Environmental governance through metrics

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INTRODUCTION

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Introduction

Metrics do not merely describe an external or objective reality but instead reflect and animate political struggles over what and how to govern. Examples include: Green House Gas inventories, the Extended Continental Shelf, and excess deaths attributable to COVID-19. Applied to environment, the desire to govern is at least as old as modernity, perhaps because we have never been able to fully realize the modern ideal of the dichotomous separation of nature-culture (Latour, 1993). We understand governing – and thus environmental governance – in the Foucauldian sense, i.e. the ensemble of 'institutions, procedures, analyses and reflections, calculations and tactics that allow the exercise of a specific, albeit complex, form of power over a target population' (Foucault, 2004, p. 111). In the twenty-first century, environmental governance is far more complex and polycentric than ever before. Another reason for the complexity of the ensemble of environmental governance is that it is effectively an *agencement* (Callon *et al.*, 2013), composed of human and non-human actors who become the hybrid objects, subjects and authorities involved in the governing of relations that are sometimes incoherent and contradictory.

In this special issue, we are concerned in particular with the problems posed by unsustainable interactions among the living and non-living elements of environments, which become the targets of varied forms of 'ecogovernmentality' (Luke, 1995). Fundamental to the forms of governmentality employed in the late 20th and early 21st centuries are efforts to both know the environment and its problems in order to manage them, but also the complex interactions between forms of knowing and ways of intervening and managing. STS scholars argue that data – i.e. temporally and/or spatially bounded representations of phenomena – is increasingly seen to be essential for managing environmental systems, practices and politics (Gabrys, 2016). This special issue pushes this argument further by focusing on the eventful lives of metrics that are used to

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bind knowing and managing into governing instruments (Lascoumes and Le Gales, 2007).

Overall, the articles here discuss these questions: In representing environmental realities, how do metrics value some realities over others? How does such knowledge affect trust in the actors who govern the environment? How does such knowledge structure their accountability?

Data – including acquiring it, managing it, interpreting it, and representing it – has featured prominently in contemporary efforts to govern the environment. The challenges of recent emphasis on Big Data come from multiple and diverse sites, sources and actors. Public, private and civil society actors consistently call for more data about the environment as well as new metrics that interpret these data to inform and perform evidence-based decision-making (Power, 1997). For example, the July 2019 report of the High-Level Panel of Experts (HLPE) on Food Security and Nutrition addressing interconnections among agroecology, sustainable agriculture, food security and nutrition recommends specifically that '*Comprehensive performance metrics, covering all the impacts of agriculture and food systems, are a key requirement for rational decision-making*' (2019, p. 22, emphasis added).

Syngenta, a large multinational agrochemicals supplier, similarly calls for trusted metrics that will enable the company to fulfill its pledge to improve biodiversity:

> Agrobiodiversity is the fundament of a sustainable agricultural system. That is why Syngenta committed to help improve biodiversity on 5 million hectares by 2020. But we cannot manage what we cannot measure – it requires agreed metrics to assess agrobiodiversity in food systems. (Juan Gonzalez Valero, Head Public Policy and Sustainability, Syngenta, quoted in Bioversity International, 2017, p. 3)

Across sectors and scales of action we have observed similar efforts to quantify, objectify and 'data-fy' policy (Diaz-Bone and Didier, 2016). For example, the 50 × 2030 initiative aims to collect large amounts of basic agricultural data in an attempt to improve policy-making (GPSDD, 2022).

Although they are not strictly speaking new, efforts to support ostensibly post-political and objective decision-making and monitoring based on (ideally quantitative) data is a hallmark of neoliberal governance (Porter, 1995; Desrosières and Didier, 2014; Porter, 2015). Given the relatively recent proliferation of environmental metrics, indices and standards of various kinds (Ransom *et al.*, 2017), critics have raised concerns about what is being measured by whom and the ultimate responsibility of different actors for how the data and metrics are used. These concerns raise political and ethical problems of trust not just in what data can tell us, but also how to interpret and act on what data enables us to know – in both public and private spheres. The things that are measured, and the norms that govern how measurement is executed, obscure many things that are not measured and alternative modes of representation. In this

sense, data and metrics can reflect specific interests, values and knowledge systems rather than some singular reality.

