Information, Communication & Society

ISSN: 1369-118X (Print) 1468-4462 (Online) Journal homepage: www.tandfonline.com/journals/rics20

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To cite this article: Bartosz Ślosarski (2024) Data phronesis and the duality of care in the air quality data politics, Information, Communication & Society, 27:4, 758-773, DOI: 10.1080/1369118X.2023.2296926

To link to this article: https://doi.org/10.1080/1369118X.2023.2296926

Published online: 18 Jan 2024.

INFORMATION, COMMUNICATION & SOCIETY
2024, VOL. 27, NO. 4, 758–773
https://doi.org/10.1080/1369118X.2023.2296926

Routledge
Taylor & Francis Group

Data phronesis and the duality of care in the air quality data politics

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ABSTRACT

This article delves into the intricate dynamics of air datafication as matters of care within the distinctive context of air quality data politics in Poland. It focuses on the implementation of data-mediated care for air quality, scrutinizing two interconnected dimensions: data practices and data phronesis. The former involves the meticulous handling of air quality data, while the latter explores the phronetic valuation of more-than-human realms, including data standards, air sensing technologies, and a diverse array of actors integral to the datafication process. Data phronesis is conceptualized as the situated and context-dependent practical wisdom demonstrated by various actors, shaping the definition of 'good' data-mediated care for air quality. The article emphasizes the duality of care, highlighting the interplay between data phronesis and data practices. It underscores the ongoing negotiation surrounding air quality concerns, intricately mediated through data, within relational and contextual dimensions. Through an in-depth qualitative examination and Reflexive Thematic Analysis, four key themes, related to data-mediated air quality care, are identified: 'caring about data,' involving the valuation of situated data practices; 'caring for data,' translating polluted air into reliable data, while considering dominant standards; 'caring by data,' defining data usage methods within dynamic contexts; and 'data for caring,' exploring practical applications, particularly activist practices integrating diverse local contexts with European air quality standards. The article enriches our understanding of datafication as matters for care, shedding light on the interconnections between hands-on data practices and the contextual wisdom steering strategic action.

ARTICLE HISTORY
Received 18 July 2023
Accepted 15 December 2023

KEYWORDS
Data practices; data phronesis; matters of care; air quality data politics

The article's main purpose is to present how the datafication of air is approached as a matter of care (de la Bellacasa, 2017; Gabrys, 2022; Pink, 2022) within the Polish context of air quality data politics. It specifically focuses on how data-mediated care for air quality is realized in two interconnected dimensions: data practices and data phronesis (Eubanks, 2012; Flyvbjerg, 2013). These dimensions include the practice of handling

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air quality data, and the phronetic valuation of more-than-human worlds (de la Bellacasa, 2017; Mol et al., 2010) composed of data standards, air sensing technologies, and diverse actors participating in the process of the datafication of air. Data phronesis is understood as the situated and context-dependent practical wisdom of various actors that determines how definitions of 'good' data-mediated care for air quality are created.

In the article, I posit that the process of air datafication ultimately involves the conversion of air pollution into data, with the aim of quantifying risks and guiding prescriptive actions (Pink, 2022, p. 75). This process is upheld through the efforts of public and scientific institutions, as well as the activities of grassroots social movements. Therefore, the datafication of air as a matter of care can be comprehended as maintenance and repair practices using the data and datafication technologies necessary to preserve, sustain, and restore our breathable world 'so that we can live in it as well as possible' (de la Bellacasa, 2017, p. 3). These practices of collecting air pollution data serve as documentation of harm and are employed as a means of generating care for air quality (Gabrys, 2022, p. 105).

However, air quality data is not universal, but rather determined by context and relationships (Loukissas, 2019; Ślosarski, 2023), and their valuation is based on data phronesis. Data phronesis reveals the vulnerability of data as facts, and emphasizes their collective significance, supported by networks of both human and non-human actors. The concept of 'matters of care' considers the three Aristotelian intellectual virtues together (Aristotle, 2015). It focuses on *episteme* as the means of constructing knowledge and cognition, on *techne* as the construction of sociotechnical assemblages, as well as addressing issues of situated ethics as a key aspect of caring for the representation of things. The aim of the article is to strengthen this third aspect by proposing to study *phronesis* as situated practical wisdom that determines how definitions of good care are created, thus influencing practices. This category adds to the understanding of care by indicating how valuation is realized and linked to practices that involve adapting to various technologies and contexts. Data phronesis enables us to capture the diverse sensibilities of actors, thereby highlighting the power dynamics among them, determining whose values hold greater importance, and how certain vulnerable actors, such as local activists, adapt in relation to other actors while creatively navigating between standards and contexts. The category of phronesis facilitates the consideration of values and practices within the relational process of sustaining diverse more-than-human worlds, as will be exemplified by the case of air pollution in Poland.

