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SPECIAL FEATURE: ORIGINAL ARTICLE

Blue Degrowth and the Politics of the Sea: Rethinking the Blue Economy

Growth in the docks: ports, metabolic flows and socio-environmental impacts

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Abstract

Shipping carries virtually all internationally traded goods. Major commercial ports are fully integrated into transnational production and distribution systems, enabling the circulation of massive flows of energy and materials in the global economy. Port activity and development are usually associated with positive socio-economic effects, such as increased GDP and employment, but the industry's continuous expansion produces adverse outcomes including air and water pollution, the destruction of marine and coastal environments, waterfront congestion, health risks, and labor issues. In its quest to marry economic growth and environmental sustainability in the maritime industries, proponents of the newly coined blue growth paradigm assume the negative impacts of ports and shipping to be fixable mostly through technological innovation. This paper questions the validity of the premise that the unlimited growth of the port and shipping industries is compatible with environmental sustainability and analyses the feasibility of technological improvements to offset the sector's associated negative impacts. Based on insights from ecological economics and political ecology, ports can be described as power-laden assemblages of spaces, flows, and actors, which produce unequally distributed socio-ecological benefits and burdens at multiple scales. Focusing on the case of the Port of Barcelona, this study argues that the continuous expansion of port activity increases seldom accounted-for negative socio-environmental impacts, acquiring an uneconomic character for port cities and regions. In contrast, de-growth is presented as a radical sustainability alternative to ocean-based growth paradigms. The paper concludes by discussing its prospective 'blue' articulation in the context of maritime transportation while offering some avenues for future research and policymaking.

Keywords Ports · Shipping · Blue economy · Blue growth · Environmental impacts · De-growth

Introduction

The seas have long been sites of capital accumulation and economic growth. As maritime trade routes, resource frontiers, or waste sinks, they have become the "forgotten" but critical spaces of industrialized societies (Story 2012). While shipping is responsible for the movement of up to 90 percent of traded goods in volume (UNCTAD 2019), its crucial role in providing the material basis of current socio-economic systems remains obscure. In recent years, several international organizations, financial institutions, think tanks and environmental NGOs have been promoting the twin concepts of 'blue economy' and 'blue growth' to visibilize the present economic importance and the future potential of ocean resources and maritime industries (FAO 2018; OECD 2019; The Economist 2015; World Bank 2019; WWF 2015). Although lacking a unified definition (Boonstra et al. 2018; Silver et al. 2015), these concepts are rooted in a cornucopian vision of the ocean as the great but delicate container of unexploited wealth, an image also integral to the United Nations' sustainable development discourse on the marine environment (Steinberg 1999). Blue growth proponents position the sea as pivotal in the resolution of humanity's most pressing social and environmental problems—such as secular economic stagnation, resource depletion, and ecological

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crisis—promoting the idea that an expanded and intensified use of the ocean's vast natural assets and ecosystem services can be sustainably realized through the deployment of new technologies, market incentives and technocratic regulation, while boosting global economic growth (OECD 2016). This highly optimistic vision about the ocean's economic potential has a precedent in the futuristic imaginaries of post-war "ocean boosters," such as Arthur C. Clarke and Jacques Cousteau, who popularized the cornucopian imagination about the marine world in the 1950s and 60s (Rozwadowski 2019).

The blue growth paradigm purports to bring "win–win–win" solutions beneficial to the main stakeholders of the ocean's future: coastal communities, businesses, and the environment (Barbesgaard 2018). Following this framework, the OECD (2016) and the European Commission (2017a) promote shipping as an established ocean-based industry which—together with emerging industries such as seabed mining and marine biotechnology—offers a high potential for sustainable development. This paper questions the validity of the blue growth premise that the unlimited growth of the port and shipping industries is compatible with environmental sustainability and analyses the feasibility of technological improvements to offset the sector's associated negative socio-ecological impacts. To that end, the article offers a critical and comprehensive account of port activity and development, while exploring alternative paths to a more sustainable maritime transportation sector. This research seeks to contribute to the development of sea-oriented emancipatory politics (Kosmatopoulos 2019) and a socio-ecological sustainability research agenda (Asara et al. 2015; Longo et al. 2016) by articulating the "degrowth hypothesis" (Kallis et al. 2018) in the context of the maritime transportation industry.

De-growth is a subversive proposal for a radical political and economic transformation of society (Kallis and March 2015), which is often described as a 'challenge' and 'critique' to the growth hegemony in economic thinking and social imaginaries (D'Alisa et al. 2015). De-growth proponents aim to initiate a "democratically-led redistributive downscaling of production and consumption" by drastically reducing resource and energy throughput in the rich countries to achieve environmental sustainability, social justice, and well-being (Demaria et al. 2013, p. 209). The de-growth scholarship addresses the contradiction between environmental sustainability and the pursuit of continuous capital accumulation, repoliticizing the debates on the science and practice of sustainability.[1]

[1] See the Special Feature "Socially Sustainable Degrowth as a Social-Ecological Transformation" edited by Asara, V., Otero, I., Demaria, F., & Corbera, E. (2015) in this same journal.

Even amidst a global ecological collapse and climate breakdown, the idea that infinite economic growth and environmental goals might contradict each other (Steinberger et al. 2012) remains anathema to blue economy proponents and to mainstream sustainability discourses (see Editorial in this issue). The vagueness and plasticity of the concept of 'sustainability' have generated contrasted discourses and meanings over time (Mebratu 1998; Caradonna 2018). As noted by Muraca and Döring (2018), the sustainability discoure is often articulated under the guise of the 'sustainable development' idea, which naturalizes capitalist social relations and corollaries such as the growth imperative (Longo et al. 2016). In industrialized societies, the ideological hegemony of the growth "fetish" (Schmelzer 2015) sits behind the formation of an uncontested common sense concerning the natural, necessary, and desirable character of economic growth (Kallis 2018). The blue economy discourse taps into the socially established growth paradigm to construct an ocean-based "economentality" (Mitchell 2014), whose central vision is the ocean as the new economic frontier; the source for an imagined economic future or "fictional expectation" (Beckert 2016) in which growth and environmental sustainability can be married (Arbo et al. 2018).

In the context of a global destabilization of Earth's life support systems, de-growth proponents defend the radical idea of setting social and ecological limits to the expansion of economic activity as a means to achieve human flourishing and planetary wellbeing (Kallis 2019; Schneider et al. 2010). Hadjimichael (2018) recently coined the term sustainable blue de-growth as an alternative to the mainstreaming of the blue growth paradigm both in ocean research and governance circles. Building upon other critical analyses on the ocean expansion of capital accumulation (Campling 2012; Clausen and Clark 2005; Ertör and Ortega-Cerdà 2019; Murray 2015; Saguin 2016), the following text joins other contributions to this Special Feature aiming at deconstructing and counteracting the ideological staging of what has become capitalism's latest assault on the seas.

