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Data Surrogates as Hosts: Politics of Environmental Governance

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Abstract

Data-driven environmental governance within the standard regulatory regime routinely relies on unmeasurable, missing, or abjected data. Technocrats typically use *data surrogates* to alleviate this pervasive problem. By combining feminist technoscience and critical environmental justice approaches, this article argues that data surrogates are far more than fungible substitutes and rely on more than scientific rationality and transcendent objectivity. Through a case of intersecting environmental governance and justice work in the Portside Community in San Diego, this article exposits a broader conceptualization of data surrogates by developing a partial typology of operations they perform: *calibrating*, *weighting*, and *validating*. The politics and labors of these operations are crucial to analyze how data acquire material and discursive power in environmental governance. I propose an analytical shift from examining the work of data surrogates in terms of *substituting* to one of *hosting*. This shift reveals and better explains how data surrogates negotiate relationships between body, place, and property across state, market, and civil society actors. Moreover, it demonstrates how data surrogates interrupt the dominant regulatory regime by resisting fungibility through acts of social reproduction. Far from being subordinate to technocratic tools, the work of social reproduction makes governing with scientific and technical instruments both possible and contestable.

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Introduction
My throat immediately constricted when I walked to a public meeting in October 2019 about the toxic air of San Diego's Portside Community (Portside). I hocked, belatedly echoing my asthmatic mother's expulsions from twenty years ago. Struggling to locate the meeting venue, an elementary school, my eyes adjusted to the street's unexpected darkness with the help of the speckled lights of neighboring industrial facilities. The ocean breeze drew particulate matter from the shipyards, navy facility, railyard, and highways, and joined me at the threshold of the school's cafeteria just as its double doors burst open for the meeting. The room was filled with community representatives, including residents, environmental activists, business owners, port commissioners, and officials from the San Diego Air Pollution Control District (APCD). The most significant discussion that evening was how a new state bill could help Portside collect granular data to alleviate its urgent problem of toxic air pollution. The politics of subsequently filling in for missing, unmeasurable, and compromised data while striving for environmental justice is the focus of this article.

Portside comprises Barrio Logan, Logan Heights, and Sherman Heights in San Diego and West National City. The community has a predominant population of poor, Chicanx and Latinx residents. For instance, the Barrio Logan neighborhood comprises about 96 percent minority residents, 78 percent of residents characterized as low income, and about 75 percent living in rental properties. Barrio Logan has been a linchpin in many environmental justice (EJ) efforts and Chicanx uprisings in Southern California, most significantly between the 1940s and 1960s to protest the city's rezoning of the barrio that prioritized scrapyards, shipyards, and Interstate 5 over its marginalized residents. EJ highlights how marginalized communities disproportionately bear the burdens of exposure to pollutants (Bullard 2000), and in Barrio Logan activists have organized against these burdens and fought for cleaner air in the community through a historically robust social infrastructure of organizers rooted in working-class and racial struggles. As a result of this existing social infrastructure, the state agency that oversees air regulations, the California Air Resources Board (CARB), selected Portside as one of fifteen communities to pilot Assembly Bill 617 (AB 617) in 2019. Also called the Community Air Protection Plan, AB 617 is a landmark piece of legislation California passed in 2017. It is the first to focus on toxic contaminants and criteria pollutants rather than greenhouse gases and the first in the United States to privilege community-scale monitoring to address air quality inequity by providing measurement resources to disadvantaged areas throughout California.

Business-as-Usual Abstractions

The EJ movement in Portside routinely confronts the regulatory regime, as it did with AB 617. The term *regulatory regime* refers to the ideas, institutions, tools, and policies that structure and govern social relations among community groups, the state, and the market through historically particular political-economic forces and bureaucratic measures (Eisner 1993; Levi-Faur 2011). Environmental governance is one such regulatory regime. The contemporary environmental regulatory regime converts and manages natural resources into public and private ones. It does so through command and control, a mechanism that purports to designate relationships of duty and enforcement—the duty not to pollute and the enforcement of this duty through technology-based standards and bureaucratic measures. However, as Max Liboiron has noted, this system effectively functions as a "permission to pollute," where the environment is considered capable of coping with or "assimilating" contaminants up to a certain threshold, crossing which a contaminant becomes a pollutant (2021, 39). Under this regime, in California, metrics such as "safe harbor levels" identify exposure levels of chemical contaminants that pose "no significant risk" to those exposed. Command and control predominantly relies on trust in rational expertise, scientific objectivity, and data-driven tools—such as models and monitors—to anticipate and mitigate risk (Beck 1992; Eisner 1993; Fortun 2012; Porter 1992, 1996); to generate, manage, and operationalize data for regulation (Edwards 2010; Miller and Edwards 2001); and to develop interdisciplinary encounters (Garnett 2020). These mechanisms largely maintain the contours of industrial capitalism by prioritizing market-driven solutions (Eisner 1993; Sabin 2021; Sinclair 1997). The tools create abstractions of relations between natural resources, human actions, and spatial configurations through technical experts' representations (Lefebvre 1991; Loftus 2015). These abstractions translate the lived experience of impacted residents into discrete variables such as culpable chemical compounds, types of harm, and inventories of offending sources (Fortun 2004; Hepler-Smith 2019). Such classifications order social processes in ways that facilitate administrative processes but, in turn, make invisible various other forms of lived experiences and knowledge (Bowker and Star 1999). When the community members at the Portside meeting in 2019 expressed a lack of toxic air pollution data at a granular scale, they followed this command-and-control approach to regulate the environment. This approach gives little critical attention to *which* data regulators collect, *when* they collect it, *how* this data informs technology-based regulations, and what work lies outside of standard regulatory practices.