In a theoretical sense, the article aims to contribute to the problem of the 'double vision of care' (Lindén & Lydahl, 2021), specifically regarding an ethico-political issue of what worlds are composed and sustained by air quality data (de la Bellacasa, 2017, p. 44), as well as which 'good' practices using air sensing technologies are expected to be 'handled with care' (Mol, 2008, p. 5) in order to have a meaningful impact in object-oriented politics (Marres, 2015). To understand this double vision, the concept of phronesis (Eubanks, 2012; Flyvbjerg, 2013), which refers to practical wisdom and the valuation of practices, technologies, and power relations between human and non-human actors, will be applied in the context of air datafication. This approach offers a non-idealized understanding of care in critical studies of data and air pollution, while also highlighting the ability to analyze situated data practices (Kitchin, 2022). In an empirical sense, the article will explore the Polish datafication of air, focusing on matters

of care in terms of practical engagement in data production and use, and examining 'good' practices through the lens of data phronesis as practical judgments. I will focus on the network of organizations comprising the Polish Smog Alert. These organizations are striving to exert influence on the course of air quality policy by using data and engaging in various relationships with other actors, including public measurement institutions and scientists who research air pollution in Poland. For local activists, however, handling data is not simply about using it in their practice. It also entails a situated practical wisdom – data phronesis – which involves recognizing the value of data and technologies, while also considering how these things are valued by other actors.

In the next section, I will formulate a theoretical contribution related to data phronesis by conducting a literature review regarding matters of care and air quality data politics. Subsequently, in the following section, I will introduce fundamental aspects related to the empirical context of Polish air quality data politics, demonstrating how data practices and data phronesis manifest in the Polish context. Finally, I will discuss the results in the context of the previously outlined concepts.

The duality of care: practice and phronesis in air quality data politics

A range of scholarly works shed light on different aspects of matters of care in critical data studies, including the practices (Fotopoulou, 2019; Meng et al., 2019), infrastructures and technologies (Gray & Witt, 2021; Slota et al., 2023) or imagined futures associated with it (Ruckenstein & Trifuljesko, 2022). Building upon previous studies that have predominantly explored the intersection of techne/episteme in the study of data-mediated care and caring ethics of research, I argue that we should also amplify issues of data phronesis, which pertain to situated and context-dependent practical wisdom determining how definitions of 'good care' are created, thus influencing practices.

In the field of air quality data politics (Marzecová & Husberg, 2022), the issue of data-mediated care for air has gained prominence. According to Gabrys (2022, p. 105), citizen-sensing practices in monitoring air pollution express concern for breathable worlds. These practices speculatively aim to document harm and advocate for care, operating independently from official public infrastructures, and encouraging corrective actions; but their political engagements often lack specific outcomes such as immediate regulation, policy, or consensus on environmental issues (Gabrys, 2022, p. 105). The latter is often associated with the category of 'just good enough data', suggesting that data usage alone can be adequate in creating awareness about air pollution (Gabrys et al., 2016), but may not be enough to bring about a significant impact on public institutional policies (Ślosarski, 2023). The contradiction between data practices aimed at caring for air quality and the question of having sufficiently 'good' data to effectively implement or influence those caring practices is a crucial aspect of comprehending the interplay between data practices and data phronesis in the realm of air quality policy, as will be shown in the case of Polish air quality data politics. However, before delving into this, I will examine the datafication of air, drawing upon existing research in this domain.

Matters of care ultimately involve representing things as vulnerable, interconnected, and predominantly dependent on often neglected maintenance work, as well as ethical obligations that lead to the specific aesthetic articulation of politically demanding issues

(de la Bellacasa, 2017, pp. 56–57). Care is fundamentally dualistic in nature because, on one hand, it entails active practical engagement and material actions, and on the other hand, it embodies an ethical responsibility for things (de la Bellacasa, 2015, p. 90).

