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Editorial

Political-industrial ecology: An introduction



Political ecology and industrial ecology have emerged as influential, but distinct, intellectual thought traditions devoted to understanding the transformation of nature-society relations and processes. Evolving from the pioneering work by physicists and environmental engineers in the late 1960s (e.g. Ayres and Kneese, 1969), industrial ecology emerged as a distinct field in the 1990s (Graedel and Allenby, 2003). It is a largely normative project that seeks to quantify and dematerialize the resource stocks and flows of industrial ecosystems, product life cycles, and societal metabolisms. To systematically dissect production-consumption processes across cradle-to-grave phases (e.g. extraction, manufacturing, use, reuse), industrial ecology deploys material flow analysis, life cycle assessment, environmental input-output modeling, amongst other methods, and has cultivated more abstract principles and practices such as industrial symbiosis and socio-economic metabolism. As the field has matured, industrial ecology has branched out by becoming more heterogeneous, not only in terms of topical foci and methodology, but also in terms of how it understands the material basis of societal transitions (cf. Vienna School of Social Ecology; Haberl et al., 2016). Nevertheless, the overwhelming focus of industrial ecology is on the *material* rather than *social* dimensions of resource use.

Political ecology emerged at roughly the same time (the term is usually attributed to Wolf in 1972) out of concern that environmental science and dominant narratives of environmental change were ‘apolitical’ in that they did not sufficiently consider the role of social and, especially, political economic processes in shaping these outcomes (Robbins, 2012). Its roots are much older than this, of course, with inspiration ranging from Humboldt and Marsh to Kropotkin and Marx. Political ecology has evolved to become a powerful thought tradition that now reaches across geography to cognate fields such as anthropology, environmental sociology, development studies, environmental history, and science and technology studies (STS). Political ecology investigates connections between political economy and environmental change, with special attention to issues of equity, power, access, and governance. Epistemologically and methodologically pluralistic, by explicitly questioning and destabilizing apolitical accounts of environmental change, political ecology is decidedly critical.

Despite the shared focus on nature-society relations, until recently, industrial ecology and political ecology have not substantively engaged each other. This is curious given that both fields study resource flows and their transformation. As Liverman et al. (2003, p. 273) lamented in a review on global change research, despite obvious synergies, “Relatively few geographers have been involved in the study of industrial ecology.”

But geographers and political ecologists are starting to engage in new and exciting ways. This has been sparked by the potential of leveraging theoretical and methodological strengths of each field to more deeply explore how ecological, political, and socio-economic process shape the relationships between a product, commodity, or material process, its primary inputs and outputs, and the relevant social and ecological implications. This led Newell and Cousins (2015) to propose the creation of a new subfield, *political-industrial ecology*, to enable the cross-fertilization of ideas, epistemologies, and approaches between political and industrial ecology.

This editorial provides the opportunity to introduce a working definition, rationale, and process for this emerging subfield:

Political-Industrial Ecology (PIE) represents a confluence between two thought traditions: political ecology and industrial ecology. PIE focuses on the ways in which *resource* (e.g. *material and energy*) *flows and stocks* shape (and are shaped by) environmental, socio-economic, and political processes and patterns over time and space. As part of a broader rebalancing of nature-society relations, PIE is committed to situating resource extraction, transformation, and consumption within their social and political economic context. This also includes a commitment to altering, reducing, or transforming these stocks and flows – as guided by principles of equity and justice. PIE embraces epistemological and methodology pluralism, which often (but not necessarily) entails scholars working collaboratively on particular projects. The friction between the varied epistemologies of political ecology and industrial ecology is highly useful as it yields unexpected and transformative understandings and approaches. This *useful friction* is made apparent by a dialectic and quasi-fusion between the respective qualitative and quantitative methodologies found in both fields, including modeling of resource flow and form, spatial analysis, historical materialism, ethnography, and more.

