaya and Côte, 2026). The United States and Western Europe historically produced and consumed most of the world's synthetics. Recently, production has shifted to Asia, where over 50% of global plastic is now manufactured while the EU and US together still produce about 30% (Plastics Europe, 2025). Nonetheless, consumption remains concentrated in the Global North. China is now the largest single consumer of plastics, accounting for 20% of global consumption in 2022 (Houssini et al., 2025). Taken together, however, three core Global North economies—the United States, the EU28, and Japan—alone account for 38% of global consumption, nearly twice the share of China, and the United States has the world's highest per-capita consumption, at 216 kg per capita, ahead of Japan (129 kg) and the EU28 (86.6 kg). Global North countries also remain the dominant centers of value capture in the global plastics chain. Transnational oil, gas, petrochemical, and plastics corporations headquartered in the Global North have meanwhile used the Global South as a key base for extraction, production, and sales, while flooding its waste-management infrastructures with single-use packaging, following a process referred to as ‘waste colonialism’ (Dauvergne, 2023; Mah, 2022; Peryman et al., 2024).

Existing studies have begun to map these asymmetries: Bai and Givens (2021) provide a longitudinal analysis of ecologically unequal exchange in the international plastic waste trade, and Houssini et al. (2025) offer a trade-linked material flow analysis of the global plastics supply chain. Yet, global, multi-scalar accounts of the cross-border material and commodity flows that reproduce unequal exchange in plastics—comparable to analyses of imperial appropriation already conducted for energy, biomass, raw materials and labor (Dorninger et al., 2021; Hickel et al., 2022, 2024)—remain missing. What is needed is a plastics-specific accounting of net appropriation across the full life cycle: one that integrates embodied plastics in traded goods rather than waste flows alone, the distribution of value capture along the chain, and the displacement of environmental and health burdens (Wang et al., 2021).

Waste flows follow a similar logic. After China's 2018 ban on foreign waste imports, global plastic waste trade was redirected toward Southeast Asia (Wang et al., 2020). Imperial cores increasingly dispose of waste within their own regional peripheries. For example, Turkey is now the largest importer of European waste, and Latin American countries have emerged as waste importers for the US (Dell, 2024; Zambrano and

Donoso, 2024). EE is theoretically and methodologically well equipped to study these dynamics rigorously and fill an important gap in the literature.

The environmental justice tradition could complement ecological unequal exchange studies by examining who bears the proximate burdens across plastics' material life cycle—where polymers are extracted and produced, where they are consumed, and where plastic waste is processed, recycled, incinerated, or dumped—and how these uneven ecological and health burdens shape efforts to expand or suppress plastics use. This involves mapping who lives nearest to extraction sites, crackers and refineries, polymerization plants, recycling and waste-handling facilities, and incinerators, and how these proximity burdens intersect with race, class, indigeneity, and migration status (Hanaček et al., 2020). Case studies already document harms among fenceline communities and precarious workers, including refugees and waste pickers (Feltrin et al., 2022; Kuruuzum, 2025; Mah, 2023; Rosaldo, 2016). However, many aspects of environmental justice struggles in relation to plastics are yet to be revealed, unpacking the social and embodied debts to workers and reproductive workers in situated locations that are woven into global trade and the ecological debt of the Global North to the Global South (Chertkovskaya and Côte, 2026; Hickel et al., 2022). Tools such as the Environmental Justice Atlas can support systematic mapping and cross-case comparison (Temper et al., 2015). Priority questions for the field are: (i) how do proximity burdens accumulate at different points of the polymer life cycle, and how are they distributed within and across countries; (ii) what is the labor-burden composition of plastics value chains; (iii) how do trade and corporate policy decisions—siting of new cracker capacity, redirected waste flows, packaging mandates — translate into measurable changes in local exposure? Suitable methods include geospatial mapping linked to trade and corporate-ownership data, ethnographic, longitudinal and action research of fenceline communities and workers engaging with plastics at different stages of their lifecycle and of their value chains, as well as exposure assessments coupled with material-flow accounts so that local proximity burdens are explicitly tied to transnational waste and trade regimes.

The plastics crisis is a rare case where a wide range of agents—scientists, social movements, prefigurative grassroots alternatives (Chertkovskaya et al., 2023, 2024) and even some governments—are increasingly supportive of production reductions (Bergmann et al., 2022; Bonacini, 2024; Break Free From Plastic, 2025). These positions closely align with degrowth discussions about downscaling of throughput, particularly in socio-ecologically harmful economic sectors. At the same time, surprisingly little has been written on plastics within degrowth research so far (some notable exceptions are Calisto Friant and Chakori, 2025; Chertkovskaya and Côte, 2026; Hasselbalch et al., 2023; Tilsted, 2026).

