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Why data for a political-industrial ecology of cities?

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ABSTRACT

Despite our declared era of 'Big Data,' we lack information on the flows of energy, water, and materials that support modern societies. These data are essential to understand how ecologies and the labor of people in far flung places supply urban areas, as well as how these resource flows are used by whom, where, and for what purpose. Like other places, the state of California is struggling with issues of data privacy and access. Water scarcity and the state's commitments to greenhouse gas emission (GHG) mandates raise the issue of consumption and the unequal burdens that derive from it. These mandates have unveiled the lack of comparable and verifiable data to understand crucial production-consumption dynamics. This paper illustrates how spatially-explicit big data can be harnessed to delineate an urban political-industrial ecology of resource flows. Based on research using address-level energy and water use consumption data for Los Angeles County, the analysis reveals how the region's wealthy residents use a disproportionate share of the water and energy resources. The paper also identifies structural obstacles to increasing fees and taxes or altering property rights that would reduce this consumption and foster more equitable resource use. This study has implications for theory, method, and policy related to urban sustainability, which is unobtainable without first unraveling the political-industrial ecology of the material basis of urbanization processes.

1. Introduction

Despite the declared era of 'smart cities' and big data, we have little information with respect to the flows of resources—water, energy, food—upon which cities depend, nor how they are used by whom in cities across geographical space and for economic indicators such as level of income. Yet, consumption patterns leave indelible and uneven environmental and socio-economic imprints on the places and spaces from where these flows are sourced, processed, and consumed. Reflecting on this paucity of information while seemingly drowning in a sea of urban sustainability indicators reminds us of Kitchin's (2014a) insights about data; they do not exist independently of the ideas, techniques, technologies, people and contexts that conceive, produce, process, manage, analyze and store them. Rather, continues Kitchin, they are instrumental features of a mode of governance that asserts cities can be measured, monitored, and treated as technical problems to be addressed through technocratic solutions.

In this paper, we illustrate how purpose driven data collection that explicitly links resource use to socio-demographic characteristics, ecological hinterlands and policy regimes, can yield important insights to better understand the political, industrial, and ecological fabric of cities. This then provides the basis for developing strategies to foster urban sustainability by reshaping a city's metabolism in an informed, equitable manner.

Our approach differs fundamentally between data that is typically collected to enhance 'smart city' monitoring and top down technocratic approaches that ignore the structural conditions shaping how cities function (Graham and Marvin, 2001; Kitchin, 2014a, 2014b). This includes, for example, data gathered to implement new technologies for city efficiency, such as sensored streets or buildings connected to smart apps on mobile phones or to city bureaus and for utility energy dispatching, that is divorced from institutional and governance power dynamics that often yield uneven processes and outcomes.

Rather, we argue that big data (i.e. very large quantities of data, often trillions of records) can be joined with or matched to other datasets to yield insights into patterns of production and consumption across urban landscapes and their resulting political, industrial, and ecological implications of these dynamics. Thus, we argue for using big data that is also granular to place and spatially explicit, so that it reveals processes by connecting actors, activities, and impacts across time-space (Bair and Werner, 2011). Recognizing there are other types of big data relating to social media, we

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refer specifically to data about the resources that sustain cities as we know them, particularly in the industrialized West. It is only by tracking and tracing these flows and the regulatory regimes that structure them, that cities can develop meaningful strategies to the impacts both in the city and the 'hinterland' that such resource use can be reduced.

This big data approach we adopt and the examples of water and electricity flows that we provide nests within a broader effort to develop a political-industrial ecology of cities, which seeks to combine the critical theory and insights of urban political ecology, with mass-balance methodologies largely developed by industrial ecologists and engineers, and a sustained focus on resource consumption. This political-industrial ecology approach provides the framework necessary to assess the quantities of resource flows, to track them across space and time, and to decipher intertwined social and environmental dynamics that both reveal internal urban inequities and link the city to the distant areas from which these flows originate.

An offshoot of political ecology, urban political ecology emerged in the late 1990s and addressed a major gap in the field by drawing attention to how nature-society relations co-evolve to form the metabolism of a city and how access and use of resources are inequitably controlled and distributed (Heynen et al., 2006). Although in this theorization urbanization processes are indeed planetary, as Angelo and Wachsmuth (2015) point out, the empirical focus of much urban political ecology has privileged spatially bounded inquiries of the city (i.e. "methodological cityism"). Others have noted that a Marxist lens predominates and the approaches are largely qualitative and focus on social processes, with far less attentiveness to ecological ones (Jonas et al., 2013; Newell and Cousins, 2014).