As feminist technoscience and critical data science increasingly interrogate the role of data and tools of abstraction to create and maintain just futures (Costanza-Chock 2020; Dillon et al. 2019; Fortun et al. 2016; Mah 2017; Taylor 2017; Vera et al. 2019), this article conducts an intersectional feminist analysis of a specific kind of variable common in many regulatory data practices: the data surrogate or the

proxy. Scientific and technical knowledge production routinely relies on data surrogates to fill in for missing or immeasurable information. Grounded in Portside, this article yokes feminist science and technology studies (STS) and critical EJ scholarship to interrogate how power circulates within the environmental regulatory regime's data practices. Rather than dismissing the role of the data surrogate as an incidental, intermediary, and abstracted stand-in for missing information, an intersectional feminist technoscience and critical EJ approach considers seriously the material and embodied nature of surrogate work through the case of mediating environmental governance and justice.

Foregrounding regulatory-regime-fueled EJ in more detail is imperative for a feminist analysis of the material and embodied power of data surrogates. In Portside, as in many other Latinx and Chicanx neighborhoods in Southern California, as EJ scholars Laura Pulido, Ellen Kohl, and Nicole-Marie Cotton (2016) and Eric Carter (2016) have found, EJ groups and state agencies have historically attempted to work together via the regulatory regime with varying effects. Similarly, EJ activists in Portside range in their approach. Conservative activists enter well-established pipelines between serving in prominent EJ groups to holding positions in municipal government or as port commissioners with the hopes of reforming the system; a handful of activists take a more radical approach, organizing to shift the power of governance back to communities. Residents stay legible to the state through their service on various municipal and state EJ committees while sustaining attempts to improve their scientific and technical understanding. However, when state agencies commit to EJ within the regulatory regime, various social groups find themselves at impasses that stem from epistemological differences and incompatible frames (Benford 2005), benchmarks and values (Halvorson 2021), and prestructured relations between the state, market, and civil society (Betsill and Corell 2007; Fox and Brown 1998).

Dealing with Data Gaps

During such impasses, data-driven tools become mediators among social groups. As a result, an epistemic dependence on representative and accurate data challenges more radical forms of EJ. In turn, EJ becomes tethered to the regulatory regime's standard portmanteau of tools in the name of scientific proof, data collection, and technological control. This portmanteau is rife with unmeasurable data and data gaps (Murphy 2013; Ottinger 2013; Shapiro, Roberts, and Zakariya 2017), which technical experts fill in with data surrogates.

The technical literature about data surrogates presents them as *substitutes*, demonstrating how certain unmeasurable or computationally intensive measurements can be replaced with more readily available ones or simulated data. In terms of data analysts, this data is either simulated through the statistical method of *inference*, where missing data is ascertained from an existing sampling distribution, or by *imputation*, which is the process of predicting missing data.

Such processes aim to maintain performance by ensuring adequate size of data sets. In air quality modeling, surrogates conflate categorical variables such as descriptions of activities such as "construction" with numerical ones such as "population." They disaggregate data by temporalizing, speciating, and spatially allocating regional, area-wide emissions to a more granular scale to describe offending locations (Adelman et al. 2015; Boulton et al. 2002; Li et al. 2021). This literature serves to maintain the momentum of the production of scientific knowledge by focusing on the computational mechanisms of fashioning one variable to replace another (Forrester 2008) and best practices to develop surrogates quicker (Boulton et al. 2002). In effect, substitutes are fungible.

This treatment of fungibility, wherein one variable is considered replaceable with another, with minimal consequence, however, is deceptive. The supposed interchangeability of data surrogates masks the distribution of power and participation between various social groups through data operations. Technocrats use these operations to perform all sorts of predictive functions that inform environmental policy and the distribution of resources to vulnerable communities. For example, in California's modeling to determine the economic impacts of new environmental regulations using an input-output model, modelers proposed using "household income" data as a surrogate for "ethnicity" when ethnicity data was unavailable. This substitutive mode, while all too common, encompasses serious risks. By abstracting the full range of who does the work of data surrogacy, and the full scope of embodied and affective work that data surrogates do, a substitutive approach flattens structural issues, such as racism and the subversion of reproductive labor, into computationally suitable categories like "race" (Chun 2021; Pulido 2000) and "gender."

