Sensing Reality? New Monitoring Technologies for Global Sustainability Standards

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Abstract

In the 1990s, civil society organizations partnered with business to "green" global supply chains by setting up formal sustainability standard-setting organizations (SSOs) in sectors including organic food, fair trade, forestry, and fisheries. Although SSOs have withstood the long-standing allegations that they are unnecessary, costly, nondemocratic, and trade-distorting, they must now respond to a new challenge, arising from recent developments in technology. Conceived in the pre-Internet era, SSOs are discovering that verification systems that utilize annual, expert-led, low-tech field audits are under pressure from new information and communication technologies that collect, aggregate, interpret, and display open-source "Big Data" in almost real time. Drawing on the concept of governmentality and on interviews with experts in sustainability certification and natural capital accounting, we argue that while these technological developments offer many positive opportunities, they also enable competing alternatives to the prevailing "truth" or governing rationality about what is happening "on the ground," which is of critical existential importance to SSOs as guarantors of trust in claims about sustainable production. While SSOs are not helpless in the face of this challenge, we conclude that they will need to do more than take incremental action: rather, they should respond actively to the disintermediation challenge from new virtual monitoring technologies if they are to remain relevant in the coming decade.

In the 1990s a new institutional form of environmental governance emerged, in the shape of sustainability standard-setting organizations (SSOs). Pioneered by the organic, fair trade, and sustainable forestry movements, these first-generation SSOs developed multistakeholder standards that interested companies could voluntarily adopt to become certified. Certification typically involves a third-party audit by a qualified and accredited certification body, which assesses compliance

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with the standard, identifies corrective actions to rectify nonconformities, and issues certificates of compliance once it is satisfied that the standard has been met. On obtaining certification, companies can apply to utilize the SSO's logo on products to signal to consumers that the products have been "responsibly" or "sustainably" produced.

Academic interest in these new, private environmental governance arrangements has been widespread, with scholars analyzing how individual systems operate, their institutional form, and their legitimacy, effectiveness, and transparency (see, e.g., Auld and Gulbrandsen 2010; Bartley 2007; Cashore et al. 2004; Gale and Haward 2011; Gulbrandsen 2010; Gupta 2010; Meidinger et al. 2002; Tollefson et al. 2008). As SSOs became established and began to exert market influence, competitor schemes emerged in some sectors, and new schemes in others. For example, following the establishment of the multi-stakeholder Forest Stewardship Council (FSC) in 1993, the forest industry evolved a competitor scheme, establishing the umbrella Programme for the Endorsement of Forest Certification (PEFC) in 1999 to unite the large number of national forest certification schemes that had emerged in the intervening years. Meanwhile, increasing controversy over the production of such commodities as palm oil, soy, biofuels, and farmed fish saw second-generation schemes emerge in the 2000s, including the Roundtable on Sustainable Palm Oil (RSPO), the 4C Association for coffee, and the Aquaculture Stewardship Council (ASC). Globally, standard-compliant commodity production grew by 41 percent in 2012, far exceeding the corresponding conventional-commodity market growth of 2 percent, and market penetration is now significant—for example, 40 percent of global production for coffee, 22 percent for cocoa, and 15 percent for palm oil (Potts et al. 2014, 8).

The rise of sustainability SSOs has taken place despite many theoretical, practical, and political challenges, linked to concerns about the feasibility of global environmental governance, the practicality of supply-chain monitoring, and the legitimacy of civil society involvement, among other issues. Although SSOs have demonstrated a remarkable capacity to adapt, they now face a new challenge, in the form of recent technological developments. A revolution in information and communication technologies (ICT), combined with "Big Data" analytics (Kitchin 2014), is enabling information from remote, aerial, and terrestrial sensors to be collected and aggregated for almost real-time display on sophisticated, open-source Web platforms like Global Forest Watch, SkyTruth, Oceana, and Global Fishing Watch.[1] The timeliness, volume, integration, and openness of the information provided by such "virtual" monitoring platforms challenges the static, limited, and closed "analog" model of auditing conventionally employed by SSOs, based on brief, intermittent field visits by small expert teams. While new technologies have the potential to improve both

1. Respectively, http://www.globalforestwatch.org/, http://skytruth.org/, http://oceana.org/, and http://globalfishingwatch.org/ (accessed May 13, 2016).