As standardized forms of measurement, representation, and expressions of value, metrics have long been the preferred mechanism for translating data into instruments for governing. They can act 'at a distance' (Rose, 1991) by prioritizing scientific standards for evaluation in an attempt to render the governing process merely technical, rather than be seen as political. Standards are integral to both the standardization of knowledge and creating the effect of objectivity, particularly when the metrics are quantitative (Porter, 1992, p. 1995; Ferguson, 1990). This is evident in the sociotechnical performances of markets, standards, and the adventures (and mis-adventures) of impulses toward legibility and bureaucratic objectivity (e.g. Hopwood and Miller, 1994; Scott, 1998; Bowker and Star, 1999; Busch, 2000; Espeland and Stevens, 2008; Lampland and Star, 2009b).

Critical analysis of the various effects, ambiguities, and unforeseen or hidden consequences of metrics and standards is an important focus within studies of environmental governance. Such analysis emphasizes environmental and sustainability policy regimes and ostensibly more ecologically benign production and consumption regimes (see e.g. Guthman, 1998; Mansfield, 2004; McCarthy and Prudham, 2004; MacDonald, 2005; Prudham and Morris, 2006; Robertson, 2006; McAfee and Shapiro, 2010; Dempsey and Robertson, 2012; Lippert, 2015; Loconto, 2015; Fouilleux and Loconto, 2017; Wang *et al.*, 2017; Wolf and Ghosh, 2020). As novel metrics, indices, standards, and labels proliferate in new institutional and scalar configurations in the age of sustainability and the climate emergency, there is a need to analyze the knowledge politics of how the environment is measured, valued, and governed.

Metrics govern through qualification and quantification

The papers collected in this special issue use a range of STS theories – affect, uncertainty, performativity and social construction of technology (SCOT) – to critically explore how environmental data are expressed, interpreted, and mobilized through a variety of metrics (Table 1). Brunet (2024) explores how ecosystem (ES) measures have been used by economists, conservationists and local authorities in France in an attempt to transform environmental governance, especially by inducing positive emotions such as hope, trust and enthusiasm. Demortain (2024) focuses on the 'auditing of predictions' in the United States Environmental Protection Agency (EPA), which produces environmental knowledge through mutual mistrust between industry-based scientists and government regulators. Ghosh's (2024) analysis of the United States Department of Agriculture's (USDA) Conservation Stewardship Program (CSP) shows that the algorithms of environmental scoring emerge not despite, but through, the contestations among farmers, scientists, bureaucrats and lawmakers over the

Table 1. Which environments are governed through metrics in this special issue?

	Brunet	Demortain	Ghosh	Nost
Theories of STS	Affect	Uncertainty	SCOT	Performativity
Object of Governance	Nature conservation	Chemical hazards	Environmental stewardship	Wetlands restoration
What is measured?	Ecosystem services	Doses	Agronomic practice effects	Sediment diversions
Value judgements	Which environmental service creates more human well-being?	What harms the environment more?	Who contributes more ecological value to the public?	Which environments are worth restoring? for which stakeholders?
Accountability conflicts	Logics of conservation policy	Mutual mistrust of the models (metrics)	Bureaucratic black-boxing	Incomplete arbitration of value-laden tensions
Contributions to STS	Transposition	Regulatory space	Accountability structures	Metrical modes of authorized seeing

purpose and practicality of doing data-driven governance of the environment. Nost's (2024) performativity analysis of the metrics developed in the US state of Louisiana's Coastal Master Plan (CMP) models potential future wetlands loss and the effects of restoration. By introducing flexible thresholds, interested indicators, and weighted metrics, planners can interactively (de)prioritize values when discussing plans with a range of stakeholders with competing interests. These four in-depth qualitative case studies analyze 'which knowledge counts' (cf. Harding 1991) in constructing metrics and how they support specific interests attached to environment advance our understanding of governance.

The four articles collected in this special issue also describe processes of quantification that establish new *agencements* to govern the environment, with different consequences for human and non-human actors. To advance discussions about the performative effects of governing the environment through metrics, we build upon Desroisières' two dimensions of quantification: the establishment of conventions, made up of creative value judgements about what can be in the world; and measurement, the rule-based implementation of these conventions (Desrosières, 2009; Desrosières, 2015). As we know from Wittgenstein, the application of the rule becomes part of the rule itself (Biletzki and Matar, 2018).

Thus, quantification is fundamentally performative (Callon, 2007), as it functions to value and bring into being both objects and the people who are concerned with them (Law and Lien, 2013). In this sense quantification and metrification are forms of valuation. They are a means to govern action that combines assigning value and evaluating actions taken to implement that value (Vatin, 2013). Metrics are a key element of accountability relations, as they structure evaluations (i.e. tests) of actors' internalization of specified norms (Sareen and Wolf, 2021). Here we understand accountability as those feedbacks that produce discipline (Wolf and Arnold, 2023). In this sense, metrics justify the application of sanctions and rewards, thereby influencing strategy, competition and development.