Critical EJ scholars also have argued against the collapse of differences of race, class, gender, ability, nativism, and speciesism in the broader EJ movement. Instead, they call for an intersectional examination of how power and domination within dominant categories of bureaucratic and administrative systems reproduce environmental inequalities (Álvarez and Coolsaet 2020; Pellow and Brulle 2005; Pellow 2017). Political ecologists have disparaged the predominantly liberal nature of the EJ movement that prioritizes the distribution of environmental threats (Swyngedouw and Heynen 2003). However, a critical approach to EJ combined with a feminist technoscience one avoids this trap by not merely focusing on liberal ideas of the redistribution of environmental threats but also on robust recognition and representation (Fraser 1990) of marginalized lives in environmental struggles (Schlosberg 2007), by following intersecting systems of oppression (Sze 2020). This critical approach should also extend to examining the role of technical tools and data practices in mediating EJ and regulation. As we will see in the Portside case, the assumed fungibility of parameterized data impedes exposing forms of gendered and racialized extraction and subjugation within the regulatory regime. This exposure and the disaggregation of differences

of what kinds of lived experiences finds their way into governance technologies and who creates it, with what visibilities, is vital to implementing just futures.

In the following section, I argue that data surrogates bridge the predominantly parallel tracks of the tools of environmental governance and critical EJ. In simplified terms, environmental governance focuses on controlling environmental threats through market mechanisms and technological solutions sanctioned by the state, and critical EJ on multiscalar and multi-issue approaches to tackling social inequities regarding the environment (Pellow 2017). Through the Portside case, I suggest the concept of *hosting* to replace *substituting* to analyze the work that data surrogates perform while filling in for data gaps and abjected data. Here, I use *abjected* to refer to data that is compromised, discarded, ejected, and refused (both in terms of phenomena that refuse to be disciplined as data and the regulatory regime's refusal to recognize the experiences of non-experts *as* data).[1] This analytical shift reveals guest-host relationships, either invited or parasitic, which in turn distribute power, mediate cultural processes, and materialize historical trajectories to produce environments.

While expositing the differences between substituting and hosting, I align with intersectional feminist scholars who challenge technical abstractions. Instead, they attend to relations between the body and property (Hartman 1997; McKittrick 2006), placing the corporeality of subjugated bodies at the center of social justice in the United States (Pulido and De Lara 2018), grounded in sites of refusal of oppressive systems that undermine life itself (Davis 1972; Weinbaum 2019). These scholars consider the body-self relationships of those they observe and of themselves, to produce accounts of "embodied data" (Ellingson 2017). Further, this feminist interception is analogous to the vast and generative feminist scholarship on "gestational surrogacy." The analogy extends to how racialized and stratified forms of discrimination create abstractions of bodies and/as property within market systems that control reproduction (Vora 2012), commodifying reproductive work as a "gendered afterlife of slavery" within systems of racial capitalism (Weinbaum 2013, 438; Twine 2011) that implicates certain bodies into a technological process of being cyborgs (Lewis 2019). Feminist analyses of gestational surrogacy not only offer ways to interrogate how repetitive labor is outsourced to robotic technologies (Atanasoski and Vora 2015) but also, as I will argue, to the supposed fungibility within data practices aimed at social justice. Questioning the supposed fungibility of data surrogates interrogates the racial capitalist system of market and command-and-control forces that constrain the choices and consequences for certain bodies to participate within the regulatory regime's data practices. Considering data surrogates as substitutes lead to germinal questions posed by STS and media scholars about how proxy wars produce network ties, predictions, and errors that reproduce segregation and discrimination (Chun 2018, 2021). However, seriously considering the non-

fungibility of surrogates as hosts also reveals opportunities to interrupt the hegemonic regulatory regime.

Challenging Universalizing and Replaceable Abstractions: The Operations of Data Surrogates

Throughout my fieldwork in Portside, the regulatory regime's demand for producing data out of environmental knowledge was unrelenting. An intersectional feminist and critical EJ approach to examining the work that data surrogates do to fill this demand and make regulatory instruments usable reveals a partial typology of operations: *calibrating, weighting,* and *validating.* These are routine and vital operations in the emic—or culturally specific—practices of scientific and technical experts to produce stand-ins for data gaps. However, I show that in Portside, the actors and relationships that perform these operations lie far beyond the domain and sites of scientific and technological expertise. I draw attention to how the regulatory regime's tools that rely on abstractions normalize the gendered and racialized extraction of the surplus value (Robinson 2005; Weinbaum 2019) of the work of a broader conceptualization of data surrogates. I exposit and analyze these operations not merely to document them but to highlight opportunities where alternative epistemologies break through within and despite the existing regulatory regime.