This understanding has consequences for the way care is conceptualized. First, the issue of the *double vision of care* (Lindén & Lydahl, 2021) is conceptualized as an ethico-political concern regarding the composition and sustenance of worlds through material practices (de la Bellacasa, 2017, p. 44), as well as the identification of 'good' practices for addressing specific issues with care (Mol, 2008, p. 5). This duality of care, as both a practice and a world-composition, is always situated within a particular terrain characterized by power relations, exclusions, and marginalization (Lindén & Lydahl, 2021, p. 4). Second, care is understood as *practical tinkering* or a process aimed at finding local solutions to the challenge of reconciling the coexistence of diverse human and non-human actors in real-world scenarios (Mol et al., 2010). It involves working with socio-technical elements to improve situations and address the complexities inherent in balancing multiple values and objectives (Lavau & Bingham, 2017). As highlighted by Mol et al. (2010, p. 13), the practice of caring necessitates the reconciliation of diverse understandings of 'good care' through practical experimentation and adaptation. The qualification of what constitutes good care is not a separate process preceding its implementation; rather, it is integrated into the very act of providing care – instead of critically evaluating the notion of goodness from an external perspective, those involved in caring must actively undertake actions to bring that 'ideal' to fruition, while actively engaging in their tasks (Mol et al., 2010, p. 13). It means that the practice of caring itself is relationally and contextually bounded (Gill et al., 2017). 'Good care' is context-dependent and its very definition is an object of ongoing negotiation in the realm of the more-than-human world (Gill, 2017). Therefore, care is 'relational per se' (de la Bellacasa, 2017, p. 69); however, in order to study it empirically in a situated way we should start from practices, discovering their material, relational, and contextual interdependencies (Fotopoulou, 2019).

In air quality data politics, we can observe this interrelationship between data practice, as practical tinkering with data, and data phronesis, as value judgments of air pollution data. This duality includes both the practices of handling data and the concept of data phronesis, which entails valuing these practices and making practical judgments that consider materiality, context, and various relationships.

The handling of air quality data is one aspect of the spectrum. Data practices are relational, involving various actors (Ślosarski, 2023), and contextual, because these relationships unfold differently in specific settings (Loukissas, 2019). In this realm, we are dealing with a multiplicity of actors and their datafication practices. We can identify specific practices employed by public institutions, which focus on the administrative logic of air governance (Kunz & Hornidge, 2022). Scientists conduct basic research within this field, while data activists or citizen scientists generate knowledge to evidence harms (Gabrys, 2022) and understand their localities, or conduct 'undone science' (Hess, 2016). Furthermore, market players concentrate on establishing a specific market for selling air purifiers and other commodities as individual and commercial responses to the issue of air pollution (Negi & Srigyan, 2021). This stream of research perceives actors as fulfilling the fundamental criterion of matters of care, as they actively contribute to the understanding and acknowledgment of air pollution as a constructed fact and represented entity. They also express varying degrees of ethical responsibility for air quality, albeit with different

visions and interpretations. Moreover, this line of research implies that the practices themselves, regarded as local tinkering involving conscious adjustments to specific contexts and relational interdependencies, are complex, uneven, frequently contradictory, and give rise to conflicts among divergent practices (Crooks & Currie, 2021).

At the opposite end of the data handling spectrum lies everything that impacts and influences these practices. This includes the concept of phronesis as a value judgment pertaining to practices that are contextually and relationally situated. In air quality data politics, the understanding of the topic is multifarious, firstly encompassing regimes of perceptibility and the politicization of air as a contested political space (Calvillo, 2018). Secondly, there is contention regarding the concept of 'just good enough data' which involves using diverse sensors, including low-cost ones, to go beyond traditional perspectives and engage with air pollution from multiple angles (Gabrys et al., 2016). Thirdly, interpreting data of varying quality requires an awareness of potential errors and their contextual implications, influencing how air pollution is understood and perceived (Garnett, 2016). Fourthly, the role of citizens or actors using air quality data is closely intertwined with the conceptualizations of data and its potential within various settings, shaping definitions of 'good' citizenship and enacting different forms of citizenship (Gabrys, 2022; Gross et al., 2019). This line of research focuses on phronetic meanings, connecting the values and judgments of actors to their practices, and encompassing the definition of citizenship and active involvement in the process of air datafication to generate care for air quality.

Prior research has given limited attention to air quality data as a matter of care, encompassing practical considerations and the definition of 'good' practices. There is a need for a comprehensive conceptualization of caring that acknowledges the interdependence of these two aspects: a definition of caring for the state of air quality through data, while also situating it in a relational context. The data phronesis concept reinvigorates awareness of power dynamics within the realm of data care. This is crucial because data is often perceived in terms of its objectivity and purity, while focusing on phronesis sheds light on how power influences data production, evaluation, and use.[1] This perspective helps us grasp the vulnerability of sociotechnical systems in air datafication, and facilitates a nuanced understanding of the multifaceted roles data plays in air pollution data politics. In the following sections of the article, I will demonstrate how we can conceptualize the duality of care for the air – as practice and phronesis – in the material, relational, and contextual realm of air quality data politics, referring to the specific landscape of anti-smog politics in Poland.

Polish air quality data politics

Poland's high pollution levels, ranking among the highest in the European Union, present a critical environmental concern due to the negative impact on human health (Matczak et al., 2023; Wróblewski et al., 2021). Winter seasons in Poland see heightened pollution levels from heating activities, leading to increased public discourse and around 50% of the population recognizing smog as an urgent issue (Frankowski, 2020). Heightened public awareness of air pollution has spurred the involvement of various actors who are actively engaged and care about the air datafication process, turning it into a dynamic arena where diverse actors participate (Ślosarski, 2023), including public institutions, anti-smog activists, scientists, as well as commercial actors (Matczak et al., 2023).