the mechanics and performance of private regulation by SSOs (Auld et al. 2010), the provision of direct, continuous, real-time information threatens to undermine the relevance of SSOs and their auditors as intermediaries guaranteeing the reliability of sustainability claims to consumers. There is an urgent need for SSOs to recognize and respond to this challenge, because the pace at which technological changes "shape the realm of the possible" (Lövbrand and Stripple 2009, 20) is extremely rapid. Drawing on interview data from key informants working in the field, we suggest that SSOs should embrace the potential for virtual monitoring to enhance transparency and consumer trust in sustainability claims. This would enable a shift from routine, low-tech, and costly field audits to more strategic audits to investigate cases of possible noncompliance. A new audit function, designed to assure stakeholders that any given virtual monitoring platform is in fact a fair representation of reality, would be required, but the costs could be spread over many users, and potentially across multiple standards. However, achieving these synergies will require closer cooperation between SSOs on the development of metagovernance standards.

This article is organized as follows: in the next section, we discuss the concept of governmentality as a theoretical framework for making sense of the various ways in which technologies enable SSOs to perform the work of environmental governance. We then apply this framework in the next two sections to analyze the challenges posed by new virtual monitoring technologies, drawing on interviews with experts in sustainability certification and natural capital accounting. In our conclusions, we summarize the technological challenges that SSOs face and outline possible responses, as well as directions for further research to better understand and address these challenges.

Governmentality and Technology

The term "governmentality" is closely associated with the work of Michel Foucault, who first used it in his lectures on government at the Collège de France in 1978 and 1979, although prior uses—for example, by Roland Barthes—have been acknowledged (Lemke 2007). Foucault's own multistranded definition (Foucault 1991, 102–103) has been taken in various directions by subsequent scholars. For our purposes, we adopt Dean's (1999) interpretation of governmentality as an analytics of government—the *thinking* (rationalities or mentalities) involved in *practices* of government in its most general sense, having to do with how we govern and are governed, whether at the level of the individual, the community, the state, or any other relevant field. This is distinct from the term's use in historical analysis to identify particular eras or modes of government, a second meaning identified by Dean (1999, 16), Oels (2005), and others. We include in our understanding of the term how we govern (and are governed by) the environment (Agrawal 2005; Oels 2005; Okereke et al. 2009; Stripple and Bulkeley 2013). "Government" in this sense can be regarded as sharing a family resemblance with the term "governance," because neither presupposes that government is limited to the exercise of power by the state. However, most "governance" research is oriented towards its political, institutional, and regulatory dimensions (Jordan et al. 2005; Tollefson et al. 2012), whereas our focus is on the rationalities that underpin it, as revealed through practice.

Foregrounding the rationalities or mentalities involved in practices of government is useful because it provides a conceptual link between the intangible ways in which we perceive, describe, and interpret the world, and the ways in which we act upon the world, and are in turn acted upon, through tangible practices and technologies. In this article we are particularly interested in exploring the connections between intangible *rationalities* and tangible *technologies*; we use the latter term in both a narrow sense, to refer to specific technical artifacts such as sensors or software, and in the broader sense of the many ways in which "society [is] made durable" (Latour 1990, 103). This broader sense is implicit in the distinction drawn by Miller and Rose (2008) between the "rationalities" and "technologies" of government: "'Rationalities of government' refers to the collective and taken for granted body of knowledge and styles of thinking that render aspects of reality thinkable and governable.… 'Technologies of government' in turn refers to the vast assemblage of techniques, devices, tools, instruments, materials and apparatuses that render rationalities operable" (Lövbrand and Stripple 2013, 32–33). In this broader sense, technologies may include nonmaterial elements that are nonetheless "out there" shaping, and shaped by, social relationships. Latour (2014, 508), after MacKenzie (2001), argues that "forms, format, instructions, softwares, and standards are active in the world and are just as 'material' as eel traps or cars.… 'Technical' is an adjective that is able to resonate with any layer of what I hesitate to call materiality: songs as well as wood, noise as well as steel, narratives as well as fences." From this perspective, voluntary standards can therefore be seen as a technology of governance, expressing a particular rationality about how the environment should be governed.