While the dominance of quantification in governing the environment can block out different ways of knowing, representing and valuing (Rottenburg

et al., 2015), the articles in this special issue confirm that not all forms of quantification lead to the same forms of governing (Diaz-Bone and Didier, 2016). This differentiation is partly explained by the specific knowledge infrastructures (e.g. nomenclature, training, laboratories, computer networks) and materiality that support calculation (Latour, 1987; Star, 1999; Edwards, 2017). Attempts to 'qualify' knowledge for governing still require categorization and calculation (Callon and Law, 2005; Lampland and Star, 2009a).

The recognition that governing complex ecosystems needs pre-analytic visions (Costanza, 2001) and ways to account for relational values (Díaz *et al.*, 2015; Chan *et al.*, 2016; Chan *et al.*, 2018; Himes and Muraca, 2018) offer pathways for exploring how qualitative and quantitative valuations can be complementary or may impose untenable trade-offs. Given the tensions that cannot be reduced to power struggles over valuing, knowing and governing, the articles in this special issue demonstrate that studies of metrics need to deal with ontological multiplicity (Mol, 1999) and epistemic pluralism (Turkle and Papert, 1990, p. 185).

This special issue interrogates performative quantification by examining questions that help us to understand specifically how metrics are productive of socioecological outcomes, intended and otherwise. Individually and collectively, the articles in the special issue offer important insights into open questions about the role of metrics in environmental governance. We explore each of these in turn.

How do metrics describe environmental realities?

As a core theme that runs through the four papers, metrics can describe different environmental conditions and describe them differently, contingent on what is measured and how. As Table 1 illustrates, what is being measured is distinct from what is being governed. In effect, metricization is premised on selection of indicators that function as proxies. This selection process is a key site of openness and contestation.

As Brunet (2024) found, when economists were brought in to engage stakeholders' support for conserving the Port-Cros Nature Reserve, the measurement of ecosystem services switched registers. Local Mayors viewed notions of nature (e.g. biodiversity) as abstractions, and they viewed recreational opportunities and job creation as directly beneficial for humans. Through this process, the proponents of the nature reserve, who had been focused on counting species as a way to describe the pertinence of the park, described a new environmental reality filled with people in nature.

This analysis chimes well with the environmental realities described by the Coastal Master Plan in Louisiana. Nost (2024) shows how tinkering with models of sediment diversion can drastically change understanding of which wetlands can be restored. The addition of social and economic indicators to

these models has concrete effects on future environmental realities. The dominant reality, however, is one where the Louisiana Coastal wetlands remain an attractive area for oil and gas exploration. Comparing the cases found in Ghosh (2024) and Demortain (2024), we see how two national regulators describe environmental realities completely differently. While the USDA builds from a positive vision of private actors who are voluntarily stewarding the environment, the EPA emphasizes private actors who cannot be trusted to voluntarily safeguard environmental qualities (Figure 1).

The first two cases mentioned above were attempts to introduce qualitative indicators that transparently calculated interests into the models, while the latter two cases are examples of the quantification of qualitative elements that resulted in obscuring their contexts. In the case of the EPA, Demortain explains that the focus on measuring doses, which are highly context specific, offered the modelers the opportunity to scientize a notion of safety. This was a similar effect in the case of USDA's translation of guidance for training farmers on agronomic practices into a quantified measure (Ghosh, 2024). When legitimizing different descriptions of environmental realities through metrics, policy-making risks gravitating towards simple metrics and indicators that consolidate the positions and policies of the status-quo, along with the actors who uphold it. Ironically, it seems that seeing a diversity of environmental realities can stall meaningful debates about alternate forms of governance.

How do these descriptions value some realities over others?

Brunet's (2024) analysis showed how the quantification of ecosystem services could re-frame the relationship between humans and nature. In his case

Figure 1. Caption: Soil Health Workshop, North Dakota, 2015. ©Ritwick Ghosh 2015.

study, economists worked with conservationists to ensure that the role of nature in the well-being of humans was valued more than the negative impact of humans on the conservation of nature. Indeed, the expansion of the nature conservation area was advanced not as a response to 'eco-anxiety' of environmental scientists, but rather as an outcome of successfully registering the pleasure, hope and health outcomes of people interacting with clean, conserved nature. This case resonates with Nost's (2024) notion of the 'weighted metric', where prioritizing some realities over others was done explicitly. While barge navigation and the historical value of land and buildings were positively weighted, the value of 'support for oil and gas communities' emerged to dominate all restoration objectives.