Table 1. Phronesis and practices of data-mediated care in relational and contextual dimensions.

Dimension	Phronesis	Practices
Relational	*Caring about data* – definitions of 'good' data practices and standards of air quality data	*Caring for data* – socio-technical data practices focused on practical tinkering with various measurement tools
Contextual	*Caring by data* – definitions of good data uses and their appropriate scope of use within perceived contexts	*Data for caring* – practical uses of data combining various local and global contexts of action

Data usage is a central issue, as the various actors use data from diverse sources – public infrastructure and low-cost sensor networks – in their strategic actions.

Within this context, the Chief Inspectorate for Environmental Protection (GIOŚ) is the key actor. Since 1991, this government agency has maintained its role as the provider of the most dependable smog data, operating nearly 300 public measurement stations that constitute the foundation of its monitoring network, using this data to inform both domestic and EU government entities. However, since 2012, due to the increasing social efforts to combat smog, GIOŚ has encountered an unforeseen challenger in the anti-smog movement, which measures and reports air pollution within local communities using public and lower-cost sensors, despite their higher measurement inaccuracies. The upsurge in interest and active engagement in the air datafication process in Poland has not only impacted researchers who previously faced challenges in sharing their findings with the public, but has also catalyzed the growth of a market for commercial entities establishing private measurement sensors and selling air purifiers as privatized solutions to the public issue of air pollution. Air datafication in Poland is, therefore, a realm where a variety of actors pursue their distinct objectives through data use. This involves engaging in mutual interactions that manifest as practical involvement in data practices and making value judgments concerning data, infrastructure, and other actors, essentially encapsulating the essence of data phronesis. In this context, GIOŚ as the incumbent entity collects data for institutional reporting and collaborates with scientists. Meanwhile, local activists, as part of the anti-smog movement, engage in data action using public and low-cost sensors, often seeking guidance from knowledgeable scientists. Together with market players and civic-tech entities, the anti-smog movement challenges the status quo by raising public awareness, providing content for journalists, and influencing local and state institutions.

For the study on air quality data politics, I conducted 20 in-depth, semi-structured interviews involving a diverse group of 12 activists from different locations. The interviews aimed to explore the various data practices and meanings within the movement (Blee & Taylor, 2002). Based on insights shared by the activists, an additional eight key actors were identified, including public institutions, air pollution scientists, civic technology actors, and data journalists. The interviews employed a deliberative and phronetic approach (Flyvbjerg, 2013) in which I unpacked the process of datafication of air with interview participants, noting how individual actors value these processes, taking into account other actors, the relationships between them, and how they value the practices of using data in their strategic actions. The aim of the interviews was to collaboratively establish the practical meanings and importance ascribed to actors, practices, and various types of data. This was not about distinguishing them in terms of ontology (e.g., human vs. non-human actors), but rather in the context-specific ethical considerations of

what is deemed right or wrong in the case of active involvement understood as caring about air quality. The analysis of the empirical material using Atlas. Ti software followed the principles of reflexive thematic analysis (Braun & Clarke, 2022), with the aim of generating patterned meanings across the dataset and exploring the socially perceived practices, actors, relationships, and phronetic meanings associated with them.

In this research, conducted as part of a larger project, the focus was on how data legitimizes the actions of environmental activists. During the study, the concept of care emerged incidentally through interactions with activists, shifting the perception of data from being a universal resource for activism to recognizing its role within sociotechnical networks of care. This involves acknowledging shared vulnerability across diverse relational contexts. As a result, data itself can be conceptualized as an object of care. Consequently, I generated four themes on the intertwining of data practices and phronesis in air quality politics, as presented in Table 1.

The themes address the duality of care as phronesis and data practices, while highlighting the significance of relationality and contextuality in these practices and practical valuations of data. The detailed explanations for each of the four themes aim to show how phronetic meanings influence the understanding of environmental care in relation to data practices and the perception of more-than-human worlds. It is important to note that the themes are analytically divided to represent the four elements that constitute datafied care in air quality policy.

Caring about data

The first theme – 'caring about data' – encompasses both phronetic and relational aspects, focusing on the definitions of 'good' data practices and standards within the realm of air quality data. The attitude towards data, rooted in practical judgments, serves as the primary differentiating factor among actors involved in the politics of air quality data. Caring about data involves developing a vision of the standards applicable in this domain and evaluating various data sets and types based on these standards. In other words, this theme addresses the issue of 'good care' as appropriate air datafication, resulting from a situated negotiation between actors engaged in air quality data politics (Mol et al., 2010).