Theoretical framework and methodology

This research builds upon insights from the fields of ecological economics (EE) and political ecology (PE), which have proven to be a fruitful analytical combination for the study of complex socio-ecological realities (Martinez-Alier et al. 2010; Spash 2017; Gerber et al. 2009). EE adopts a biophysical view of the economy and conceptualizes it as a system embedded in the environment (Martinez-Alier 2015). The central concept of social metabolism refers to the processes in which biophysical inflows and outflows are organized to sustain social systems through the extraction, transformation, consumption, and disposal of energy and materials

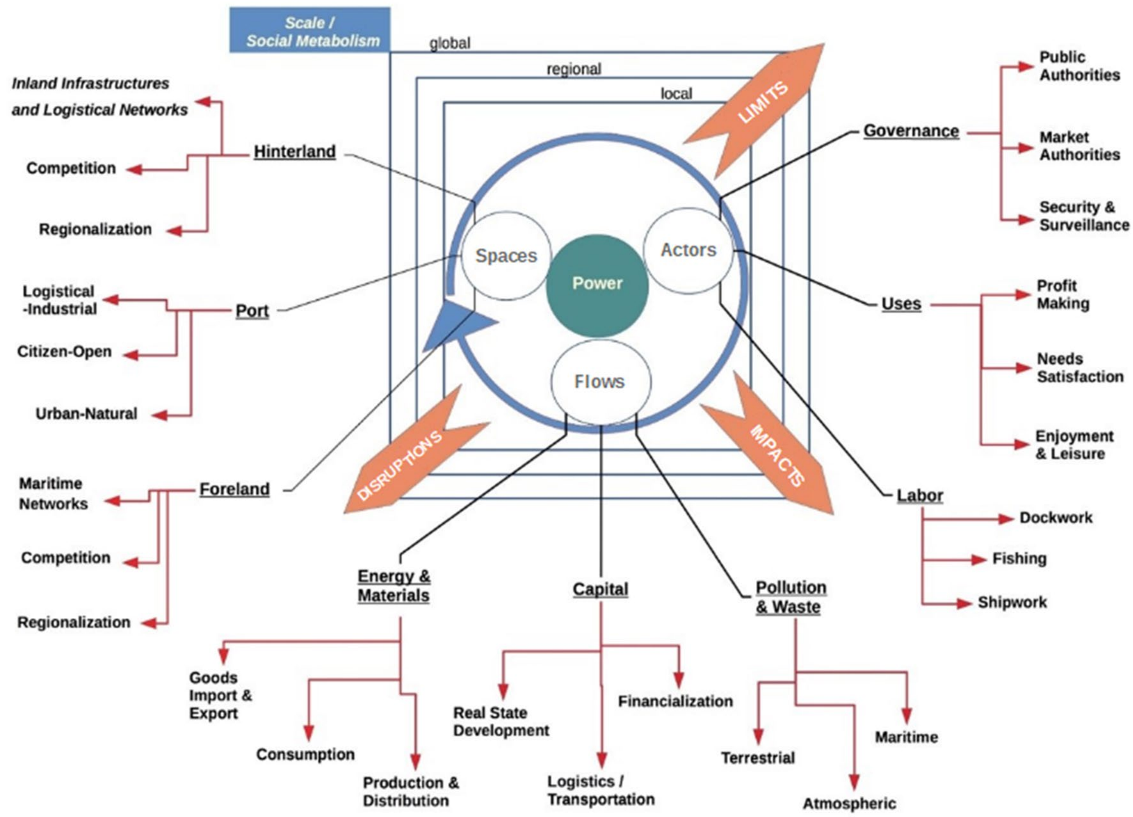

Fig. 1 Conceptual diagram for a political ecological economic analysis of port activity and development based on the study of the PB. Source: own elaboration

(Martinez-Alier et al. 2010; Molina and Toledo 2014). PE brings a critical approach to the study of socio-ecological dynamics, with a particular interest in the conflicts they generate and in the constitutive role of power relations (Billon 2015; Svarstad et al. 2018). PE's epistemological departure point is that differential power relations unequally distribute socio-ecological benefits and burdens, resulting in environmental injustices, and conflicts (Robbins 2012). Some researchers have promoted PE as a critical complement to EE's biophysical perspective, which often lacks a strong socio-political and historical content (Burkett 2009; Murray 2015; M'Gonigle 1999). A combined EE and PE approach allows for a more nuanced understanding of the processes of production, reproduction, and social mediation of the materiality of life (Heynen et al. 2006; Spash 2011). Previous works linking the metabolic and (urban) PE perspectives have mostly analyzed the extraction (Arboleda 2016), production (Huber 2017), consumption (Delgado-Ramos 2015), and disposal (Demaria and Schindler 2016) aspects of social metabolic expansion.

This research addresses the existing gap in the literature on the means and processes of metabolic circulation by looking at the role of contemporary global transportation and logistics systems. The paper is based upon a literature review combined with qualitative research and fieldwork carried at the Port of Barcelona. Ports are complex assemblages of spaces, flows, and actors whose activity and development produce socio-ecological benefits and burdens at multiple scales. Due to space constraints and for the sake of simplicity, this paper will focus on just some key analytical elements mapped during the fieldwork (Fig. 1). Research was conducted following the case study methodology, combining data from primary sources—grey literature from the port, governmental bodies and environmental agencies—and 11 semi-structured and in-depth interviews with port researchers, workers, public officials, journalists, grassroots activists and environmental NGOs conducted between March and June 2018. Interviewees were selected through purposive expert sampling to represent a broad spectrum of interests and knowledge regarding port activity and development.

The port research literature

Human geography was among the first disciplines to consistently engage with port research, starting in the 1950s, with pioneering works on port development and the port-city relationship (Bird 1963; Gottmann 1951). As Ng observes (2013), geographical research progressively dropped its humanistic content and adopted more functionalist approaches that highlighted profit-making and efficiency-oriented meanings (Ng et al. 2014), increasingly collaborating with the fields of applied (port) economics, logistics and supply chain management (SCM) (Pallis et al. 2010, p. 201). The approaches within these fields adopt a positivist methodological paradigm, combining mathematical modeling and advanced statistical analysis (Woo et al. 2011).

The other relevant body of literature dedicated to seaports has its origins in emerging preoccupations with the ecological impacts of port activity during the 1980s. This research comes from a diverse disciplinary background, spanning across marine ecology (Katsanevakis et al. 2014), oceanography (Tournadre 2014), environmental planning and coastal management (Nebot et al. 2017; Pearson et al. 2016), maritime policy (Acciaro et al. 2014; Poulsen et al. 2018), environmental and coastal engineering (Grifoll et al. 2011), environmental and ecological economics (Carić 2016; Saz-Salazar et al. 2012) and industrial and urban ecology (Cerceau et al. 2014; Darbra et al. 2005; Mat et al. 2016; Puig et al. 2014). Most of this scholarship focuses on the negative impacts of the shipping industry on human and non-human communities, proposing technical or policy solutions, but rarely addressing questions of power relations, environmental injustices, or social conflict.