This theme issue—a collection of six research papers and one perspective essay (Breetz, 2016)—offers an exciting entrée into what PIE is and, especially, what it might become. Most of the contributors to this issue participated in formative sessions that explored the interface between political and industrial ecology. This included a panel session entitled ‘Theorizing Political-Industrial Ecology’ at the 2015 American Association of Geographers (AAG) conference in Chicago, which evaluated epistemological and methodological concerns associated with industrial ecology approaches, including narratives of ecological modernization, apolitical industrial ecologies, and the bifurcation of nature and society. The following year, at the 2016 AAG in San Francisco, four paper sessions on PIE further explored these issues through the presentation of empirical research on resource flows ranging from water, to e-waste, to biofuels.

The remainder of this editorial is divided into three sections. First, we briefly summarize historical antecedents of PIE, focusing on the uptake of

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industrial ecology concepts in recent geographic thought. Then, we introduce the six papers in this special issue, dividing them into two themes: ‘Political-industrial ecology perspectives of resource geographies’; and ‘Urban political-industrial ecologies.’ We conclude with a synthesis and, drawing on Breetz’s perspective essay, suggest future research avenues for this intriguing new subfield.

Political-industrial ecology: historical antecedents and foundations

The papers in this collection (and PIE more broadly) draw on previous scholarship in geography that has either engaged directly with industrial ecology concepts and practices or indirectly through a focus on stocks and flows of material and energy. Space limits a full review of this scholarship here. Rather, we identify and briefly describe three key research strands that have particular relevance for this collection of papers and for the development of PIE generally.

First, there are those aligned with the subfield of resource geography. This includes the work of [Bridge \(2002, 2008\)](#) who has long pushed economic geographers, including those working on global production networks (GPNs) to engage more substantively with extractive industries and to the “process of materials transformation in which environmental change and the organization/disorganization of matter and energy are *integral rather than incidental* (authors emphasis) to economic activity” (2008, p. 77). In the concluding paragraphs of an editorial with Jonas ([Bridge and Jonas, 2002](#)), Bridge even used the phrase ‘critical industrial ecology,’ which they credited to Jody Emel. Unfortunately this phrase was not further developed. Rather, it served as a rhetorical vehicle for their primary purpose: To call attention to “power geographies in and through which resource production and consumption take place” (p. 764). Among economic geographers, Gibbs and Deutz have engaged with industrial ecology most directly and substantively, especially through critical evaluations of eco-industrial parks and industrial symbiosis ([Deutz and Gibbs, 2004, 2008; Gibbs, 2003; Gibbs and Deutz, 2005; Gibbs et al., 2005](#)). Other notable examples of scholarship that interrogates the socio-economic and political dynamics of resource flows include: [Huber’s work \(2010, 2017a\)](#) on the ecological underpinnings of industrial capitalism (through flows of oil) and his recent call for ‘industrial political ecology’; [Bergmann’s \(2013\)](#) integration of input-output modeling with critical geographies to excavate global connections and interrelations between distant carbon emissions, regions, and economies; and [Baka and Bailis \(2014\)](#) integration of material and energy flow accounting and political ecology to evaluate the governance processes shaping biofuel land use decisions.

The second research strand explores the boundaries between industrial ecology and political ecology through engagements with life cycle assessment (LCA) – its theory, methods, and how it is marshalled and deployed as a generator of metrics, standards, and other instruments of governance. [Newell and Vos \(2011\)](#) compared the carbon burden of coated-paper sourced in Indonesia vs. other geographic regions by coupling LCA with GIS. This enabled them to interrogate LCA modeling assumptions related to scale, system boundary, inclusiveness, and uncertainty. They argued that the LCA process itself, especially the spatial delineation of actors and sites through the life cycle phases of a particular resource (from extraction to end-use), was a useful exercise that could ground, link to, or support studies of global production networks, value chains, filières, actor-networks, and related approaches ([Coe et al., 2004; Gereffi et al., 2005; Murdoch, 1998; Raikes et al., 2000](#)). More skeptical of the emancipatory potential of LCA, [Freidberg’s \(2013, 2014\)](#) work brings attention to ways in which LCAs work to govern supply chains and influence systems of sustainable food through a form of ‘footprint technopolitics.’ Similarly [Mulaney’s \(2014\)](#) paper, “Cadmium narratives in the life cycle of Photovoltaics,” draws on global commodity chain analysis, political ecology, and science and technology studies (STS) to illustrate how the PV industry has used LCA to shape debates about cadmium pollution. More broadly, his work unveils tensions between green jobs and environmental justice.