Caring about data is primarily influenced by air quality scientists, who shape the concept of 'good data' based on their expertise in data acquisition and use. They emphasize the importance of producing data that adheres to technoscientific standards and employs professional equipment and reference methods. These standards are established by scientists and public institutions. A crucial factor in this determination is the value attributed to differentiated air pollution sensors. In Poland, both public measurement stations and low-cost, commercial, or citizen-made sensors are available. However, as one scientist pointed out, low-cost sensors *were originally designed for measuring pollution in workplace settings, focusing on larger pollution peaks than those typically found in Polish cities* (Sci-Smog-1). As a result, public measurement stations are considered the most reliable source of quality data, providing information on average pollution exposure rather than temporary spikes. This high standard is reinforced by legal regulations, as emphasized by an environmental lawyer who states that data from the Chief Inspectorate of Environmental Protection *is the only reliable data admissible in lawsuits* (Law-Smog). Ultimately,

the definition of 'good data' encompasses both the phronetic aspect of responsibly handling data according to scientific and legal standards, and the relationships with various actors, including the public institutions responsible for maintaining measurement infrastructure, and the involvement of experts and scientists in the measurement process.

The practical significance of 'bad data' in this context is minimal, but it primarily serves as a reference point for the interviewees. It refers to the misuse of data obtained from unreliable sensors, which raises questions about its quality. As one scientist ironically remarked, these devices often lack clarity regarding what they measure: *but it shows on some screens some concentration. It measures every second, right? All it takes is for some truck with a broken engine to pass and it will emit a pile of this dust into the air. The instantaneous concentration will be dramatic, for example, eight hundred. The norm is forty. God, twenty times the permissible concentration!* (Sci-Smog-2). This observation aimed to emphasize the lowest standard of data, which was universally acknowledged by all study participants. Among the interviewees, which included both scientific and lay actors, there was consistent mention of the technological fetishism exhibited by certain users, showcasing the lowest standard that manifests through an inability to properly assess the value and composition of technological tools and the data they generate.

Existing value judgments regarding good and bad data shape the landscape within which local activists operate. They use public data if it is available in their area, but also rely on 'just good enough data' (Gabrys et al., 2016) from low-cost sensors to communicate daily air pollution levels not captured by official measurements. Their practical judgment of data revolves around the specific requirements of their strategic actions aimed at addressing air quality concerns within their communities. It is important to note that activists are not unaware of the standards set for 'good' data. On the contrary, they actively engage with and assign significance to these standards, based on their relational practices. For example, when engaging in official communication, they use publicly accessible data that they obtain and analyze independently. As described by a female activist from the conservative context of a small town in southern Poland, their access to data provides a basis for their claims and enhances the credibility of their efforts: *when local authorities finally put up the measurement station, we also had something to base our claims on. If a blonde comes to the city hall and says, 'because the air stinks, do something about it,' well, we weren't taken seriously at all. And now, when we have data, we can somehow base our actions on that* (Act-Smog-3). Activists use low-cost sensors to provide real-time updates on local air conditions via social media platforms. While this approach allows for *quick information sharing to indicate whether air quality is good or bad, the results are not precise* (Act-Smog-11). In this manner, activists employ various types of data as a strategic toolbox to address diverse needs.

All actors, particularly activists, align themselves with the 'good' data concept, acknowledging its empowering influence on strategic action. It enables them to shift from neglected matters of concern to undeniable matters of fact. The 'bad data' figure helps draw a line between actors who can participate in air quality data politics and those who choose technological fetishism as a counterweight to the matter of concern. Nevertheless, real adaptation relies on addressing the initial concerns through tinkering, which involves recognizing the shared fragility of the socio-technical assemblage supporting it. In this sense, it boils down to practical and goal-oriented caring for data (Schrader, 2015, p. 668).

Caring for data

The second theme – 'caring for data' – specifically concerns socio-technical data practices focused on practical tinkering with various measurement tools. On one hand, this represents a practical and tangible manifestation of 'good practices.' On the other, it fosters various more-than-human relationships.

Practical tinkering uncovers a whole network of human and non-human actors who care about air quality data. As highlighted earlier, the primary source of information is the state's Air Quality Monitoring, with nearly 300 stations spread across the country, which not only meets several methodological standards, but also ensures that *these stations are regularly serviced, looked after, and maintained in such a way that these devices operate under the conditions that the manufacturer imposes* (Sci-Smog-2). However, there are also numerous networks of low-cost sensors that are used by local activists to monitor air pollution. The primary distinction between these low-cost sensors and traditional monitoring stations lies in the method for extracting data from polluted air. As a local activist explained, low-cost sensors *shine a laser and detect dust particles in the air stream (…) The difference between the official station and the amateur sensor is that the official station prepares this air properly, it simply dries it. And only such dried air is subjected to measurements. Amateur sensors are not able to do that* (Act-Smog-6). In this sense, the existing data standards are materially rooted in entire networks of measurement infrastructure maintained by the state or commercial-citizen efforts. Yet these methods of caring for data quality are not all treated as equal, and the 'good practice' of data handling influences the specific practices undertaken by actors – especially the grassroots actors, who are not representatives of the dominant state-corporate-academia datafication trio (Treré, 2019).