Engaging with the topic offers degrowth scholars a strategic opportunity. More concretely, it implies researching the feasibility of 'non-reformist reforms' (Gorz, 1968; Schmelzer et al., 2022; Schmelzer and Hofferberth, 2023) such as instituting scheduled caps and phase-outs of virgin polymer capacity, essential-use criteria, public investment in and control of reuse and refill infrastructures, mandatory polymer and additive registries, antitrust and de-consolidation tools, just-transition supports for petrochemical and waste workers, monitoring bodies able to revise targets using material-flow and social indicators. Because plastics combine genuinely useful applications with vast volumes of harmful and superfluous ones, essential-use criteria are pivotal: the aim is not blanket elimination but the selective and planned downscaling of harmful and excess production while safeguarding uses that meet real human needs (Kallis et al., 2020). Such planning is not austerity but a "prosperous way down" rooted in needs-based, democratic control of the social metabolism (Foster, 2023; Odum and Odum, 2011) — in effect, a democratization of the provisioning systems through which plastics are produced, circulated, and discarded (Durand et al., 2024). Moreover, if plastics are a material foundation of the Synthetic Age, addressing the crisis at its source requires degrowth proponents to challenge the growth mandates, fossil-feedstock dependence, and petrochemical infrastructures that reproduce synthetic throughput, while ultimately confronting the self-expansive dynamic of the capital system and its social relations of production (Ceddia and Bergamo, 2025; Chertkovskaya and Paulsson, 2021; Longo et al., 2025).

3. Conclusion

Our aim has been to clarify how ecological economics can advance the study of plastics by foregrounding structural and material drivers of overproduction and pollution. EE has made very limited inroads studying the plastics crisis. To address this, we present a research agenda that moves plastics research from incremental consumer- and techno-fixes toward a systemic account of the political economy of plastics. This agenda also faces important obstacles and limitations. Plastics data remain fragmented, uneven, and often proprietary; existing stock-flow studies identify inconsistent classifications, short time series, incomplete country coverage, uncertain recycling and leakage estimates, and weak reporting on additives and final material fate. Causal inference is difficult because plastics flow across sectors, borders, firms, households, and temporal scales, while material-flow indicators alone cannot capture toxicity, labor exposure, household responsibility, cultural meanings, or localized environmental injustice. Politically, upstream reduction confronts petrochemical lock-in, corporate delay strategies, state industrial priorities, institutional inertia in trade and chemicals governance, public support that varies by policy type, and uneven capacities across countries and communities.

These limitations do not weaken the case for ecological-economics research; they define its central tasks. Supplementary Table S2 consolidates the agenda across the three lines of inquiry, setting out for each the core research questions, candidate indicators, data sources, suitable methods, and principal limitations discussed above. Advancing this research program entails comparative, mixed-methods work that (1) tests paradox and rebound dynamics with time-series data across various units of analysis; (2) builds open, standardized public-interest data infrastructures on production, trade, additives, and waste; (3) analyzes unequal exchange patterns and multi-scalar environmental injustices, linking local proximity burdens to transnational waste and trade regimes and evaluates how the plastics industry can be radically transformed through a planned degrowth approach. In short, the task is to explain how the Synthetic Age was built, how it is reproduced, and how it can be dismantled, realigning provisioning systems with biophysical limits and human needs across places and generations.

CRediT authorship contribution statement

Borja Nogué-Algueró: Writing – review & editing, Writing – original draft, Validation, Investigation, Conceptualization. **Richard York:** Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **Stefano B. Longo:** Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **Ekaterina Chertkovskaya:** Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **Patrick Trent Greiner:** Writing – review & editing, Writing – original draft, Investigation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

We are grateful to the handling editor and the anonymous reviewers

for their careful reading of the manuscript and their insightful comments and suggestions, which substantially improved the clarity and quality of this article. BNA & SBL acknowledge the support of the Swedish Research Council/Vetenskapsrådet (Grant 2023-00961). RY acknowledges the support of Ingeborg and Knut Johansson Mark Foundation Guest Professorship grant at Gothenburg University. EC acknowledges the support of Formas—the Swedish Research Council for Sustainable Development (Grant 2021–02440).

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ecolecon.2026.109264.

Data availability

No data was used for the research described in the article.

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