Both rationalities and technologies of government are, by virtue of being deeply ingrained in everyday life, capable of being at the same time out in the open and easily overlooked. As Dean (1999, 16) observes, "The idea of mentalities of government … emphasizes the way in which the thinking involved in practices of government is explicit and embedded in language and other technical instruments but is also relatively taken for granted, i.e. it is not usually open to questioning by its practitioners." Furthermore, "The analysis of government is concerned with thought as it becomes linked to and is embedded in technical means for the shaping and reshaping of conduct and in practices and institutions. *Thus to analyse mentalities of government is to analyse thought made practical and technical*" (Dean 1999, 18, emphasis added).

Governmentality as a theoretical lens has been extensively applied to the study of standards as a technology of governance in general (see, e.g., Higgins and Larner 2010; Ponte et al. 2011; Timmermans and Epstein 2010), as well as to studies of climate governance at different levels (e.g. Bäckstrand and Lövbrand 2006; Okereke et al. 2009; Stripple and Bulkeley 2013) and to the intersection between climate and forest governance (Astuti and McGregor 2015; Boer 2013; McGregor et al. 2015). Governmentality approaches can also be found in studies of specific voluntary sustainability standards in areas such as water (Vos and Boelens 2014), biofuels (Ponte 2014), fisheries (Ponte and Cheyns 2013), and palm oil (Djama et al. 2011; Ponte and Cheyns 2013). In focusing on the broader level of SSOs in general, our analysis builds on and is distinguished from these more specific case studies.

The role of technology in voluntary sustainability standards is under-researched. The one study that directly addresses the topic, by comparing the use of technology in general (including but not restricted to ICT) in fourteen schemes across forestry, fisheries, coffee, and climate mitigation standards (Auld et al. 2010), does not take a governmentality approach. Nevertheless, that study argues that technological innovations have rationality implications, shaping how we think about global problems and their solutions. Auld et al. conclude that new technologies largely complement existing SSO activities, benefiting especially those with narrowly defined goals (e.g., a focus on product legality rather than sustainability). In our analysis, which is more narrowly focused on ICT innovations, we find both positive potential and more-fundamental challenges to the rationality of the current SSO governance apparatus. Nevertheless, we describe some ways forward that, if pursued proactively, would allow SSOs not only to maintain their relevance, but potentially to increase take-up and encourage the pursuit of wider rather than more narrowly defined goals in future.

The present study draws broadly on a set of twenty-six interviews conducted with key experts in fields such as forestry, fisheries, water and carbon certification, and natural capital accounting during the course of a twenty-month research project on the political economy of natural capital, plus insights from around thirty invited experts (only six of whom had previously been interviewed) at a two-day international workshop held in February 2016, on the role of environmental "Big Data" in natural capital accounting. Seven of these interviewees—three with extensive backgrounds in forest, water, and carbon accounting, two in natural capital accounting, and two in financial accounting—provided empirical evidence of particular relevance to the present study.[2] Each was selected because of work done at the interface of certification, accounting, auditing, and new monitoring technologies. The interviews were semistructured, with questions designed to encourage discussion about the current and the potential future role of new monitoring technologies in each expert's area of practice. The interviews were transcribed, and emergent themes were identified using "holistic" coding (Saldana 2009). In the next section, we draw on this empirical material, as well as on a review of both academic and broader literatures that was undertaken as part of the project, to unpack the effects of emerging

2. Due to space constraints, only five have been directly cited in this article.

monitoring technologies on SSO practices and the challenges they pose to SSOs as a form of private environmental governance.

The Evolution of Sustainability Standards

The turn to sustainability standards forms only a recent chapter in the long history of standard-setting. Standards for weights, measures, and time have been around since the dawn of civilization (Perry 1955). The modern development of product standards dates back to the Industrial Revolution and was initially driven by crises in critical areas such as safety and interoperability. The first national-level product standards organization, the Engineering Standards Committee, was established in the UK in 1901, eventually becoming known as the British Standards Institution (BSI).[3] Other national-level standards organizations were established over the next couple of decades. In the postwar period, increased concern within governments and industry over the potentially trade-restrictive nature of national standards led to the establishment of the International Organization for Standardization (ISO) in 1947. Today the ISO has major responsibility for coordinating international product standards development.