Indeed, the descriptions of the social construction of the four metrics across the four articles in the special issue highlight 'the specification of what actors interpret as the purpose of the tool and the constraints they are working within to make the tool practically achieve this purpose' (Ghosh, 2024). This is the performative element of how the prioritization of specific values is often a first step in the enactment of those values through actors' attempts to (re)shape their environmental realities.

How do feedback loops between the knowledge used and the knowledge produced through metrics affect actors' trust in the actors who govern the environment?

Generally, across all four cases, the detailed analysis of the knowledge used and produced through metrics revealed a pattern: that reliance upon data-driven governance eroded actors' trust in governance, rather than reinforcing actors' trust in the rules and the actors that govern the environment.

Demortain (2024) explains how a 'regulatory space' formed through the emergence of shared references and common knowledge for actors who were not used to working together. The distribution of expertise among these actors fostered and mediated their interactions. Finally, a network of intermediaries formulated rule-making practices acceptable to the actors who became interdependent in the space. This concept offers the STS community a way to study how the space itself structures relationships and power positions according to the outcomes of trials of credibility, no matter who was responsible for producing the knowledge and associated metrics.

In this case, uncertainty is a judgement about the value and quality of knowledge. Uncertainty and mistrust have thus become fundamental aspects of how metrics for doses govern the regulation of environmental toxins in the US. This analysis rings true also for some of the other cases.

In Ghosh's account, while the USDA did legitimize public spending by invoking metrics, the need to resist political interference in the content of the metrics undermined their integrity and the quality of environmental

stewardship. Indeed, the metrics were used to satisfy the often-conflicting demands of urgency and rigor, but failed to satisfy both. Nost argues that when planners say their decisions are driven by the best available science and data, but also responsive to stakeholders, they are criticized on both accounts.

Coastal modeling is contested precisely because it has opened up more space for explicitly accounting for interests, priorities, and values in decision-making. But not everyone's interests (or data) are equally taken into account, and the fishers, who were negatively affected by the decisions supported by coastal models, asked 'why not our data?'. Greater transparency in the formulation of metrics worked in these cases to increase mistrust in the motivations of the actors who govern the environment.

A slight exception to this rule is Brunet's (2024) story of Port-Cros. He explains how the creative production of knowledge in alternative ways enabled scientists to conduct emotional work and manage the emotions generated by their profession. He argues that scientists invert the logic of political issues in order to produce positive emotions, which are in turn used to facilitate environmental governance. Echoing Beisel and Boëte (2013), Brunet argues that knowledge can reverse and invert the logics used to resolve issues. This opens up new opportunities for trust to be built between stakeholders and the actors who govern the environment.

How do metrics structure relations of accountability?

A range of actors developing, using and promoting metrics invoke them to defend their endeavors to various audiences. Through these 'rhetorical registers of numbers in context' (Jasanoff, 2017), metrics structure relations of accountability. As the papers in this special issue show, however, the number and diversity of actors who are active in rendering accounts and demanding accountability may actually increase the promulgation of metrics used to know and govern the environment.

The case of ecosystem service metrics is one of shifting accountabilities. Conservation scientists originally were trying to counteract decreasing conservation funds and inaction by policy makers by producing more and more quantitative proof of conservation benefits for nature. However, by developing metrics based on perceptions and emotions, they were able to shift the accountability for conservation to local authorities, who in turn became accountable to citizens based on their ability to improve socio-economic well-being in their communities (Brunet, 2024). In this instance, relations based on negativity were transformed into positive and productive relations.

However, in the other three cases, the politics of governing the environment via metrics demonstrates how numbers can foster resistance to these types of accountability shifts. Demortain (2024) claims that uncertainty analysis and auditing are rules that have emerged to respond to a politics of uncertainty

in environmental governance, particularly the regulation of chemical hazards. This combination of metrics and rules for their use frame and further depersonalize calculations, whereas the instrumental and political use of numbers has eroded their presumed objectivity.

This sentiment is echoed in Ghosh's analysis of how the Conservation Stewardship Programme (CSP) tool deflected accountability pressures for more rationalization in public spending and avoided major policy disruption. The inclusion of more actors and transparency in the metric creation process has been a response to these concerns. But as Demortain, Ghosh and Nost all show, this doesn't automatically reduce conflict, or increase the legitimacy of the process. Nost demonstrates quite well how irreconcilable values rub up against attempts to integrate them within metrics. The result is often a metric or tool that doesn't meet the expectations of any of the actors. Thus, the creation of context-specific metrics may be more responsive to ecological conditions, and more accommodating to the local planning apparatus, but less accountable in the long run.