Through urban metabolism studies, meanwhile, industrial ecologists have conducted detailed accounting exercises of the material and energy stocks and flows of cities, using methodologies such as material flow analysis and life cycle assessment, but the socio-economic and political context for how and why these stocks and flows are shaped the way they are is starkly absent, as well as matching the flows to specific geographies and residents (Kennedy et al., 2007; Newell and Cousins, 2014). Thus, urban metabolism studies in industrial ecology are largely aspatial with respect to situating these flows in specific geographies, and apolitical in the sense that the demand processes that drive urban consumption (and the infrastructures that support it) are left unexcavated.

Recently, scholars have called for combining elements of these disciplinary-bound approaches to more fully apprehend a city's metabolism (Kennedy et al., 2011; Broto et al., 2012; Pincetl et al., 2012; Pincetl, 2012; Newell and Cousins, 2014). Empirically, Pincetl et al. (2015) have carried this work forward through detailed analysis of the energy flows of Los Angeles County and matching consumption to income and built environment attributes (www.energyatlas.ucla.edu). Similarly, Cousins and Newell (2015) did so through a study of the political-industrial ecology of water supply dynamics for the city of Los Angeles. Coupling life cycle assessment with spatial data, they delineated the geographic origins of this water supply metabolism and quantified its carbon footprint. Then through interviews and historical analyses, they illuminated environmental and social justice concerns associated with these supply sources. This coupling of industrial and political ecology approaches offer an example of how to move beyond 'methodological cityism' through a mapping and analysis of a distal flow (e.g. water) of the metabolism of a city.

This paper effectively extends work on the political-industrial ecology of cities through an analysis of how urban-scale consumption patterns and institutional configurations shape the dynamics of two flows (electricity and water) in Los Angeles County. As such we seek to reframe urban sustainability of a city beyond the sensor-based smart city, not only by quantifying resource flows into and consumption within cities but also by critically asking who is using these resources to do what where. In the process, we broadly characterize the socio-economic characteristics of these flows and prod how they are embedded in the urban built environment. This entails explicitly linking political and economic power to ecological and human impacts. Of necessity this requires discussion of the regulatory structures, different actors and possible policy choices. To conduct this research we use many millions of records of use, match them to relevant variables from millions of other records such as county assessor files and census data, and careful reconstruct of regulatory regimes. All the layers form an opaque, imbricated, multi-scalar system whose future direction is being contested and whose detail is best known by the interested parties: utilities and their regulators.

Data at the spatial scale necessary for this delineation is usually proprietary, and enormously complex and tedious to obtain and process. It is contained in database structures developed by agencies, often in isolation, that have both limited motivation to explore socio-demographic trends in resource flows and no mandate to do so. For example, each utility in the state of California tracks its use data and attributes of that use, differently; each county assessor organizes their parcel data differently and with a range of attributes that are not consistent county to county. Thus data important to the mission of the organizations themselves is not collected in ways that make it readily usable for exploration and comparison. More conventional smart city data is self-referential – the city as the universe – and is likely based on public activities. It is also collected with goals of efficiency and to improve services rather than a sustainability that aims toward reductions of resource flows and impacts on hinterlands, as well as greater equity.

With this in mind, the next section briefly characterizes and critiques the rise of data-analytics for so-called sustainable cities. This is followed by the electricity and water case studies of Los Angeles County. Analysis of these resource flows reveals the significance of consumption at the household level, especially wealthy households who represent a disproportionate level of use for both water and electricity. We also delineate the convoluted institutional arrangements and governance structure that inhibit transparency with respect to resource use as well as structure changes necessary to foster more sustainable and equitable outcomes. The paper concludes by reflecting on how big and spatially explicit granular data can be harnessed to broadly illuminate differences across urban landscapes and provide an empirical basis for analyzing processes and impacts.

1.1. City sustainability, institutions, and data analytics

Over the course of the 20th century, in agencies, bureaus, programs and international organizations, the use of quantitative data to generate public policies has become firmly entrenched. Different protocols are used to collect the data at different scales. Concerns about the sustainability of cities, and shifting the course of development to mitigate or curb environmental impacts, has driven data collection on city performance and efficiency. Data for sustainability indicators of all types have been collected, and utilized to create benchmarking programs, dashboards, and metrics. Such efforts are aimed at tracking progress toward goals, empowering residents to monitor how well their cities are doing, to advance transparency and accountability, as well as, of course, political careers.

This surge of data collection is increasingly enabled and joined with systems driven by information and communication technologies (ICTs). Smart meters, sensored road intersections, building management systems, and new transportation apps are just a few examples of proliferating technologies, which are often dis-