Calibrating

In technical practices of using sensors and monitors, calibrating instruments is crucial to gather granular data. Calibration minimizes error propagation by increasing data quality and usability. This operation occurs at the sensor manufacturing factory, the laboratory, and the field (Gao 2022; Giordano et al. 2021) and involves tuning the outputs of sensors to reference monitors through methods like momentary matching using drift detection algorithms and machine-learning models. However, when it comes to EJ, calibrating to ensure usable, granular data is performed in many more ways. At the 2019 community meeting in Portside, participants debated where to place air pollution detection monitors in their community's mixed-use industrial and residential zone. Although under the optimistic aegis of AB 617 at the time, public participation in air pollution monitoring had a long-standing and fraught precedent in Portside. In 1999, as in 2019, regulatory monitors focused on toxic emissions of industrial production processes. Back then, a chrome-plating facility in Portside, Master Plating, became a site of contention. The facility was emitting hexavalent chromium (Cr_6), a known carcinogen, but within levels permitted by the Environmental Protection Agency, Office of Environmental Health Hazard Assessment, and APCD. The facility was in an area zoned as mixed-use industrial and residential; it was compliant. The facility sat within its property lines; it was compliant. As per local regulation, Master Plating was equipped with fume suppressants as control technology, and sensors did not pick up aberrant levels of Cr_6 during production;

the facility was compliant. However, the residents' experience was otherwise. Those co-located with the facility noted a spike in asthma rates, particularly evidenced by a young boy who developed asthma within a few months of moving into a house adjacent to Master Plating (Environmental Health Coalition 2004).

Local activists and residents assumed the role of data surrogates to fill in for what they were convinced were faulty or compromised sensor readings. A local EJ group worked with residents and the state's inspectors to add and reposition monitors to measure the facility's emissions more accurately, at a whopping cost of $1 million. Over the next few weeks, by tuning into the times of day and days of week when they sensed heightened emissions from the plating facility, the embodied surrogates highlighted a problem of time of exposure that the standard regulatory sensing practices missed. They noted that during "housekeeping activities" of dusting and sweeping on Monday mornings, settled, toxic particulate matter was re-suspended in the air as "fugitive dust." This fugitive dust was not detected during the regulatory inspections, and the fume suppressants within the production line had little effect on them. Animated during "off hours" of production, the detected hexavalent chrome was at times 175 times higher than the statewide average (Murchison, Suer, and Cook 2003). After multiple rounds of monitoring, CARB and APCD conceded to the residents (Lee 2005), and the county finally filed an injunction to shut down the chrome-plating facility.

The residents and activists participated in the recalibration of the monitor-based sensor network in ways that far exceeded ensuring the accuracy of a sensor compared to reference monitors (Ottinger 2010). In effect, the broader recalibration work constitutes what the feminist and postcolonial STS scholar Sandra Harding (1991) has called the "strong objectivity" program. Strong objectivity upends illusions of "neutral" objectivity institutionalized by dominant institutions of Western science to instead value knowledge produced from various standpoints that collectively produce something close to socially constructed accuracy. This approach amends how the knowing body is made distant by the "unregulated gluttony" and unrestricted vision of dominant instruments (Haraway 1988, 581). Additionally, rather than a statistically derived surrogate to *substitute* information about the emissions in the facility during the hours that the monitors were not collecting data, the specialized, embodied knowledge of the volunteers exposed significant gaps in the protocols of regulatory sensing. These embodied and sensorial labors filled in for missed data from inspectors who ignored emissions outside the primary plating process. As a result of this recalibration, CARB revised their statewide regulatory requirements, included fugitive dust as a contributor to hexavalent chromium emissions, and re-evaluated the sufficiency of fume suppressants as a control mechanism (US EPA 2002). This outcome did not result from merely technical calibrations.

Data surrogates are also calibrated to historical, place-based precedents of environmental harm through sensory tunings. For example, when a 40,000-ton, twenty-two-year-old amphibious US Navy assault ship, the *Bonhomme Richard*, was set afire by a sailor in San Diego in 2020, regulatory monitors failed to record adequate and timely data. The ship blazed for four days, injured forty sailors and twenty-three civilians, and polluted Portside. In the absence of "real-time" scientific data, silence from the navy, jurisdictional confusion between agencies, and slow official incident response, the collective calibrations of residents generated surrogates for missing data to mobilize action. Residents were alerted by "smelling that something was off" many hours before statements from San Diego officials, rivaling the navy's claims that all that was burning was "rags and paper." A National City politician who had long championed EJ for people of color in Portside exclaimed that the smell instantly transported her to another historical fire at a wrecking yard in 1987. Then in elementary school, she and over a thousand other schoolchildren were evacuated from their schools in Portside. Calibrated to these smells and their gravity, she mobilized action in her constituency thirty-three years later on the first whiff of smelling a mix of burning rubber and paint. Calibrations thus bring nonrepresentational ways of being tuned to the world to drive action within sites beleaguered by struggles over power and knowledge recognition.[2] Portside members exposed to toxic pollutants were calibrated to environments differently than how scientific tools are tuned. In both the chrome plating case and the navy ship fire, specific bodies challenged privileged knowledge from monitors' sensing mechanisms to recalibrate what the regulatory regime senses, when, and by whom. In effect, these surrogates were non-fungible.