Despite a recent upsurge of interest in oceans,[2] and the publication of notable works in geography and sociology dealing with maritime transportation (Anim-Addo et al. 2017; Chua et al. 2018; Cowen 2014; Birtchnell et al. 2015; Wilmsmeier and Monios 2015), PE and EE researchers have brought limited contributions to the subject. Some relevant works dealing with ports and shipping from a broader PE perspective have studied the production of socio-natures on urban waterfronts (Bunce and Desfor 2007; Desfor and Vesalon 2008; Laidley 2007), the ecologically destabilizing practices of standardizing global transportation infrastructures (Carse and Lewis 2017), the expanding scale of shipbreaking as a result of the sector's growth and contraction periods (Sibilia 2019) that generate ecological distribution conflicts in coastal areas of the Global South (Demaria 2010), the impact of freight throughput on the health of communities adjacent to ports (Houston et al. 2008) or the role of the flag of convenience system of open registries as a particular form of capitalist sovereignty at sea (Campling and Colás 2018).

Three aspects of port growth

The growth imperative

Economic competition underlies the activity and development of commercial ports. The sector follows a capitalist grow-or-die logic in which the investment of surplus is the goal and precondition for greater surplus creation and further investment. Port operators struggle to acquire a bigger market share, ports compete against each other to capture more traffic flows, and port regions vie to become the main gateways to entire national markets (Ducruet and Lee 2007; Merkel 2017; Notteboom et al. 2017). Port management models differ in the ratio of public-to-private participation, but virtually all assume a market-centric perspective on the goals of port functions and development (Brooks and Cullinane 2007). In the landlord port management model, dominant in large and medium-size ports, the port grounds are state-owned but leased to private operators who offer their services to incoming ships (World Bank 2006). Following this model, a public body manages the port (usually the Port Authority) and must ensure the development of competitive infrastructure for its private operators and customers, while also contributing to regional and national economic growth (Bergqvist and Monios 2019; van der Lugt et al. 2014).

Until the mid-twentieth century, commercial ports in most capitalist countries were public assets managed under a centralized regulatory framework, with minimal competition within and between them (Brooks and Cullinane 2007; World Bank 2006). In general, traditional bureaucratic port management schemes did not prioritize efficiency but focused instead on providing positive economic benefits for the local and regional economies by assuring a high level of employment and stimulating industrial production (Ferrari et al. 2015). This model began to change in the 1980s when port systems in most Western countries went through a devolution reform process based on three principal instruments: decentralization, privatization, and greater competition (Brooks and Cullinane 2007). The goal of these reforms was to improve the efficiency of port services and their responsiveness to global market dynamics (Coto-Millán et al. 2016). International financial institutions engaged in the neoliberal restructuring of global production such as the World Bank widely promoted these policy changes (Debrie et al. 2013; World Bank 2006), enabling the creation of globally integrated just-in-time production schemes and demand-driven commodity chains (Bonacich and Wilson 2008; Gereffi and Korzeniewicz 1994). However, even after several rounds of reform, most commercial ports in

[2] For a recent subject review, see Bennett (2019).

advanced capitalist economies remain in part publicly managed and funded[3] (Bergqvist and Monios 2019).

Currently, the high capital costs of port activity and development encourage the maximum utilization of fixed assets, leading to a process of spatial sorting that marginalizes some ports by driving the "spatial concentration of freight flows at one or two big ports by region" (Guerrero 2014, p.84). In this development phase, known as regionalization, a port acts as the main load center in a regional network of multimodal logistical platforms, concentrating greater quantities of flows and operating at higher geographical scales through the externalization of port operations to its hinterland (Notteboom and Rodrigue 2005; Rodrigue et al. 2016). This process turns major commercial ports into outsized consumers of physical space onshore and inland, promoting the development of coastal and hinterland transportation infrastructures and requiring constant capacity upgrades to handle ever-growing freight throughput.

Socio-environmental impacts

Port activity and development produce a series of negative social and environmental impacts, such as air and water pollution, seafloor erosion, wave and current regimes alteration, introduction of invasive species, underwater noise pollution, land-use change, waterfront congestion, and health and labor issues (Bonacich and Wilson 2008; Darbra et al. 2005; Dinwoodie et al. 2012; Gupta et al. 2005; Merk 2013; Puig et al. 2014; Walker et al. 2019; Wooldridge et al. 1999). Although shipping is the most significant source of these problems (Cullinane and Cullinane 2013; Merk 2014; Micheli et al. 2013) land-based operations, such as cargo handling, maintenance, and construction works, dredging, and other logistical operations produce additional atmospheric emissions, sewage, solid waste, leakages of harmful materials and accidents (Cowen 2014; Gupta et al. 2005; Lam and Notteboom 2014; Peris-Mora et al. 2005). To satisfy the need for spatial expansion, ports often relocate from city centers to specially designed areas at the urban periphery (Birtchnell et al. 2015), or they overcome constraining natural barriers by expanding into adjacent locations or out into the sea (World Bank 2006). The construction of port infrastructure has a direct bearing on the structure and configuration of the coast, as it replaces natural sandy or rocky seabeds with artificial blocks and landfill, changing the direction and intensity of coastal dynamics (Alemany 2006). The maintenance and expansion of port facilities also affect marine and coastal ecosystems, mainly through the dredging of large volumes of sediment required to maintain the water depths adequate for berthing the ever-bigger ships, a practice that is expensive and ecologically destabilizing (Carse and Lewis 2017).

The proliferation of mega-ships represents another growth-driven socio-ecological disruption of the sector. On the one hand, their carrying capacity is so large that it is rarely fully used; and on the other, it often becomes a logistical bottleneck as most ports cannot handle it efficiently (Wan et al. 2016; International Transport Forum 2015). Mega-ships' oversized dimensions pose navigation difficulties in traditional shipping routes without enough water depth, canals lacking width or ports with no maneuvering room (Grammenos 2013). The gigantism of vessels decreases cost savings and requires constant infrastructure expansion and upgrades, often leading to port infrastructure overcapacity and redundancy (European Court of Auditors 2016; Haralambides 2019; Núñez-Sánchez and Coto-Millán 2010) while creating greater socio-ecological pressures for marine and coastal environments (Wan et al. 2016) such as the constant dredging of canals and harbors required to be accommodated (Carse and Lewis 2017). Moreover, crew sizes are about 60% smaller than in 1970 while ships are about three times larger (Walters and Bailey 2013) which has resulted in an intensification of labor: seafarers work longer shifts, have flexible tasks and are rarely given free days or shore leave (Alderton et al. 2004). These developments, coupled with the poor labor regulations facilitated under the system of open registries or 'flags of convenience,' partially explain why contemporary seafaring stands as one of the most precarious and dangerous professions globally (Walters and Bailey 2013; Roberts et al. 2014).