In the 1970s, civil society organizations with a more activist agenda on social and environmental issues began using the model of national and international standards to promote sustainability by rewarding best-in-class products or behaviors, employing a label or logo to identify them to consumers. One of the earliest examples was the organic movement, which established the International Federation of Organic Agriculture Movements (IFOAM) in 1972. Today, IFOAM unites over two million producers in 170 countries through its 800-plus affiliated member organizations (FiBL 2016). Another early, activist-led SSO to emerge from the 1960s was the Alternative Trading Organisation (ATO) movement. ATOs eliminated middlemen in the supply chain and directly linked Third World producers to First World consumers, enabling the payment of a "fair" price premium. As the number and sizes of ATOs expanded, concern developed regarding the diversity of standards in use and the price premiums being applied. In 1988, the Dutch group Max Havelaar established a widely used standard and a label that in 1997 became administered by the Fairtrade Labelling Organizations International (FLO), now Fairtrade International.[4]

From these early beginnings, voluntary environmental SSOs rose to prominence in the 1990s, in part due to the failure of governments to provide adequate regulation of various environmental problems in the face of growing public demands. Most voluntary environmental SSOs adopted the same broad "technologies of governance" as their national and international product SSO equivalents: a set of requirements written up in a published standard; a process

3. British Standards Institution, http://www.bsigroup.com/en-GB/about-bsi/our-history/ (accessed April 12, 2016).
4. Fairtrade International remains popularly referred to as FLO.

for recognition (accreditation) of approved third-party auditors; and a process for assessing compliance with the standard, usually via an annual field visit by an approved auditor, followed by the issuance of audit reports and compliance statements or certificates. The use of technology in this governance apparatus has traditionally been quite limited, typically relying on visual inspection, questioning, and spot-sampling of data, with more technical analysis such as laboratory tests usually being undertaken by third parties and accepted on the basis of written reports or certificates.

Through the enactment of this governance apparatus, SSOs aimed to provide a definitive and transparent account of what was happening "on the ground" in forests, fisheries, agriculture, and other commodity sectors, this "truth" being inscribed in audit reports and compliance certificates, and publicized via an SSO's logo. SSOs' claims to be the arbiters of this "truth" were of course challenged by both internal and external actors, the former leading to the establishment of increasingly robust dispute resolution and appeals procedures within SSOs, and the latter, either to the cooptation of divergent interests or, where that failed, to the emergence of competing standards such as the PEFC scheme in forestry and the Worldwide Responsible Apparel Scheme (WRAP) in textiles.[5] However, these challenges were not directed at SSOs' technologies of governance per se, but at perceived failures in standards' development, firm compliance, or auditor interpretation. Efforts to improve performance across each of these components, coupled with the establishment of metagovernance institutions like the ISEAL Alliance, have until now insulated SSOs from more fundamental challenges to the very nature of their "truth" claims. However, as we discuss in the next section, by enabling the public, real-time depiction of a multiperspectival, integrated virtual "reality," new sensor and Big Data technologies are demonstrating the capacity to provide an alternative—and often far more compelling—account of the "truth" about the sustainability status of resources. This capacity of the new virtual monitoring technologies to disintermediate the audit function is challenging the very *raison d'être* of SSOs, and we argue that they need to respond to this challenge in a more than incremental fashion.

New Technologies and Disintermediation

ICT-induced disintermediation—the removal of intermediaries in a supply chain due to new flows and arrangements of information—is having profound effects across society, fundamentally altering long-established business models in sectors as diverse as media, entertainment, procurement, and education (Porter and Heppelmann 2014). A governmentality approach helps in understanding how new technologies have the agency to disrupt established ways of thinking, across many fields. SSOs, and the standards they uphold, are key intermediaries

5. WRAP was set up in response to the 1996/1999 establishment of the NGO-backed Apparel Industry Partnership/Fair Labor Association (Bartley 2007).

in the supply chain of an intangible quality: trust in a certain claim about a product, from its origins with primary producers to the end consumer. Yet they have only recently begun to consider the implications of ICT innovations for standards systems. The ISEAL Alliance, a group of twenty-one multistakeholder sustainability SSOs, recently commissioned a consultancy to explore this issue, which concluded that "While the corporate world has learned to integrate data flows across global supply chains, most standards systems are lagging behind" (Herding and Fischer 2015, 3). The report characterizes the challenge posed by technology in the following terms:

> Most of the sustainability standards as we know them have developed over the past two decades; their requirements were refined through continuous stakeholder engagement. However, the underlying certification process nowadays remains remarkably similar to 20 years ago: an expert auditor visits a certificate holder about once a year and completes a checklist.... Sending auditors to a client, perhaps to a coffee farmer in a remote tropical mountain region or to a salmon farm in a sub-arctic fjord, is expensive, and often the only information that remains from this visit is a simple checkbox that says compliant/non-compliant. (Herding and Fischer 2015, 5)

This view was confirmed in our interviews with auditing experts. For example, one commented: "I think that the way that we are framing our work on ... the certification side of standard systems, is that essentially we have been working in an analog model. Audit teams going into the field and collecting data has inherent limitations because it's one-off, it's time limited, it depends on the competence of the individuals, etc."[6] Another, noting the "potentially revolutionary" implications of remote sensing, stated that:

> The thing to remember is that right at the moment the standards as they are written don't anticipate this sort of thing.... And so to expect them [the audits] to then use remote sensing data, which is a completely hands-off approach, would lead to a fundamental change in the way in which the indicators accept or don't accept remote sensing data.[7]

A third interviewee observed that the "truth" of a conventional audit depends to a considerable extent on unanalyzed, static company data:

> With forest management, the audit is very much focused on management systems and processes.... The actual data collection of outcome and output is very limited, and whatever the forest manager says, as long as it looks reasonable, it's taken as agreed. You know, you are trying to audit 100,000 hectares in a week. The reality of you seeing anything on site is very, very limited. So you're very much reliant on the forest manager producing a map, or you produce a map, and the forest manager says, "This is what we've harvested.

6. Personal interview A2, July 29, 2015.
7. Personal interview A3, July 30, 2015.

> This is what we've restocked. Here are some timber figures." And that's pretty much trusted—99.9 percent of the time that's taken as correct.[8]

Currently, assessing compliance against a standard is labor intensive: in the forestry sector, for example, depending on the complexity of the standard and the size and readiness of an operation, an audit can involve a team of three or four experts and take up to ten working days (see, e.g., ForestEthics 2014, comparing forestry audits). While some auditing companies are utilizing portable electronic devices to collect data, our interviews indicated that most continue to use paper-based checklists, resulting in inaccuracies and delays in interpreting and representing the information. Clear opportunities therefore exist to make auditing more efficient, from the deployment of smartphones and tablets linked to auditor databases, to directly recording operator performance. From the ISEAL Alliance report's perspective, the major problem confronting SSOs is to work out how to utilize new technology to more efficiently deliver audit services. The more fundamental threat of disintermediation is acknowledged at less length: "multi-stakeholder standards systems need to provide faster and easier access to data about the state of certified companies, *or they are destined to lose relevance in the dialogue on how our society defines and assesses sustainability*. Ignore technology innovation at your own risk" (Herding and Fischer 2015, 6, emphasis added).

Our research suggests that new technology poses a fundamental challenge to SSOs, due to its ability to provide alternative accounts of the prevailing "truth" or governing rationality about what is happening "on the ground," at the origins of product supply chains—accounts that are not necessarily mediated by SSOs themselves. New technologies appear to offer a completely different approach to creating transparency by gathering, integrating, analyzing, and sharing vast quantities of data. On the input side, a range of established and new technologies linked to remote, aerial, and terrestrial sensors is enabling much more accurate data to be collected about terrestrial and aquatic ecosystems and the human-nature interactions occurring within them. Although remote sensing technology has been in use for the past thirty years and has delivered increasingly accurate and timely information regarding landscape change, new high-powered digital cameras linked to the deployment of mini-satellites are producing even better-quality images from more-frequent orbits of the earth. Such images can be made even more precise if they are supplemented with data from aerial sensors carried on drones that undertake low-altitude flights across regions of interest. These data can be further supplemented by the deployment of fixed and mobile sensors and other inputs to provide precise information on matters of interest such as tree species, biodiversity counts, illegal logging and fishing, or the boundaries of indigenous peoples' lands and customary rights.