Weighting

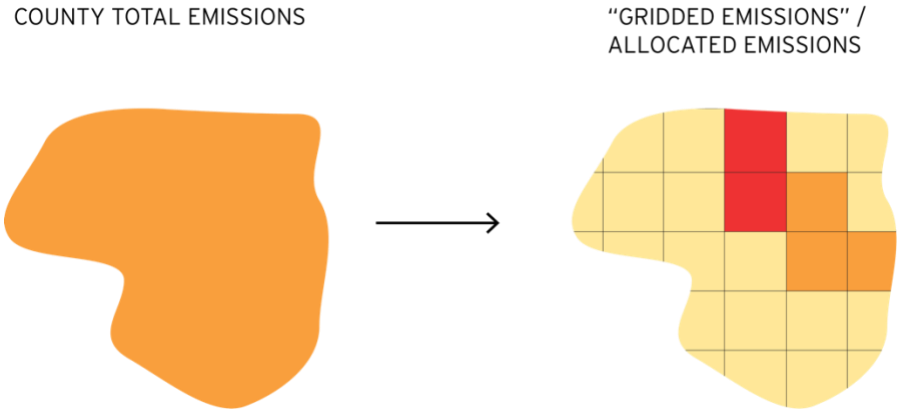

Figure 1. Spatial allocation of emissions. Area-wide emissions are allocated to geographically specific locations using weight values. Diagram based on Adelman et al. 2015.

Data surrogates also perform the operation of weighting. Within technical practices of air quality modelers, the weighting of surrogates is a statistical

operation to disaggregate emissions data. This is not a straightforward process. In California's air pollution modeling, the Atmospheric Modeling and Support Section of the Modeling and Meteorology Branch at CARB uses the US Environmental Protection Agency's spatial allocator tool combined with python scripts and modeling domains. They create, maintain, and regularly update a list of over a hundred spatial surrogates. Modelers provide vector data in shapefiles or raster datasets comprised of geographic data objects in the form of points, lines, or polygons (Adams and Adelman 2016). They then use this data to assign weights to a surrogate to spatially allocate area-wide emissions to potential sources (Boulton et al. 2002) since many emissions do not emerge from point sources. In doing so, they define a relationship between a data source of emissions and the geographic area to which modelers allocate the emissions (see Figure 1). For every geographic area of interest (GAI), n_GAI is the number of available data sources such as monitor data and emission inventory data, and f_GAI is the i^{th} fraction within the GAI for a particular grid cell (i,j), which must then sum to 1 (Σ, or sigma, refers to a sum function).

$$For\ GAI\ \in State, \sum_{i=1}^{n\_GAI} f\_GAI_i = 1$$

However, unrecognized by the regulatory regime, a significant form of weighting for disaggregation occurs outside such algorithms. The inability of models and monitors to provide data at a granular scale can hamstring the vital aggregation and disaggregation processes in standard regulatory practices. As a result, I extend the operation of weighting to explain the work of actors who unequally bear the burden of collecting and providing more granular data. For instance, in Portside, the San Diego APCD regularly enrolled "sensitive receptors" to do this work. Sensitive receptor locations include schools and care centers for children, the elderly, or the sick, who are at a higher risk of air pollution harm. Over the past few decades, APCD has installed regulatory monitors on these sites to collect data for better disaggregation of regional emissions. As Kim Fortun (2004) has found, standardized knowledge in the form of environmental information technologies like chemical inventories is routinely used to undermine the experiences of community members. In Portside, industry representatives often downplayed the stories that sensitive receptors presented about children or the elderly having high rates of asthma or other respiratory conditions resulting from toxic Portside air as anecdotal or overblown and joined the chorus to favor more "scientific data" instead. Thus, in an EJ neighborhood, sensitive receptors not only disproportionately experienced the harmful effects of pollutants but were also frequently enlisted by the regulatory regime to perform vulnerability and bear the responsibility to provide "scientific data."

The responsibility to generate scientific data for disaggregation often came at material costs that lay behind the scenes of the regulatory regime. Regulatory monitoring stations are often large trailers installed atop concrete plinths. Their size is a factor of specialized instruments to measure a variety of individual compounds or metals (NOx, SOx, COx, lead, arsenic, etc.). Although AB 617 promises more granular monitoring, commissioning, and maintaining regulatory stations is no small task. This process includes establishing a memorandum of understanding with the site, procuring construction and temporary encroachment permits, obtaining an address for the trailer to access power from the power company, and procuring a contract with a lab to perform regular analyses of the data, all before building the station. These steps are time intensive, expensive, and involve multi-agency coordination. Once the monitor is up and running, district inspectors must regularly maintain it. Only after the monitors have collected a few years' worth of data can scientists observe usable patterns to inform their responses to public concerns about the health impacts of exposure to pollutants. All this time, the sensitive receptors must maintain the trailer on their premises.