Ghosh provides a rather shocking example of how, despite the increased inclusion of actors within the construction of the metric, none of these actors (farmers, bureaucrats, lawmakers, peer reviewers) could access the model. Instead, the tool was designed for pre-existing accountability structures that governed the bureaucratic relations farmers and public agents awarding subsidies. While the intent of the bureaucrats was to optimize public spending, an effect of the tool was that it eroded accountability. This was particularly the case when we note that the metrics served to reinforce the power relations and hierarchy that they were meant to check (Ghosh, 2024). These results signal a significant limitation to environmental governance through metrics at least when it comes to creating accountability and trust.

How might values be assessed differently?

Nost argues that performances of accountability through metrics fail. He claims that these performances are often unstable and that they are not replicable or scalable. This begs the question as to how values might be assessed and expressed differently, as a means to structure more resilient accountability relations among actors in environmental governance?

Perhaps the best example of assessing value differently is found by Brunet (2024). By developing a 'feel for accountability' through alternative metrics, the scientists provided a demonstration of how knowledge is transformed and adapted to address new concerns, and how knowledge can be used to exercise power through emotions. Critical examination of how actors use (i.e. not only create) metrics and thereby produce knowledge to manage actions and interests is necessary if we are to understand how the politics of value shape governance and environments.

Conclusion

This collection interrogates the relational character of knowledge-power, observation-action, measurement-production, authority-accountability across several domains of environmental metrics, standards, and indicators. We focus on the role of data in governing the environment as data are filtered, standardized, elaborated and interpreted through metrics aimed at different publics. The papers collectively emphasize that the question is seldom as simple as whether or not the right metrics and standards have been chosen for the policy objectives in question. Instead, it is also important to analyse the various effects of metrics in their complex lives (Loconto and Demortain, 2017), including how various actors are aligned in relation to metrics within relational *agencements* of governing. This includes asking how metrics are implicated in the changes of the conjoined social and environmental transformations that they purportedly describe.

In this Introduction, we explored key questions about governing – legitimacy, trust, accountability and values – that built on Desrosières' two dimensions of quantification. The articles demonstrate that the distinction made between convention creation and measurement is blurry. Measurement often demands *ad hoc*, creative judgments, as rules are not in place for all contexts and contingencies. The links connecting mechanical repetition, quantification and objectivity are not always the purpose of measurement, while selectivity, creativity and room to maneuver are part of the realities created through metrics. This changes the valence of objectivity: is mechanical objectivity really achievable through efforts of quantification and metrification?

Moreover, it also has implications for the ways we think about the promulgation of metrics and the search for accountability in regulation. As we learned, although trust may be an important consideration, a key issue is how metrics produce – or fail to produce – stability by closing down contestation and debate. This special issue confirms that accountability, like metrics, is an ambiguous element of governance arrangements (Wolf and Arnold, 2023). Both have potential to mobilize progressive values (e.g. justice, equity, sustainability), but they also have potential to advance values of exploitation, capital accumulation and privilege.

In this special issue we built on the concepts developed in the 2017 special issue entitled 'Counting on Nature' in an important way. There Whitney and Kiechle (2017) explored the quantification of nature (cf. Höhler and Ziegler, 2010) by trying to understand 'who quantifies, and to what purpose?' The authors of that special issue were concerned with the ways in which the quantification of nature empowered different actors to assert their authority in ways that could challenge or reinforce older regimes of power. The ideas of embodied values (Besky, 2017), political narratives (Brooks, 2017), and

different means to envision future alternatives (Hébert and Brock, 2017; Kinchy, 2017) offer a starting point for empirically exploring Law and Mol's (1998) notion of performativity. Their focus was on 'the division between metrification and narration on the one hand and that which cannot be counted or told on the other.'

In other words, counting and being counted are closely linked to the stories that we tell about why we count and what we count. They distinguish between that which is (ac)countable and that which is fluid in order to argue that there is deliberate work carried out by actors to create the division between the two. As we argue, this division is something that must necessarily be engaged by actors in order to organize and manage the environment.

Metrics have emerged as the preferred tool of managing that division because of their own fluid nature: the same metric can be applied to numerous contexts. This dominance has served to entrench the *status quo* of a market-based neoliberal approach to environmental governance (Lockie, 2020). At the same time, however, metrics can pose challenges to privileged ways of knowing and ways of calling actors to account (Rajão, 2013). These tensions changing how we govern the environment.

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