Shipping is the most energy-efficient transportation mode for large volumes of cargo (Wan et al. 2016): it uses only 7% of all energy consumed by global transportation activities while carrying about 90% of global trade goods (Rodrigue et al. 2016), and has a much lower ratio of CO_2 emissions per ton-kilometer compared to road transportation (Song and Panayides 2012). Nonetheless, the maritime transportation industry is powered by massive consumption of fossil fuels, amounting to 300 Mtonne (fuel oil equivalents) in 2012 (Fridell 2019), with resulting aggregate GHG emissions making up 2–3% of the global total emissions (IMO 2015). Ships use cheap, unrefined, and highly polluting fuels known as heavy fuel oils, which emit higher levels of CO_2 and much higher levels of nitrogen oxides (NOx), sulfur oxides (SOx), and particulate matter than diesel burned on land. These emissions have all been shown to be harmful to the environment and human health (Cullinane and Cullinane 2013; Fridell 2019; Tian et al. 2013), causing around 50,000 premature deaths in Europe in the year 2000, according to Brandt et al. (2011). Shipping is one of the least regulated anthropogenic emission sources (EEA 2013) and, along with aviation, it has been omitted from all international

[3] With the exception of countries like the United Kingdom, where much of the port system has been fully privatized since the onset of Thatcher's neoliberal reforms.

agreements on climate change since the Kyoto Protocol. Projections show that in a business-as-usual scenario the industry could account for 17% of global CO_2 emissions by 2050, as demand for shipped goods is expected to increase (European Parliament 2015; IMO 2015).

Facing the prospect of a fourfold rise in emissions from global shipping by mid-century (Merk 2014), the International Maritime Organization signed a landmark agreement in April 2018 to halve carbon emissions by 2050, in addition to introducing a strict global sulfur cap to be implemented in 2020. To meet these reduction targets, industry experts have developed the concepts of "green shipping" and "green ports," favoring decarbonization strategies that strike a balance between environmental sustainability and economic growth (Acciaro et al. 2014; Lam and Notteboom 2014; Lam and Van de Voorde 2012; Psaraftis 2016). Most of these strategies rely on the substitution of bunker fuels with liquefied natural gas (LNG), together with the use of filtering techniques, more energy-efficient vessel designs and the deployment of renewable energy use in ports and on ships (Davarzani et al. 2016; Wan et al. 2018, 2016). However, researchers have pointed out that LNG can only provide a marginal reduction in greenhouse gas (GHG) emissions, as the methane leakage during the extraction, transportation, and bunkering of LNG can render its purported benefits insignificant (Baresic et al. 2018; Speirs et al. 2019). Methane has a global warming potential (GWP) 86 times higher than CO_2 over a 20-year time horizon, which is why, according to some estimations, LNG substitution could increase shipping's current carbon footprint (Kollamthodi 2016).

Big shipping companies like NYK and Wallenius have recently promoted hydrogen as an alternative non-fossil fuel with minimal environmental impacts, although its practical deployment is currently anecdotical and limited to short-distance travel. However, Cullinane and Cullinane (2013) list a series of complications in using hydrogen as a "clean" alternative. First, hydrogen is not an energy source but an energy carrier, which means that energy has to be produced from other sources, making it only as clean as these sources are (Euractiv 2012). Second, it acts as an indirect greenhouse gas with potential global warming effect (Collins et al. 2002). Third, its usage would require building whole refueling infrastructure networks; and the fuel-cell batteries require expensive materials like platinum, whose extraction and refinement produce additional negative socio-environmental impacts (Cullinane and Cullinane 2013).

In addition to a transition from heavy fuel oils to LNG or hydrogen, researchers have also promoted slow steaming—intentionally decreasing speed to curb fuel consumption—as an emissions abatement strategy that increases efficiency without added resource consumption and coupled environmental impacts (Chang and Wang 2014). But as Wan et al. conclude (2018, p. 430), slow steaming may at best offer a partial solution, and is unlikely to be applied at the scale necessary to achieve a significant emissions reduction, as it will "inevitably increase transit time and other operating costs (e.g., on-board labor costs) and reduce on-time performance possibly interrupting logistics reliability." Overall, the combination of LNG and slow-steaming strategies with highly ambitious energy efficiency improvements are likely to fall short of the IMO's 50% carbon emissions reduction target (Bergqvist and Monios 2019; Speirs et al. 2019). Given the aforementioned contradictions and shortcomings it can be argued that, in regards to atmospheric pollution and GHG emissions from shipping, blue growth theory resembles its land-based green growth precursor in lacking an empirical basis for the argument that increased economic activity can decouple from associated negative socio-environmental effects (Hickel and Kallis 2019; Parrique et al. 2019).

The production of uneconomic growth

Port activity and development are commonly associated with beneficial socio-economic impacts in their host localities, as they advance and facilitate international trade, and therefore economic growth. This assumption echoes the widely held view behind the 'growth idea,' which is that growth is always economic, i.e., that it makes people richer, not poorer (Daly 1999a). But according to ecological economist Herman Daly growth also has an "uneconomic nature", expressed when the optimal scale of the economy within its hosting ecosystem is exceeded, increasing "environmental and social costs faster than production benefits" (Daly 2014). Since usually only production benefits are measured and not their attached socio-environmental costs, economists typically fail to recognize the uneconomic character of growth. "Illth" refers to the often-obscured socio-ecological cost incurred by economic growth: when illth increases faster than wealth, people get poorer rather than richer, producing uneconomic instead of economic growth (Daly 2014).

Maritime transportation has facilitated and sustained the expansion of social metabolisms throughout history (Armitage et al. 2017; Bevan 2014; McPherson 1997). Historical economist Douglass North (1958) famously argued that the eighteenth century's fall in freight costs, combined with the expansion of international trade and technological improvements in shipping, had a positive effect on capitalist development as it widened the resource base of Western countries and provided the raw materials for industrialization. Indeed, shipping was fundamental to the expansion of European colonialism, by allowing the forced transportation of millions of enslaved humans across the Atlantic (Rediker 2007), facilitating exctractivism and the advancement of commodity frontiers (Moore 2000) while also exporting the jurisdictional, legal and socio-technical structures required for the deployment of the colonial enterprise (Mawani 2016).

In fact, and as Campling and Colás point out (2018, p. 3), historians of large-scale socio-economic processes such as Fernand Braudel see capitalism as "a world-system emerging out of maritime trade during the long 16th century and premised on the accumulation of mercantile wealth in seaports like Venice, Genoa, Amsterdam, and London." Indeed, ports have historically acted as catalysts of capital accumulation and urban development, exemplified by the fact that most major cities have developed originally as port cities. According to Fujita and Mori (1996), in 1920 the ten largest US cities all developed as port cities, most of which remain major cities today.

During the post-war capitalist restructuring of global production, the introduction and standardization of the Twenty-foot Equivalent Unit container (TEU) exponentially sped up cargo shipping and handling, affecting the entire structure of supply chains (Levinson 2016). Containerized freight became the physical expression of international trade, with traffic levels growing at a faster rate than both the value of exports and global GDP due to the shipping industry's economies of scale, which continually reduce transportation's economic costs (Dean and Sebastia-Barriel 2004; Stopford 2009). Since the 1970, global seaborne trade has quadrupled in tonnage (UNCTAD 2019) mirroring cyclical fluctuations in the rate of global economic growth, as industrial production drives most of the demand for sea-traded goods (Stopford 2009). This relationship is most apparent in the decline in shipping traffic that occurs during economic recessions: in 2009 seaborne trade dropped by 20% compared to the previous year as a result of the global financial crisis (Pallis and de Langen 2010). Besides, transshipment traffic has also been growing at a faster rate than regular container traffic (Stopford 2009), signaling a shift in port activity towards more purely logistical functions such as the handling of cargo bound to third destinations as opposed to catering industrial production in the host regions.