The main sociotechnical practice of data care is calibration, by coordinating cheaper sensors with public measurement stations, in order to respond to the value judgments of other actors and reinforce the importance of the data and the claims behind it. Although the intentionality of this process is on the human side, the implementation is dependent on a network of non-human actors. Firstly, calibration comes down to the sensor *calibrating itself with the official stations and just putting in some corrective algorithms, based on the current humidity, to make those measurements more reliable* (Act-Smog-6). Secondly, the algorithmic calibration is still subject to measurement error, hence the anti-smog movement in Poland is also taking a more materialistic approach, by developing its own measuring station – certified by the Chief Inspectorate of Environmental Protection – at two locations in southern Poland. The activist in charge of the maintenance describes what the measurement process looks like at these stations: *Dust is collected and measured through an online measurement system and sent to a laboratory where it is weighed again to confirm the measurements. This process serves as a validation in case any disturbances or issues occur with the spectral device or laser spectroscopy device during the initial measurements. The dust collected on the tapes is carefully checked and weighed in the laboratory, and specific thresholds are used to confirm the accuracy of the results* (Act-Smog-12). Air pollution measurement essentially involves the de facto weighing of dust (Choy, 2011), which undergoes multiple levels of verification, both technical and in laboratory settings. In this context,

practical caring for data refers to the notion of seeing-touching (de la Bellacasa, 2017, pp. 113–114), understood as the process of translating air samples into tangible dust and subsequently transforming them into data.

In terms of sociotechnical practices, the measurement stations are used to calibrate mobile dust meters to measure locations not covered by state monitoring – which is done by placing them next to the measuring station and manually correcting the results, adjusting them for reliable measurements. A dust meter calibrated in this way creates the most reliable measurement data, approaching the 'good data' standard. Calibration is a form of practical socio-technical adaptation to the data standard; it is a practical example of maneuvering and tinkering between the standards of technologically diverse devices and data quality, but at the same time it relies on diverse non-human actors, such as measurement stations, dust meters, low-cost sensors and the measurement networks that coexist with them.

Caring by data

Phronetic valuing of data in relation to specific socio-technical practices is not realized only in terms of the relational dimension, but also in terms of the perceived and defined context of maintained action. The third theme – 'caring by data' – specifically addresses these issues, focusing on the definitions of 'good' use and the 'appropriate' scope of data use within perceived contexts. A notable aspect of this theme is the tension between the local and global contexts.

In the local context, the strategic placement of public and commercial/citizen sensors plays a crucial role. The local context is highly important in data usage, but disagreements often arise regarding the role of data within specific contexts. Public actors prioritize localization by establishing measurement stations at the local level, considering spatial resolution, and aiming for accurate and comprehensive data collection for air quality management at the administrative level. The selection of station locations adheres to methodological criteria and reporting obligations stipulated by European Union law, and requires negotiations with landowners to *secure a certain level of inviolability (…) that ensures that stations are not arbitrarily relocated* (Public-Smog). The primary administrative objective is to ensure continuity, scientific reliability, and compatibility with air quality reporting systems at both national and EU levels. On the other hand, local activists employ a proximity strategy, by focusing on specific locations to highlight the environmental situation and advocate for change. The proximity and locality of data hold significant importance for the community, as individuals tend to concentrate on tracking immediate surroundings, such as nearby streets and neighborhoods. However, these two values often clash, since public measurement stations predominantly provide averaged and longitudinal pollution data, whereas activists and the local community – mostly vulnerable people such as children and elders – need real-time data specific to their immediate location.

However, this does not mean that activists are locally entrenched, and public institutions are oriented toward reporting the results of the European Union. All actors participate in a kind of ecology of comparison (Choy, 2011), viewing localities in relation to the global context and constructing scales of comparison between these contexts. As one activist summarized this contingent comparative approach by stating, *Poland is also the*

most polluted country in the entire European Union, both in terms of PM10, PM2.5, and benzopyrene. As for benzopyrene, the standard is one nanogram per cubic meter, and the average for Poland is about five nanograms per cubic meter. These are the concentrations, the annual average for the whole country, but there are localities such as mine, which is the record holder in this area, where the annual concentration of benzopyrene is eighteen nanograms per cubic meter (Act-Smog 11). Thus, the immediate neighborhood is constantly compared with the entire country and the European Union, influencing the ways in which locality is valued. This comparison serves to highlight disparities in public policy actions across different localities, underscoring the issue of unjust metrics when compared to other EU regions.