8. Personal interview A1, June 27, 2015.

These new technologies are already being deployed by a variety of different actors, to different ends. For example, forest managers are now able to carry out precision forestry, where the "characteristics of forests and treatments can be determined accurately at stand, sub-stand or individual tree level" using a combination of airborne laser technology and terrestrial sensors (Holopainen et al. 2014, 1691). Sensors embedded in harvesting and logging equipment could supplement these field measurements, "providing both more inexpensive and detailed ground truth" (Holopainen et al. 2014, 1688). From this perspective, new technologies primarily serve the economic rationality of the commercial forest owner, although they may also mitigate environmental impacts. Other actors, however, are using similar technologies in quite different ways, to carry out "citizen science"—thus democratizing scientific "truth" about matters such as biodiversity and air and water quality. For example, the UK Government's GB Non-Native Species Secretariat encourages the public monitoring of invasive species, noting that "Everyone can provide useful biological records of non-native species, and with the development of online recording sites and smartphone apps it is now easier than ever" (DEFRA 2016). Another example of citizen science is Global Forest Watch, an online platform operated by the World Resources Institute (WRI), presenting forest data from multiple sources in a user-friendly open framework. Not only can interested parties use the site to review what is occurring with regard to deforestation and degradation in any given region, but they can also create customized forest maps—a discursively powerful device, as Google, a partner in the platform, expresses:

> Previously, the data required to make these maps was difficult to obtain and interpret, and most people lacked the resources necessary to access, view, and analyze the information. With Global Forest Watch, this data is now open to anyone with Internet access. We encourage you to visit Global Forest Watch and make your own forest map. There are many stories to tell about what is happening to forests around the world—and your stories can lead to action to protect these special and threatened places. What story will you tell?[9]

Similar technologies are being used in community-mapping projects to assist indigenous peoples and local communities to assert rights to their lands and protect them from outside interference. Bradley and Pullar (2015) describe a new tool developed by the United Nations Food and Agriculture Organization (FAO) called Open Tenure, which utilizes handheld tablets using open-source software linked to a cloud-based server to enable "local communities in many countries to easily record and have their tenure rights recognized at the *community level*. This recognition is distinct from formal recognition of tenure or titling by government authorities, and focuses instead on satisfying the community's own desire to better govern its natural resources" (p. 1). Further examples of the

9. https://maps.googleblog.com/2014/02/monitoring-worlds-forests-with-global.html (accessed May 13, 2016).

use of community-mapping apps can be found in a recent report for the World Bank's Program on Forestry (PROFOR) by Castrén and Pillai (2011, 41–48).

Our interviewees recognized the capacity of the new technology to provide an account of the "truth" that is alternative to that contained in a formal audit report. One expert commented: "So the standards are going to have to change to accept the technology, but that technology is way ahead, absolutely way ahead, in terms of what it can do. And it's being used by people to say: 'Well the audit's not right, and here's our reasons why.'"[10] Another observed how the use of sensor technology could alter perceptions about an industry's effects on the environment:

> Even though we're 80% FSC certified … the NGOs tend to look back at 1980s forest practices and go, look at what you did 30 years ago. Whereas if we were able to say: "Hang on guys. Look, this is the quality of the water that's coming out of our forest—you compare that to what's coming out of your adjacent farmland. We've been monitoring CO_2 for the last ten years, we've stored X amount of CO_2."[11]

In summary, new technologies pose both practical and existential challenges for SSOs. At the practical level, the challenge is to adapt existing processes to make use of new opportunities, thus maintaining the relevance of SSOs and potentially increasing market coverage by decreasing the costs of compliance audits, reducing the time taken to access information, and improving the quality and quantity of that information. A good example of this is FSC's recently launched TransparentForests project, which seeks to harness new sensor technology—especially remote satellite sensing—to improve forest audits. The project, implemented in conjunction with the European Space Agency's Telecommunications and Integrated Applications Directorate, aims to provide "greater transparency for all stakeholders, improve the reliability of the inspection process, enable further expansion in certified areas without associated risks *and improve the credibility of FSC certificates issued*" (ESA-ARTES 2016, emphasis added). Utilizing a combination of satellite and in situ data, the project will enable certification bodies to overlay site-specific information about a forest operation with up to nine different land classifications derived from satellite data, and to chart trends in land use change since the last certification audit. This project illustrates an incremental, assimilative approach to the challenge, where the underlying assumption is that the "truth" as revealed by remote sensing will be complementary to that of conventional audits, with the role of the former being to improve the timeliness, accuracy, and transparency of the latter.