A well-established common sense among industry stakeholders and expertise is that ports function as "springboards for economic development" enabling higher levels of output, income, and employment in their host cities and regions (Wang 2007). Indeed, some empirical research appears to support the hypothesis that port activity and development have positive effects on trade and productivity (Bottasso et al. 2018; Clark et al. 2004) local and regional employment (Bottasso et al. 2013; Fageda and Gonzalez-Aregall 2017), and regional development (Bottasso et al. 2014). However, this body of literature is limited, and as Ferrari et al. (2019, p. 236) have recently noted, most of it "struggles to go beyond robust correlations in the data given the difficulty of constructing convincing instruments or finding credible quasi-natural experiments." Port economic impact studies (PIS) represent another stream of research that looks at the relation between port activity and economic benefits (Chang 1978). Port Authorities and economic stakeholders usually rely on these publications to "maintain and strengthen the societal acceptance of seaport activities" (Dooms et al. 2015, p. 2). Many academics consider this type of research to have significant epistemological and methodological shortcomings and to lack scientific interest (Coto-Millán et al. 2010; Ferrari et al. 2001; Hall 2004; Merk and Hesse 2012).

Since the onset of neoliberal globalization, researchers have found it increasingly difficult to directly correlate port activity and development to positive economic impacts in host cities and regions (Bottasso et al. 2013; Ducruet et al. 2016; Ferrari et al. 2019; Haralambides 2002). The deployment of capital-intensive cargo handling systems decreases labor-intensive port operations, leading to reduced employment (Musso et al. 2000). In fact, studies have found a weak (Ferrari et al. 2001; Heijman et al. 2017) or even negative relation (Grobar 2008) between port throughput and local and regional employment. The presence of transport infrastructures facilitates the import of cheaper goods which can reduce the demand for less competitive local products, decreasing regional growth and employment levels or even wiping out local industries (Bottasso et al. 2013; Fujita and Mori 1996). Moreover, waterfront congestion in urban cores has pushed both cargo handling activities and related productive industries away from port cities into specialized industrial-logistical spaces in the hinterland such as inland intermodal terminals, container depots and distribution centers (Haralambides 2017; Musso et al. 2000).

The "de-maritimization" process of port activity (Ferrari et al. 2006; Lee et al. 2008) allows for increased efficiency in handling ever-higher freight throughput but it does not create much additional economic activity, employment, or added value for port regions (Musso et al. 2000). In fact, as port functions become interlocked with globalized economic processes, they progressively delink from the economic development of their host localities (Ducruet et al. 2016; Zhao et al. 2017), because a greater share of the economic value produced by port activities is dispersed away from port regions into the entire economic area of port customers and operators, while the negative social and environmental burdens remain concentrated at the local and regional levels (Ferrari et al. 2001; Grobar 2008; Haralambides 2002). These developments seem to confirm Daly's (1999b) claim that globalization acts as a stimulus for uneconomic growth as trade liberalization and free capital mobility accelerate illth-production processes such as increased income inequality (Cornia 2004; Hickel 2017) and environmental impacts (Wiedmann et al. 2015; Steinberger et al. 2012). Indeed, researchers have linked trade liberalization with rising carbon emissions from shipping as the reduction of tariffs raises the demand for imported goods, increases the profitability of practices such as redundant trade or re-importation, and promotes the geographical dispersion of global production

Fig. 2 Aerial view of the Port of Barcelona. Source: Barcelona Port Authority

in facilitating capital's access to cheap pools of labor and resources (Islam et al. 2019; Liu 2013).

The Port of Barcelona: wealth and illth

The case study is situated on the northeastern corner of the Iberian Peninsula. Covering an area of over 10 km^2, the Port of Barcelona (PoB) (Fig. 2) is among the busiest commercial ports in the Western Mediterranean and the top cruise port destination in Europe (Barcelona City Council 2012). Barcelona is representative of what Ducruet and Lee (2007) call a maritime city: cities such as Marseille, Cape Town, or Buenos Aires where port functions are efficient despite their proximity to large urban environments.

Wealth

The PoB handles 71% of regional and 22% of national foreign trade, ranking first among Spanish ports in turnover and goods value (PoB 2017) and it acts as a primary gateway for Europe–East Asia international trade routes, with China as its major trading partner. The PoB's position near the traditional Mediterranean trunk route has recently helped to attract a share of the traffic growth resulting from Chinese strategic investments in the region as part of the 21st Century Maritime Silk Road Initiative (Chaziza 2018; Wang 2007). The Port is a fundamental infrastructure of Barcelona's urban metabolism as it plays a vital role in the metropolitan energy production and distribution systems. Moreover, the PoB is a leading regional distribution hub for hydrocarbons in the Western Mediterranean and North Africa (PoB 2017). The energy wharf contains Spain's biggest natural gas storage and regasification plant which periodically receives liquified natural gas (LNG) shipments from its three main suppliers (Qatar, Algeria, Nigeria) which then is injected into the gas supply network or re-exported to faraway places like Brazil, Japan, South Korea and India (Nualart and Pérez 2017). The PoB is managed according to the landlord port model, the mixed public–private management model most commonly adopted in Europe. The Port grounds are publicly owned and managed by the Port Authority of Barcelona (PAB), but they are leased to private operators to carry out their business. Despite being a public entity dependent on the Ministry of Industry, the PAB is fully market-oriented: its main aim is to provide a competitive infrastructure for the benefit of the private enterprise. Although the PAB nominally includes political and labor representatives, they lack authority in front of powerful economic actors, such as the big shipping companies and terminal operators, real estate developers and energy companies, for which the institution works as a business facilitator (Solé-Figueras 2019). Containerized cargo represents the largest share of the Port's freight throughput (PoB 2018). The container terminals at the PoB are operated by two giants of the sector: APM Terminals and Hutchinson Ports, which together operate more than 200 port and inland terminals worldwide. The three biggest shipping line companies in the world, Maersk (owner of APM Terminals), Mediterranean Shipping Company (MSC) and China Ocean Shipping Company (COSCO), which together control almost half of the global share of containerized traffic (Alphaliner 2019), have regular shipping lines at the PoB. The world leaders of the cruise ship industry also have a permanent presence at the port: Carnival Corporation,

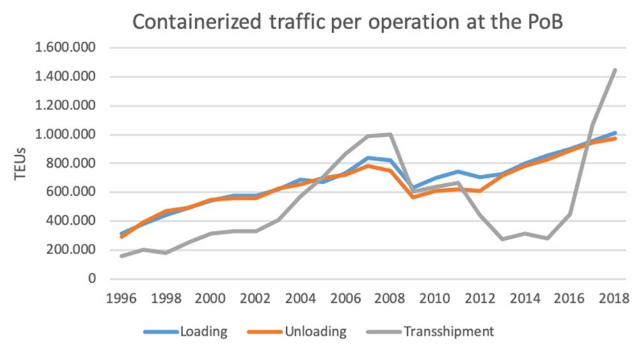

Fig. 3 Recent record-high traffic levels at the PB are due mostly to an increase in transshipment. Source: Port de Barcelona. Own elaboration

Royal Caribbean, Norwegian Cruise Line, and MSC Cruisers, which together dominate almost 90% of the cruise market. The Spanish national port administration (Puertos del Estado) and the PAB have given cruise companies a series of tax reductions, fiscal benefits, and concession extensions to attract and consolidate the sector's growth (Solé-Figueras 2019).