'Caring by data' is achieved through two contextual dimensions. Firstly, by the localization of metrics based on guiding values in administrative and community-tracking practices that may sometimes contradict each other. Secondly, they both relate to the global context, often associated with the European Union and western countries. This association allows for the creation of comparative scales that provide alternative perspectives on localities where these practices are implemented. Phronetic meaning is context-dependent, although actors in their valuing move within constructed scales, which also take on material and practical dimensions.

Data for caring

The fourth theme – 'data for caring' – directly addresses the material and practical issues of contextuality, understood as practical uses of data combining various local and global contexts of action. Certainly, it should be emphasized that data is used in many ways, coinciding with the repertoires of action of environmental data activists or the strategies of public institutions and market actors (Gutierrez, 2018; Negi & Srigyan, 2021; Sun & Huang, 2021). In the studied context, data is used for caring about individual and collective health through visual representations of air pollution shared on social media platforms or via traditional means such as informational materials displayed in kindergartens or schools. Additionally, data plays a role in engaging with policymakers. This theme also sheds light on grassroots observation and activist pressure on local and national institutions of power, as well as the use of data in implementing comparison ecology to construct comparative scales between specific locations. Therefore, the focus will primarily be on the activist practice of ranking the most polluted locations in Poland.

The practice of ranking is both a comparison and an elaborate way of informing communities and local institutions about how their locations relate to others across the country and norms established by the EU. As one of the activists described, the process boils down to combining available datasets and translating the data into specific rankings: *When we have these annual rankings of the smog record holders, we prepare a map on which we plot these localities, and we show in a very simple, graphic way where these concentrations are high. We can make some kind of graph that shows us a comparison of the norm to what the annual concentration was. Because if we say that in one location there were eighteen nanograms per cubic meter of benzoalphapyrene concentrations on an annual average, that doesn't tell a normal person much at all. But if we compare it to this [EU] norm, which is one nanogram, and show these bars one and eighteen, then*

some ordinary citizens can accept that we have a problem. Because it's not just a matter of eighteen nanograms there … It's an overrun of eighteen times! That says more than just the value (Act-Smog-10).

Value judgments identified with the ecology of comparison gain practical materialization in the form of ranking. This quote encapsulates two crucial practices of data use. One is to provide reports on the air quality status, while the other involves translating intricate information using rankings as tools for comparing and blending local contexts. These practices also involve transitioning between the EU norms of pollution imposed by the administrative logic of measurement and the logic of addressing social needs, demonstrating the practical implementation of the ecology of comparison. Furthermore, this quote alludes to the presence of two logics – administrative and social – in defining good practices, which are central to the politics surrounding air quality data in Poland. However, the most crucial practice lies in the ability to effectively translate data outputs. This involves maintaining standards on one hand, while also adapting to the communication requirements of social media platforms and the limited attention span of the public on the other. 'Data for caring' is contextualized and, at the same time, enables the merging and amalgamation of diverse contexts in relation to other localities and transnational air quality standards.

Discussion

In Polish air quality data politics, several actors have emerged who actively engage in the process of air datafication, overseeing the measurement networks responsible for generating air quality data and visualizing smog in the public sphere. This data is not merely seen as a tool for strategic interactions, but also as something that requires active involvement and caring. Those actively involved in the process view the data as vulnerable and fragile, necessitating constant maintenance work of sociotechnical assemblages (de la Bellacasa, 2017). Thus, data significantly impacts our breathable environments, giving rise to new sensibilities within the context (Lindén & Lydahl, 2021). However, its value is not uniform among the various actors involved in the air datafication process, as it depends on the practical adaptations and value judgments of these actors. In this sense, the datafication of air is understood as a matter of care with a fundamentally dual nature, straddling the line between practical tinkering with data and measurement technologies, and the situated definition of what constitutes good or just-good-enough care in the form of high-quality data.

This duality of care highlights the interconnectedness between data phronesis and practice within the studied context. Data phronesis, which serves as situated and context-dependent practical wisdom for various actors and their value judgments (Flyvbjerg, 2013), influences what is deemed good or bad in the datafication process. This primarily pertains to the definition of data meeting a good or satisfactory standard in comparison with other actors, as well as influencing which contextual scopes and areas of data use are appropriate. Data phronesis allows us to capture how actors define and perceive the vulnerability of data, while at the same time paying attention to the dependencies involved in power relations – as shown by the example of activists

adapting to the value judgments of scientists. Within this context, data phronesis is realized through the ongoing negotiation of the definition of data-mediated care for air quality. This negotiation is evident in the dominant position held by scientists and public institutions on one hand, and the orientation towards a high standard by local activists on the other. The negotiation encompasses not only data quality, but also a form of comparative ecology that addresses the connections between locality and global benchmarks (Choy, 2011), whether referring to the entire country, Europe, or other locations worldwide. In this context, data phronesis addresses the notion of 'good care' for the datafication of air, arising from a situated negotiation among actors involved in air quality data politics, where the phronetic meaning is also context-dependent, and actor valuations operate within constructed scales that also encompass the material and practical dimension.