In Portside, the demands sensitive receptor locations faced to provide uninterrupted data often had negative consequences. The presence of a large regulatory monitoring station stymied the expansion plans of a local elementary school. As the sole public school in the low-income neighborhood of Barrio Logan, it needed to provide more room for grades 6 to 8 by placing portable classrooms on the property. To do so, the school had to build on its recreational space, where the monitoring station was also installed. While the school was eager to participate in the sensing network and was committed to the health of its community, it also had to contend with the fact that the station was taking up valuable space. Notably, some school representatives also found the station to be "ugly" and noisy. After ten years of monitoring at this site, the San Diego Unified School District requested APCD to remove the monitoring station in 2016. It was subsequently moved to another elementary school a mile north. Regulatory officers perceived such requests to decommission monitoring stations as uncooperative behavior. Thus, when faced with missing or incomplete data, if calibrating exposes issues with sensing, weighting brings to light how certain social groups and their spaces unequally bear the burden to perform this sensitivity for the larger good of their community by collecting data, at all costs, for the unsatiable data needs of the regulatory regime.

Validating

In the technical practices of data modelers who simulate air pollution's physical and chemical behaviors, validation is often used interchangeably with verification or veracity. Pollution scientists consider modeling and monitoring to be complementary; the model is supposedly validated if a model matches observations of human sense-perceptions or the readouts of monitoring

networks. This emic practice of gaining confidence in models through their validation is called model performance evaluation. When the navy ship burned in Portside at the beginning of the COVID-19 pandemic, the monitors running in the vicinity failed to collect data from most of the accident because of shifting winds and non-optimal placement. They were also unable to provide data about the concentration and duration of the community's exposure to chemical compounds, a combination of which was required for experts to make useful assessments about the public health impacts of the fire. APCD deployed additional canister sensors over the course of the blaze. However, these sensors were unable to provide real-time data since APCD had to send the canisters back to a lab for analysis periodically. This left the residents, many of whom already suffer from asthma and other respiratory conditions, distressed about latent health impacts from this prolonged exposure. Later, amid rising pressure from the residents for more information, APCD sought the help of CARB to model the fire to fill in for missing data. However, these models were inconclusive because they could not be validated by the monitors, which had themselves been collecting deficient data. How, then, was data validated?

STS scholars Naomi Oreskes Kristin Shrader-Frechette, and Kenneth Belitz have suggested that the practice of validation is less about verification and more about legitimation (1994, 642). Validation as a form of legitimation indicates how the tools and methods of environmental governance come to be trustworthy by nature of who creates the tools, establishes their use, and circulates them. During both business-as-usual times and urban anthropogenic accidents, the data collection of the state through "socially recognized" and "officially validated labor, carried out by salaried workers" (Illner 2020, 27) regularly fails, exposing gaps in how the state's expertise is legitimized. During the ship fire in Portside, residents collected their own evidence in the absence of adequate, "official," and "expert" data. Marcia (pseudonym), a long-time Chicana community organizer and primary caregiver to her ailing husband, who had cancer and other respiratory conditions, brought a filter to the first public meeting to discuss the fire. She noted her shock at the amount of dark and fine particulate matter, a particularly harmful air pollutant that can lodge itself into lungs and the blood stream, deposited on the filter of her husband's sleep-apnea-reliever machine in just one night. She exclaimed it appeared as though she had not changed the filter in a year.

Evidence like Marcia's eventually mobilized action in the months that followed. City representatives and health experts drew on the shared experience of having witnessed this filter to discuss future preparedness, maintain pressure on the navy for accountability, and rally for reparative action. Amid residents' repeated impact statements and circulation of visuals of the filter's evidence, the county supervisor's office and the Port of San Diego released a total of $653,000 to provide over 250 pairs of indoor air purifiers and air monitors to residents of Portside. During this anthropogenic accident, when the stakes of missing data

were higher for the local government amid heightened demands for reparative action from Portside residents and state officials, it was the unpaid, "non-legitimized," embodied and affective labor of resident activists like Marcia that ultimately validated the tools of the state, by filling in for its incapacities. That the community continued to rally for more monitoring post-incident, placing faith in these instruments to produce data, further highlights that it is far more than the officially validated labor of the experts who made their tools operational and legitimized.

Validating also occurred through institutional collaborations, when academic institutions developed civic science projects within communities most at risk of pollution, with the promise of filling gaps in environmental pollution data. Rarely in need of proof of pollution themselves, the residents joined forces with institutionally legitimized researchers to conduct low-cost sensing with the hope of putting numbers to their grievances that could conceivably incite political action. While the assembled data of civic-sensing may invite new ways of making sense of residents' collective encounters (Gabrys Pritchard, and Barratt 2016), it rarely gave vulnerable Portside members credence at regulatory and policy tables. On the other hand, these joint efforts between communities and academic scientists lent legitimacy to the work of academic scientific partners. When I probed what these partnerships did for the residents, an academic scientist working in San Diego noted that the citizen-sensing project's success was that the data collected from their partnership could validate the data of regulatory monitors or commercial sensing networks. Rather than the sensors and models validating the experiences of disadvantaged community members to lead to regulation change, the opposite was true. The residents were data surrogates who validated the status of models and monitors as reliable epistemic tools of the experts and an empirically adequate one at that, despite the tools' shortcomings.