Global and national economic developments, coupled with the PoB's consolidation as a regional hub, resulted in a 26% traffic increase in 2017 compared to the previous year, making the PoB the fastest growing port in Europe that year and registering a 50% increase in profits, a record-breaking result touted as a "qualitative leap" by the then Ministry of Industry and President of the Port. In 2018, the Port also achieved the highest record of 3 million cruise passengers, consolidating its position as the leading European port in cruise ship traffic. That same year freight traffic grew by 10%, registering the highest record again in the Port's history in terms of traffic and profits (67.7 million tons of general cargo and 57.3 million euros). Much of this traffic growth was due to transshipment, i.e., cargo that is received and re-exported to another location, a process weakly related to local and regional economic activity (Fig. 3). As pointed by Murray (2012), the PoB presents itself as the major logistical hub in Southern Europe while generating an effect on the Western Mediterranean similar to the 'Rotterdam effect' on the North Sea in which the redistribution of massive quantities of commodities to and from other locations often leads to inflated trade figures and over-accounting.

To achieve these results, the PoB is in constant competition with neighboring ports to attract and maintain traffic flows from overlapping hinterlands and maritime trade routes. The Port of Valencia is the other major Spanish port for deep-sea cargo and Barcelona's main gateway competitor in the Western Mediterranean, in contrast to Algeciras which is almost wholly dedicated to transshipment, with other regional competitors being Genoa, Naples, and Marseille (Monios 2011; Moura et al. 2017). Improving hinterland accessibility is one of the main strategies pursued by port authorities to capture higher market shares and become more competitive (Garcia-Alonso et al. 2017). To that end, the APB invested over 50 M euros in expanding and upgrading port infrastructure such as the railway system in 2017, doubling investments from the previous year (Port of Barcelona 2018).

The most recent figures on the PoB's economic impact stem from a 2010 internal PIS study commissioned by the Port to a consulting firm, of which only the results have been published. Based on 2006 data, this study estimated a direct and indirect contribution of 1.6% regional and 0.3% national total taxed income and numbered the Port's employment figures at 13,365 direct and 32,101 indirect jobs. In addition to these, in the PoB's corporate website it is claimed that the port has a customer base of 3000 companies, which it is estimated to generate over 1 million jobs and a turnover of 300,000 million euros related to the PoB's activity (Port de Barcelona 2019). As noted by Dooms et al. (2019), PIS studies commonly account for the complete supply chain, leading to inflated figures of this sort. The Spanish branch of the Cruise Lines International Association (CLIA) has also commissioned similar studies on the positive economic impact of cruise tourism through AQR-Lab, an applied economics research group at the University of Barcelona (Suriñach and Vayá 2017). The latest study from this group estimated a contribution to regional GDP of € 413.2 M and the creation of a total of 6759 jobs, while ship emissions and excessive congestion at the waterfront are briefly mentioned as negative externalities (Vayá et al. 2018). Despite the lack of scientific consensus on the validity of the methodologies used, PIS results typically enjoy widespread media coverage and public credibility. This positive media coverage tends to overlook any socio-environmental costs attached as well as the heavily subsidized and debt-financed character of port development, which in the case of Barcelona adds up to €272 M in public subsidies and €281.1 M in long-term debts, mostly with the European Investment Bank (PoB 2018).

The financialized nature of the PoB's economic activity increases the need for ever-higher levels of liquidity to operate and pay off its debts. To find more profitable avenues of investment, the Port Authority accelerates the elimination of less productive activities from its grounds, such as the small-scale fishing wharf and shipyards remaining at the margins of the Old Port. This process of reconversion started in the 1970s with the arrival of containerization, modern intermodal cargo systems, and bigger ships which turned many port facilities obsolete, prompting the relocation of industrial port activity away from urban cores. Old port areas underwent a process of decay, conflict, and ultimately redevelopment that followed a familiar pattern across different cities (Hoyle 1989; Ng et al. 2014). In Barcelona, the redevelopment of the urban waterfront followed a way analogous to the pioneering cases of Baltimore or Boston (Desfor et al. 2010; Alemany 2015), opening excellent investment opportunities and offering an attractive "spatial fix" for overaccumulated capital seeking investment outlets globally (Harvey 2001). The massive urban transformations that took place prior to the 1992 Olympic Games adapted derelict port infrastructure to large-scale cruise tourism traffic, transforming Barcelona's marginal situation in the market to the global leadership position it enjoys today (Tamajón and Valiente 2012). The transformation of the old port was an immediate financial success, and today, the old port grounds play host to a massive influx of visitors (17 million people in 2016), as well as dozens of luxury, real estate and entertainment businesses.

Illth

Barcelona's waterfront redevelopment can also be understood as a process of accumulation by dispossession (Harvey 2004) intrinsic to neoliberal urban development (Castro 2015), in which capital encloses the urban commons, commodifying ever more aspects of social life for the purpose of expanded accumulation (De Angelis 2004). In Barcelona, the enclosure of the seashore (Hadjimichael 2018) has mobilized neighborhood organizations and social movements in the defense of the waterfront as an urban commons (Castro 2015; Tapia and Tatjer 2013). Many of these movements' protests have centered on the negative effects that mass tourism has on the city, such as congestion, gentrification or heritage loss. Recently, some have focused on the impacts of the cruise ship industry, such as air pollution (Fig. 4). Indeed, the record levels of cruise ships berthing at the port have increased the level of harmful emissions: a report by the eNGO "Transport and Environment" recently ranked the PoB the worst in cruise ship air pollution from a list of 50 European ports in terms of NOx, SOx and PM emissions (Faig 2019).

The PoB significantly contributes to the atmospheric pollution of Barcelona's urban area, of which road traffic is the primary source (Pérez et al. 2016). According to an air quality report from Barcelona City Council (2015), based on the data from the metropolitan network of air quality monitoring stations, the Port was the primary source of NOx (5.548,8 t) and PM_{10} (505,6 t) in 2013, accounting for 46% and 52% of total emissions, respectively, while Pérez et al. (2016) found the PoB to be the only major source of SO_2 in the city. Virtually all of these emissions originate from ships berthing at the harbour, and estimations on their contribution to the urban area's pollution are much lower and vary depending on the proximity to the harbor. On average, the PoB's contribution to urban NOx pollution is estimated at 7.5% while at

Fig. 4 Poster of a 2017 campaign launched by neighborhood organizations and environmental NGOs against the construction of a new cruise terminal at the PoB. It reads "No to the new terminal. We oppose the new cruise terminal because of the widespread growth of tourism and pollution that cruise activity generates for the neighborhoods closest to the PoB". Source: Plataforma per la Qualitat de l'Aire

the neighborhoods closest to the Port it has been estimated up to 14% (PoB 2016). Regarding particulate matter, Pérez et al. (2016) estimated the Port's contribution to the urban area of Barcelona at between 9 and 12% and 11 and 15% for PM10 and PM2.5, respectively. Finally, the PoB also has a significant carbon footprint: Villalba and Gemechu (2011) estimated a generation of 331,390 tonnes of GHG emissions (CO_2 equivalents) in 2008, half of which were attributed to vessel movement and the other half to land-based activities.