However, ICT transformation is likely to extend beyond the mere digitizing of the conventional audit process. The emergence of sensors, digital databases, and visualization technology now creates the possibility for auditors to

10. Personal interview A3, July 30, 2015.
11. Personal interview A1, June 27, 2015.

establish continuous virtual depictions of their clients' operations, rather than one-off snapshots. A logical extension of this idea is for all relevant data to be collated in a publicly available and easy-to-interpret database that would be continuously updated with information generated from multiple sensors as well as inputs from the operator, communities, and other stakeholders—as is already the case with Global Forest Watch, Global Fishing Watch, and other similar platforms. This raises questions about whether the annual snapshot certification audit remains relevant in such a model, since more transparent publicly available information could be regularly scrutinized for accuracy by many different groups, potentially ensuring a far more comprehensive and accurate account of the structure, operation, and accountability of the relevant activity than is currently on offer. One interviewee speculated about how this might change the role of the certification body (CB):

> All these audit processes have stakeholder input which at the moment goes via emails and letters, but lots could be like TripAdvisor.... [A person walking in a forest] may think, "Why are they cutting these trees here in April now? People shouldn't do that." And then somebody would say, "Under our forest management standard you cannot harvest trees in spring and we should follow up on this." And now the CB could be ... receiving all of this information, and there would be some defined processes about what the CB would have to do with it.[12]

Another interviewee envisaged the new sensor technology *replacing* the routine audit, making certification more attractive by reducing direct costs. In this expert's view, the full and more costly on-site audit would be reserved for those operations the data indicated were experiencing difficulties:

> The way we would like to move forward ... is to see multiple sources of information as a basis for triangulating where the most significant risks are to compliance or to impact—environmental and social impact—within an enterprise, in order to focus both where subsequent interventions, like an audit, might be needed, or even capacity building.... Then that shifts the emphasis away from the audit as a main compliance tool, to be a supplementary or deeper-level tool where needed.[13]

A third interviewee was more cautious, however:

> Well, to my knowledge this is all still more relevant for the scientific world. Talking about drones, it's a nice tool, but as a forester I wouldn't actually know how to use them because a normal drone can only fly 300 m.... At the moment I would say that the combination of technologies and satellite data together with on-the-ground auditing, these combinations, they're still most valuable.[14]

12. Personal interview A4, September 1, 2015.
13. Personal interview A2, July 29, 2015.
14. Personal interview A5, September 1, 2015.

Technological disintermediation may be as empowering as it is threatening, depending on how it is exercised, by which actors, to what ends, and according to whose perspective. On balance, it would appear to help empower previously marginalized actors—both people and "nature"—at the origin of the supply chain. It creates the possibility for greater transparency, enabling nature as well as indigenous and local community perceptions and values to be seen and heard continuously, rather than intermittently at best. However, it could also be regarded as enabling these margins of society to be brought under new regimes of panoptic surveillance and control. While open data platforms may democratize access to information, this always comes with a risk of cooptation by more powerful vested interests, as this interviewee noted:

> Scheme owners so far have been very hesitant in terms of innovations, but I think we sense a great sense of urgency. If they don't start moving now, retailers and banks just may replace auditing by sensor data and will say, "That's good enough and we get the data quicker; we don't need this cumbersome third party approach with all the stakeholders and on-site audits."[15]

Either way, the risk for SSOs is that their version of the "truth" about product sustainability claims will no longer be seen as relevant, as both business and civil society stakeholders use new technologies to construct their own competing "truths."

Conclusions

SSOs face a new challenge to the governance model that has prevailed over the past four decades: the emergence of new technologies that threaten SSOs' relevance by uniting previously distant actors in a process of information supply chain disintermediation, simultaneously facilitating transparency while enabling the construction of competing "truths" regarding product sustainability claims.