The third strand of research centers on a conceptual metaphor that both thought traditions use as the basis for theorizing and model-making: metabolism, especially at the urban scale. [Newell and Cousins \(2015\)](#) identified three ecologies of urban metabolism scholarship (political ecology, industrial ecology, and urban ecology), each of which privileges a particular (and partial) dimension of urban space. They argue that the melding of these ecologies to form political-industrial ecology will yield a richer, deeper, and politically-engaged conceptualization of the urban. In a companion paper, [Cousins and Newell \(2015\)](#) use a PIE approach to analyze the water supply infrastructure of Los Angeles. Similar to the approach taken by [Newell and Vos \(2011\)](#), GIS provides the means to insert spatiality into industrial ecology methods (i.e. LCA), which they then combine with interviews and historical analysis to simultaneously interrogate the carbon calculus that drives urban climate governance and advance efforts to quantify the uneven burdens associated with urbanization processes. Similarly, [Pincetl et al. \(2012\)](#) have combined elements of industrial ecology, political ecology, and urban planning to extend a city’s metabolism beyond the quantification of inputs and outputs. Also focusing on the Los Angeles region, [Pincetl et al. \(2016a,b\)](#) have done extensive work delineating the city’s water and energy metabolism and the environmental and social justice dimensions of this resource production-consumption dynamic.

Theme #1: Political-industrial ecology perspectives of resource geographies

The first three papers in this issue focus on the political, socio-economic, and biophysical processes associated with a particular resource flow (i.e. global commodities, vanadium – a rare earth metal, and nitrogen fertilizer). These authors primarily come out of economic and resource geography traditions and engage with PIE concepts from this context.

[Bergmann \(2016\)](#) views PIE scholarship as a means to bridge nature-society divides that persist in economic geography through the development of quantitative, relational, and disruptive representations of global commodities and economies. Blending input-output modeling (a familiar methodological approach in industrial ecology and ecological economics) with critical geography, Bergmann maps trade flows of the global economy. He destabilizes and liberates the commodity as single value by counterpoising price with embodied carbon, land area harvest, and labor time. Bergmann then asks us consider these four metrics side-by-side, relationally and simultaneously; this reveals regional disparities, trade imbalances, and ecological shadows. As a collective, these metrics begin to offer a more synthetic representation of the capitalist space-economy and prod us to consider more progressive geographic futures.

The paper by [Deutz et al. \(2017\)](#) delineates a political-industrial ecology (PIE) of vanadium, a ‘security risk’ metal used to make energy storage cells. The authors use PIE to evaluate the potential extraction of vanadium from steel residues from three lenses: environmental, technological, and stakeholder. Based on semi-structured interviews, the case study illustrates how stakeholder interests intertwine with regulatory issues and environmental and technological challenges. This socio-ecological-technical assemblage effectively shapes the potential for vanadium recovery. More broadly, the paper critically evaluates industrial symbiosis, a well-codified research area in industrial ecology. Industrial symbiosis refers to mutual exchange relationships in which waste (e.g. materials, energy) from one industrial process can be used as ‘feedstock’ for another, usually in a geographically proximate location ([Chertow, 2000](#)). This form of cradle-to-cradle thinking has many parallels with the so-called circular economy, in discourse and in practice ([Ghisellini et al., 2016](#)).

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