Port-based air pollution aggravates a chronic atmospheric pollution problem in Barcelona which has long become a serious public health issue (Forns et al. 2016; Nieuwenhuijsen et al. 2018; Sunyer et al. 1996). Data from the Spanish Ministry for the Ecological Transition (2018) show that Barcelona's average concentration of NO_2 in 2017 was 59 µg/m^3, exceeding by 47.5% the limit of 40 µg/m^3 set by the World Health Organization and adopted by the European Union (European Commission 2019b; WHO 2006).

According to a report by the European Environmental Agency, exposure to high levels of NO_2 and $PM_{2.5}$ in Spain caused over 28,000 premature deaths in 2013 (Guerreiro et al. 2016). The Public Health Agency of Barcelona has estimated a yearly average of 424 premature deaths due to air pollution in the city during the period of 2010–2018 (ASPB 2019). The European Commission (2017b, 2019a) has given repeated warnings and finally referred Spain to the European Court of Justice for systematically breaching EU's pollution limits in the urban areas of Madrid and Barcelona since their implementation in 2010. In response to air pollution, the PoB has developed an ambitious Air Quality Improvement Plan (2016) whose key abatement strategy centers around the promotion of LNG as an alternative fuel for shipping and the electrification of harbour operations. The Port has committed itself to become the leader of LNG usage in the Mediterranean, partnering with the Spanish natural gas industry in a series of R&D projects with EU funding (Cleanport, Core LNGas hive). In 2018, the Port opened the first liquified and compressed (LNG/CNG) natural gas supply station in the Spanish port system, following the EU's directive on Alternative Fuels which requires the building of refueling points on all maritime and inland waterway ports of the Trans-European Transport (TEN-T) Core Network.

Barcelona's coastal ecosystems have experienced significant impacts throughout the history of the Port's activity and development. In the 1960s, the construction of the new industrial port away from the city's waterfront resulted in the disappearance of the beaches of the nearby Llobregat river delta, as well as the agricultural area of neighboring towns. The construction of inland docks in the delta led to the salinization of the river waters, which had a profound impact on local ecosystems (Margenet 2009). The relentless expansion of port grounds finally reached the physical limit of the Llobregat river estuary by the mid-1990s, which was resolved by diverting the river 2 km southward. This diversion allowed the Port to double its operational space, at the expense of destabilizing coastal ecosystem dynamics and affecting sediment regimes (Rosa Martinez 2013). The Llobregat's diversion was a clear instance of the large-scale remaking of socionatures at the service of economic expansion (Desfor and Vesalon 2008), driven by the growth of ship sizes and an increased need for larger logistical spaces (Notteboom and Rodrigue 2005).

Stevedoring is the main work carried at Barcelona's commercial harbour, along with tugging and mooring the vessels, and driving the cargo on trucks. Dockworkers manage very heavy and voluminous cargo, handle hazardous goods, move around big machinery and work at dangerous heights; all of which is done at a very fast pace, which explains why there is a high risk of occupational illness and injury in the sector, including major and fatal accidents[4] (Greenberg 2003; O'Neill 2012). Since the neoliberal industrial restructuring of the 1970–80s (Turnbull 1992), successive pushes to de-regulate and liberalize the sector have managed to increase the capital-labor ratio in many ports worldwide, weakening unions and generating a "race to the bottom" in working conditions and job security (Bonacich and Wilson 2008; Turnbull and Wass 2007). Spanish dockworkers have been mobilizing against each wave of reforms with relative success; since the period of high conflict and major strikes of the 80s, to the most recent episode in 2017, in which 5 months of nation-wide struggle forced the Spanish Congress to revoke an executive order meant to liberalize dockworking's recruitment model (AFP 2017). Currently, major sections of the port labor force in Spain and beyond perceive automation to be an additional threat to workplaces, with unions fearing massive job loss as big companies like Maersk and APM are pushing to automate terminals, sparking labor conflicts and strikes in major ports around the world (Mongelluzzo 2019; Roosevelt 2019; Tabak 2019; Witschge 2019). However, at the moment only 9.1% of all main container terminals around the world are partially or fully automated (Rodrigue 2019) and according to business reports (Chu et al. 2018), automation at ports is advancing at a slower pace compared to other industries with similar complexity—such as warehousing or mining—due to its high up-front deployment expenditures, the risks of labor conflict and the low productivity of existing fully automated terminals.

Barcelona's longshore work is a highly unionized and internationally organized sector, with a rich history of labor militancy, and internationalist and solidarity activism (Atleson 2004; Cole 2013, 2015; Kosmatopoulos 2019). In contrast to seafarers, dockworkers have retained greater bargaining power and better working conditions partly due to their strategic position within the production and distribution networks, which allows them to easily disrupt metabolic circulation (Bonacich 2003; Cowen 2014). Moreover, dockworkers, by definition, cannot be offshored and, as highly skilled workers, they are not easily substitutable by eventual labor. Capital has historically attempted to overcome militant work forces at docks mainly through processes of liberalization, de-regulation, and technological change. In Barcelona, the combined effect of different levels of each of these processes have resulted in a progressive delinkage between port throughput and employment levels, which in the last decades have been decreasing or remaining stagnant (Fig. 5).

[4] In 2018, over 600 occupational accidents were reported in the Spanish maritime transportation sector, resulting in at least 2 deaths on ports (Ministerio de Trabajos, Migraciones y Seguridad Social 2018).

Fig. 5 Dockworkers employment data at the PoB for the last decade shows a slow but steady decline, which does not correlate with traffic levels. Source: Organización Estibadores Portuarios de Barcelona—OEPB (Data obtained by Barcelona Port Dockworkers Organization—OEPB from Estibarna, Barcelona's management company of port workers (SAGEP))

Discussion: a call for blue de-growth at ports?

The invisible circulation of the massive volumes of energy and materials that sustain industrialized countries is, following Birtchnell et al. (2015, p.6), a characteristic of contemporary commodity fetishism by which, "not only are the labor and other processes that produce commodities hidden from consumers, but also the processes that distribute and dispose of consumer objects." Already noted by urban political ecologists (Kaika and Swyngedouw 2000), circulatory networks become themselves fetishized in the commodification process, attaining a "phantom-like character, being usually hidden from view and relegated to the underbelly of the city" (Arboleda 2016, p. 236). Commercial ports function as the 'phantom-like' metabolic gateways at the sea-land interface of capitalist terraqueousness: they are "fixed logistical and social infrastructures" (Campling and Colás 2018) facilitating value circulation through the "smooth space" of global port operations (Wilmsmeier and Monios 2015), and help reconcile capital's tendencies toward mobility and fixity at sea (Steinberg 1999). Modern maritime transportation systems are paradigmatic of large scale and highly complex sociotechnical assemblages, reminiscent of Mumford's megamachine (1967), whose structure and functions are wholly geared towards the logistical goals of maximized efficiency and reliability in moving the goods. Logistics originated in the military knowledge acquired by reliably supplying armies across long distances and was transformed during the post-war period into a managerial science aimed at increasing the flexibility and synchronization of global production and distribution systems, which heavily depend on maritime transportation (Chua et al. 2018; Cowen 2010).