Moving from Substituting to Hosting: Deepening a Feminist Analysis of Data Surrogates

So long as models, monitors, and inventories serve as lodestars of the standard environmental regulatory regime, any attempt to develop more justice-oriented policies within this regime must confront the problem of missing, abjected, and immeasurable data and the use of surrogate data to resolve it. These data practices are products of and reproduce intersecting systems of oppression, by way of gatekeeping what counts and data, and who it is produced by. Calibrating, weighting, and validating are just a few examples of the work data surrogates do. This paper has articulated what constitutes the broader range of data surrogates involved in filling in data gaps to then facilitate or interrupt the regulatory regime.

A feminist STS analysis of surrogates critiques the acts of speaking for, standing-in, and representing bodies, sensory experiences, and environments. It questions

how computational technologies negotiate human–machine relations, differences, and agency in ways that transform social interactions (Suchman 2007), with specific attention to the embodied and affective labors of marginalized people like indigenous women who forge and maintain kinship relations with environments routinely go ignored in the making of "rational science" (Harding 1991; 2008, 161). I build on the above research and more to conduct a situated analysis of data surrogates. Data surrogates as substitutes rely on environmental relations drawn together by computational and statistical methods. These relationships build on the perceived universality of technical abstractions and symbolic representations, like lines of code. In this conception, a technical expert can swap out one discrete variable for another within mathematical equations. However, feminist scholarship teaches us that approximations such as surrogates do not come without contest because they mediate power relations and knowledge production (Hinterberger 2007).

Learning from the Portside case, I have suggested that the broader scope of surrogates and their work is evident by shifting the terms of their analysis from substituting to one of hosting. The former implies fungibility, and the latter resists this implication. Hosting evades solely working in terms of technical abstractions by focusing on embodied, historically specific relationships in place (Massey 1994; Mohanty 1988). Statistical operations of substitution in the regulatory regime hide the forces of racial capitalism and the undermining of gendered labor while maintaining the state's operations (Melamed 2011). Hosting, on the other hand, accounts for sites where collective subversion and resistance can arise (Ahmed 2010; Hartsock 1983) and invisibilized labor and kinship relations recovered (Hayden 2013). Surrogates in environmental management can have ethical and political ramifications because they invoke that which is unknown or even unknowable (Chun 2018; Murphy 2004). These approximations can substitute one detrimental abstraction with another to sustain bureaucratic management while doing little to alleviate toxic exposures for those most disadvantaged (Hepler-Smith 2019). Thus, while the concept of hosting does not make the data surrogate any less of a proxy, it does draw attention to the gendered and racialized relationships between body, place, and property in the regulatory regime that substitution misses. Building on the Portside case, this section summarizes the ways the above associations are embedded within and produced by hegemonic regulatory systems.

Hosting locates surrogate data in *body and place*. Theorizing fungible bodies, Saidiya Hartman argues in *Scenes of Subjection* that captive slave bodies were made interchangeable, abstracted, and universalized "empty vessel[s]" (1997, 21). This fungibility converted bodies into property that extended the master's reach and dominion (46). Tiffany King (2016) then theorizes how "Black fungibility" can serve as a way to analyze the spatial reach of domination. These analyses of the fungibility of subjugated bodies inform my argument that treating data

surrogates as fungible allows actors of the regulatory regime to abstract historically specific material practices steeped in racial and class-based tensions to make them into computationally tenable parameters. Purely computational surrogates, in turn, expand the regulatory regime's spatial and epistemic reach and dominance, under the guise of state-sanctioned EJ programs. In contrast, in the hexavalent chromium emissions case in Portside, the surrogation work of data was performed by residents and volunteers. They served as corporeal hosts to the pollutants in place. By "letting the [subjugated] body speak" (Hartman 1997, 22), they highlighted the shortcomings of the regulatory regime's inspection protocols. In the case of the navy ship fire, by invoking the filter, Marcia asserted her caregiving role and the presence of her husband's subjugated body riddled with cancer and asthma into the patchy statistical data of municipal agents. Her evidence of the filter interrupted the dominant data practices of the regulatory regime. As a data surrogate, she was not fungible.