This practical dimension is realized by data, understood as practical tinkering with data and measurement technologies. Within the Polish context, data production concerns the materialization of air, which is achieved through the conversion of air pollution into vials of dust. These vials, in turn, can be transformed into indices or rankings, thus becoming circulating references or manifestations of matter that enable the mobility of material forms (Choy, 2011, p. 163). The rankings produced by activists represent numerical representations with profound implications for their affective and aesthetic effects, shaping the affectionate understanding (de la Bellacasa, 2017, p. 62) of our polluted and/or breathable worlds (Liu, 2017, p. 448). Data practices represent a practical adaptation to the value judgments of actors dominating the sphere of air quality data politics, including public institutions and researchers. This adaptation is achieved by calibrating and aligning sensors with public measurement stations. Practical adaptation also applies to the production of air pollution rankings, wherein there is a materially grounded negotiation and blending of contexts to complement the public narrative on one hand, and reinforce it on the other, by incorporating local dimensions of air pollution.

Considered together, data phronesis and data practice represent two highly interrelated dimensions of care for air datafication in Poland, shaped by unequal relationships and influenced by individual actors' value judgments. These actors implement datafication practices and adhere to values that shape the definition of 'good' practices and the appropriate scope of data usage. These determinations influence the inclusion and exclusion of other actors and expose visible power dynamics and inequality, particularly concerning technoscience and factors like origin and gender. Phronesis thus unveils interdependencies and exclusions within specific contexts while propelling these definitions of 'good' data and practices within dynamic and relational situations. By exploring phronesis, we uncover the diverse value judgments held by actors in their practices and relationships. It also reveals the contextual sensibilities of individual actors who actively respond to values and demands. However, phronesis is not analytically dominant, but rather shaped by practical adaptation. Nevertheless, its role involves situated theorizing, undertaken by all actors involved in taking care of things, and remaining responsible for their becomings (de la Bellacasa, 2017). By examining both phronesis and practices, we gain insights into the realities of power dynamics, exclusions, and cooperative interdependencies within the networks that sustain the datafication of air.

Conclusion

In this article, the duality of care is emphasized, focusing on the interplay between data phronesis – context-dependent practical wisdom determining the practical tinkering with data/technology – and data practices. The article also highlights the ongoing negotiation surrounding air quality concerns, mediated through data, within relational and contextual dimensions.

Four key themes related to data-mediated air quality care are identified: 'caring about data' involves valuing and assessing practices based on phronetic and relational values despite tensions between activists and scientific-administrative approaches. 'Caring for data' entails translating polluted air into reliable data while considering dominant standards and influential judgments. 'Caring by data' defines data usage methods and scopes within dynamic local and global contexts. 'Data for caring' explores practical applications, specifically examining activist practices in integrating diverse local contexts with European air quality standards. These themes underscore the complex interplay between human and non-human actors, the significance of phronetic meanings, and the practical application of data within distinct relational and contextual frameworks in air quality data politics.

The concept of data phronesis revitalizes our understanding of power dynamics in the context of data handling. The phronetic approach offers several advantages aligned with the 'matters of care' perspective. Firstly, it positions the practical judgment of diverse actors actively involved in socio-technical caring practices, recognizing their significance in more-than-human world composition (de la Bellacasa, 2017, p. 35; Flyvbjerg, 2013, p. 133). Secondly, it acknowledges that the theoretical sensibilities of various actors are not neutral, fostering a dialogue concerning what constitutes good care within a specific context (Flyvbjerg, 2013, p. 61; Mol et al., 2010). Thirdly, it demonstrates reflexivity to the strategy within relational power dynamics, acknowledging that definitions of care are diverse and coexist in contradiction (Flyvbjerg, 2013, p. 139; Lindén & Lydahl, 2021). By emphasizing phronesis, we gain insight into how power shapes the production, assessment, and use of data. This perspective enables us to comprehend the susceptibility of sociotechnical systems in the realm of air datafication and promotes a nuanced recognition of the diverse roles that data plays in the politics of air pollution data.

Note

1. I express my gratitude to Reviewer 1 for helping me articulate this argument as described in this sentence.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by Narodowe Centrum Nauki [grant number 2021/41/N/HS6/01110].

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