Commercial ports are instances of what Virilio (2006) calls "metabolic vehicles," i.e., those objects that help speed up the social metabolism, as they channel and mediate the throughput of energy and materials consumed in the system, allowing higher production and consumption in less time, and hence speeding up metabolic exchange. Swyngedouw introduced Virilio's concept into urban political ecology in reference to the city itself and also to the sociotechnical and material assemblages such as "pipes, ducts, cables, canals, (rail)roads […] infrastructures of all kinds, the technical conditions that permit the flow and metabolization of energy, food, information, bodies and things—as well as their socio-ecological characteristics", which allow the production and reproduction of the urban environment (Swyngedouw and Kaika 2014, p. 471). As key nodes in the global supply chain networks, ports facilitate the intensification of global capitalist dynamics such as time-space compression (Harvey 1992) while also creating more distance than they reduce by fostering the consumption of foreign products that have traveled thousands of kilometers instead of locally produced goods (Illich 1979). Contrastingly, de-growth proponents contemplate a "relocalization" of economic activity by "slowing down long-distance trade, producing in proximity to consumption, and circulating and reinvesting surpluses locally" (Kallis 2018) as a means to slow down the social metabolism, while reducing and redistributing the aggregate energy and material throughput in the pursuit of socio-ecological wellbeing. Latouche (2009) thinks of economic relocalization as a way for communities and regions to become more self-sufficient although not isolated or autarchic, therefore envisaging the maintaineance of some level of international surplus trade in the post-growth metabolisms.

Shipping is poised to play a crucial role in sustaining international trade and travelling in post-growth socio-economic systems, as it remains the most energy-efficient mode of freight transport. Moreover, all of IPCC (2018) decarbonization pathways to stay below 1.5 C before pre-industrial levels envisage a large-scale transition to renewable energy systems, whose construction and maintenance require large amounts of materials—mostly minerals—that need to be shipped around the world as they are unevenly distributed across the earth's surface (Capellán-Pérez et al. 2019; Valero and Valero 2010). In fact, the de-growth literature does not advocate for the annihilation of industrial activity, such as modern commercial shipping and logistics, but calls instead for the subversion of its societal monopoly (Illich 1979; Gorz 1989). A de-growth transition can thus open opportunities for the rehabilitative appropriation of previously destructive technologies (Likavčan and Scholz-Wäckerle 2018). Although the size and complexity of modern maritime transportation throws into question the feasibility and desirability of repurposing its productive technologies and infrastructure towards the emancipatory ends of the de-growth transition. Researchers unrelated to de-growth have already suggested a downscaling of traffic levels as a reasoned response to maritime transportation's negative environmental impacts. Bergqvist and Monios (2019) argue that the decarbonization of the maritime transportation industry remains "impossible under present conditions without a considerable reduction in the volume of shipping." Bailey and Solomon (2004, p.14), on the other hand, encourage the "local production of goods to reduce marine traffic" as a precautionary approach to port-related air pollution, which could be complemented with emission reduction instruments such as caps or levies (Winnes et al. 2016). Other researchers have looked at port cooperation as a means for reducing the hegemonic "maritime competitive dynamics" of the sector, which is a main driver of port growth (Fraunhofer 2016; Mclaughlin and Fearon 2013). To deal with infrastructure expansion, Nebot et al. (2017) recommend a strategy for the sector's qualitative development, based on the establishment of an efficient port networking system and the development of already existing infrastructures instead of constructing new ones.

Building on the de-growth literature on transitions (Schneider et al. 2010), blue de-growth research should explore paths for a radical transformation of maritime transportation based on the core principles of ecological sustainability and social justice. Following Barca (2017), future studies should engage with the centrality of work as a mediator of the social metabolism in the maritime realm and examine the role of organized labor as a critical agent of systemic change. In a context of climate breakdown and ecological collapse, it becomes urgent to link environmental and labor demands to bring about effective change: promoting, for instance, the downscaling of shipping to sustainable levels together with relocalization of production and job guarantee schemes (Alcott 2013). Furthermore, socio-ecological and labor struggles could find a common rallying ground in demanding a democratic control over critical infrastructures and metabolic vehicles. Indeed, ports can easily be turned into chokepoints through political action, a strategic condition that researchers and activists increasingly recognize as important leverage in social struggles (Bernes 2013; Chua et al. 2018; Toscano 2011; Transnational Social Strike Platform 2017). There are historical precedents of workers' takeover of metabolic vehicles in the class struggle, which were then used as political leverage for broader emancipatory movements. As Mitchell (2009) argues, miners' strikes, sabotages and disruptions of the energy channels during the coal-powered phase of industrial capitalism were crucial in bringing about mass democracy. Furthermore, during Catalunya's social revolution of 1936 and the following Spanish Civil War, workers collectivized the Port of Barcelona itself and put it to use in the war against fascist forces (Ibarz 1997). Histories such as these can offer valuable insights into thinking about socio-ecological emancipatory politics at sea.

Conclusions

This paper has offered a comprehensive view of port activity and development by factoring in the production of 'illth' alongside wealth resulting from the growth of maritime transportation. The case of the Port of Barcelona shows that the maritime circulatory processes driving the expansion of the social metabolism are coupled with seldom accounted-for negative socio-environmental impacts at port cities and regions, which contrasted to the limited data on their positive outcomes, suggests that modern commercial ports are becoming bearers of uneconomic growth for their host localities. Proponents of the blue growth paradigm treat these impacts as negative "externalities" rectifiable mostly through efficiency improvements and the use of alternative fuels. However, in the context of rising demand for internationally traded goods and the need to rapidly decarbonize the global economy, the evidence suggests that technological change will not be enough to offset the socio-ecological illth produced by ever-increasing marine traffic and port throughput. In contrast, a blue de-growth counter-paradigm should advocate for a sustainably planned cooperative port system, the downscaling and control of traffic levels, and the relocalization of production as a reasoned response to maritime transportation's increasing pressures on society and the biosphere.

Ports are complex assemblages of spaces, flows, and actors that function as "metabolic vehicles" in allowing the social mediation and acceleration of global flows of commodified energy and materials. Economic power and market rationality dictate the structure, workings, and rhythm of port activity and development, producing ample socio-environmental benefits and burdens while distributing them unequally. A transition to a more environmentally sustainable and socially just post-growth economy will require a joint articulation of ecological and labor struggles, which can find a common rallying ground in demanding a democratic control over critical metabolic vehicles such as commercial ports. Further research on the sustainability of maritime transportation should aim to engage researchers from the marine social sciences and the broader field of sustainability sciences, as well as coastal communities, labor unions, and social movements, to address more practically-oriented questions and explore potential alliances and synergies for a radical socio-ecological transformation of the peopled seas.

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