Hosting also reveals and interrupts how the regulatory regime constructs *property systems and rights*. Environmental regulation creates property rights of the air as a natural resource by converting open access to air into public property that is then subject to private access (Cole 2002, 2011). The regulatory regime relies on the settler-colonial, "line-drawing" method of boundary-making to demarcate public and private property (Banner 2009) based on zoning laws and industrial permits, as we saw in Portside. These abstractions reduce geographic territory and the relations of bodies, land, and property to a spatial grid, as we saw in the operations of weighting through spatial surrogates. Despite the evasive nature of airborne matter that is hard to pin down (Choy 2018), mappings to spatial grids perpetuate a false sense of "fixity and stability" based on a sense of enclosure in the United States (Blomley 2003; Ellis 1993), rather than fluid constitutions (Massey 1994). Daniel H. Cole and Elinor Ostrom (2010) have argued that regulatory resolutions use these boundaries to discipline residents to attach favorable relations towards property enclosures. It upholds one user's property rights while imposing costs on others. Indigenous feminist scholars such as Mishuana Goeman, on the other hand, have long resisted these fixities of capitalist formations, where "life force becomes abstracted as property" (2013, 205), instead considering lifeforms particular to place (Goeman 2009) but also actively in transit through relations (Byrd 2011). As such, surrogate *as host* maps more than mathematical and computational relationships of fungible land onto a gridded space. It sheds light on the material nature of the politicized relationships among points, lines, or polygons, and the bodies, land, and property they encode. These relations lie far beyond abstracted demarcations of zoning, property lines, and land-use types that are rendered in the regulatory regime. In the case of hexavalent chromium emissions in Portside, hosts interrupted the abstracted boundaries and enclosures between public and private property when the life of disadvantaged communities was at stake. Hosting thus shows the possibility of

shifting power of whose property rights are upheld in the regulatory regime's air pollution management through regulation.

Together, data surrogates as hosts shifts focus from the realm of production to that of *social reproduction*. Social reproduction feminism explores the tensions between production and reproduction within social configurations that involve property and power relations (Federici 2012; Ginsburg et al. 1995; Laslett and Brenner 1989). Data surrogates treated in terms of substituting within standard regulatory practices typically focus on production processes. Hosting, on the other hand, helps explain the entrenchment of these operations within the realm of social reproduction, contributing to scholarship that theorizes EJ *as* social reproduction (Di Chiro 2008). As shown above, operations such as calibrating, weighting, and validating that stand in for data gaps are performed by bodies in spaces associated with activities that replicate human life or labor power at the level of homes, neighborhoods, and communities at large. Marxist feminists explore the everyday practices through which the reproduction of human life, labor power, and care and kinship relations are integral to social configurations of inequalities and capitalism itself (Bhattacharya 2017; Ferguson 2019). Additionally, social reproduction is routinely performed by gendered and racialized labor (Davis 1983); the same is evident in data surrogates. Thus, although social reproduction is mired within a capitalist system, it also holds the possibility for social transformation by resisting and interrupting the capitalist regulatory regime, as we see in Portside.

As states recede from the public provisioning of caregiving, healthcare, education, and community development (Bakker 2007) required of EJ, data surrogates fill in vital operations. Examining these operations in terms of hosting exposes the material commitments imposed on more-than-computational surrogates, the sites of exploiting racialized, gendered, and non-expert labor, and the ways sensorial and corporeal surrogates resist this exploitation. In Portside, surrogates as hosts interrupt relations of power attributed to race, class, and gender in EJ that are embedded in scientific and technical categories and tools. In other words, they interrupt the "racial regime" (Robinson 2012) and gender oppression of the regulatory regime. Hosting reveals the specificities of these relationships, challenges the assumptions of the work of data surrogates in standard governance, and, more crucially, points to the potential for rethinking the organization of social relations.

Conclusion

An intersectional feminist STS and critical EJ analysis of data surrogates demonstrates their ability to interrupt and potentially cleave away from the dominant regulatory regime. In effect, it opposes the dominant regime's state-sanctioned racial and gendered violence (Liboiron, Tironi, and Calvillo 2018; Murphy 2017; Pulido 2017). This article has argued that while data surrogates are

also proxies, their work is better analyzed in terms of hosting rather than substituting. This shift exposes the dynamics of how data surrogates are grounded in body, place, and property relations. Hosting draws attention to the politics of who bears the burden to fuel the Sisyphean call for *more data,* onto which the regulatory regime grafts policies, programs, and regulations. Through the case of environmental regulation in the Portside Environmental Justice Neighborhoods (Portside) of San Diego, I have developed a partial typology of operations that data surrogates perform: calibrating, weighting, and validating. My goal of drawing out the relations between missing, unmeasurable, and abjected data, and body, place, and property, is not merely to describe the historically specific and material nature of seemingly fungible abstractions through hosting but to instead explain and analyze how hosts can interrupt the socioecological organization of the regulatory regime. As the state, market, and civil society continue to iterate relations that promise EJ, these reorganizational peregrinations of hosting reveal a subaltern and subjugated politics of the data surrogate.

Notes

[1] Abjection is a central concept in Black feminist literature referring to the othering of entire populations in the service of capitalism through slavery and other forms of subjection. I'm particularly drawing from the conceptualizations of Saidiya Hartman (1997) and Jodi A. Byrd (2011). The abject is effectively bereft of subject-object relations with recognizable power.

[2] Anthropologists have theorized nonrepresentational ways of relating with environments through affect and attachment. Kathleen Stewart has developed the concept of "attunements" to attend to forms of perceptual awareness (Stewart 2011, 446). Atmospheric attunements through "conditions of suspension" (Choy and Zee 2015, 213) attend to how expert forms of sensing parse through phase-changes of particles.

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