How well SSOs adapt to this technological challenge will depend on how quickly they recognize and respond to it. SSOs have a history of successfully adapting to many past challenges. Criticisms by developing countries that such schemes could act as technical barriers to trade or that they reference practices and technologies that are unavailable or inappropriate in a developing-country context (see, e.g., UNCTAD 2008) were addressed by increasing developing-country participation in many SSOs. Ongoing civil society criticism of the Marine Stewardship Council's failure to fully consider the environmental and social impacts of fishing on marine ecosystems resulted in a range of important governance reforms in the early 2000s (Gale and Haward 2011; Gulbrandsen and Auld 2016). The proliferation of SSOs has also resulted in greater attention

15. Personal interview A4, September 1, 2015.

to "metagovernance" aimed to ensure a degree of conformity in the structures and operations of SSOs, through the establishment of the ISEAL Alliance and the development of system-wide credibility standards (Derkx and Glasbergen 2014; ISEAL Alliance 2013). The evidence suggests that SSOs are becoming aware of the new technological threats and opportunities they face, and are taking some actions, both individually and collectively, to respond. For example, the ISEAL Alliance has commissioned reports and held workshops to raise awareness across the sector about the implications of the digital revolution, and FSC is developing its TransparentForests platform. However, the current view appears to be that SSOs should proceed with cautious and incremental reforms to embrace new technologies: SSOs that adopt a "step-by-step improvement process [will] benefit from increased effectiveness and overall satisfaction, and can reduce the risk associated with technology investments" (Herding and Fischer 2015, 3).

We consider that SSOs may need to undertake a more fundamental shift in their role. It is clear that new technologies are enabling stakeholders to directly "see" what is happening on the ground—as opposed to simply trusting in the relatively obscure standard-setting and audit processes behind an ecolabel. A governmentality perspective suggests that rationalities of government render certain aspects of reality thinkable, and therefore governable through the application of various technologies (Lövbrand and Stripple 2013). However, the scope of what is governable in practice, ex-post, is limited by the technical abilities of currently available technologies, the awareness of which in turn tends to limit the scope of what is ex-ante thinkable. Therefore a substantial change in technical abilities, such as the Big Data revolution of the last five years or so (Kitchin 2014), in rendering aspects of the environment visible in new ways, also changes the scope of what is thinkable about how environmental resources can and should be governed. As Auld et al. (2010, 21) observe: "technology shapes the art of 'what is possible' to be certified using NSMD [nonstate, market-driven] mechanisms," by influencing our understanding of both the underlying problems and available solutions.

Ignoring this shift in thinking is a risky strategy. We believe there is an opportunity for SSOs, rather than adopting only incremental changes, to take a proactive approach to utilizing new technologies, and thus to reconceive the purpose and practices of the entire governance apparatus. This reevaluation should focus, in particular, on the audit function. It is worth recalling the assumed "problem" the audit function was designed to solve: in a world of increasingly long and complex global supply chains, consumers are distanced from the social and environmental impacts of production, and therefore have to rely on claims made by supply chain actors. The SSO audit function was designed to independently assess the information on which those claims were based, to enable consumers to trust that the requirements of the relevant standard had been met. Judging by the growth in consumer take-up of ecolabels, it has succeeded—up to now.

This "solution," however, is premised on the assumption of a lack of transparency regarding what is happening "on the ground," at the production end of the supply chain. New technologies, as we have discussed, can radically change this state of affairs. The means of ensuring trust in product claims that SSOs have relied on—the annual, expert-led, time-bound, backward-looking, data-deficient field audit—looks increasingly anachronistic in comparison with the potential for continuous, participatory, just-in-time, data-rich virtual monitoring platforms that can publicly display the current status of actions or impacts almost in real time. Such platforms are being developed independently of SSOs and will inevitably be used by both consumers and supply chain actors to support and/or contest sustainability claims. Rather than risk being crowded out by new, competing claims based on independent use of social and environmental data, SSOs should embrace these new virtual monitoring platforms to enhance consumer trust in claims that are in accordance with their own standards. FSC appears to be the first major SSO to take a significant step in this direction, in developing TransparentForests.

Taking up the possibilities offered by new technologies will of course create new problems, requiring new solutions to be developed. We can see two new problems that are likely to arise, where the existing audit apparatus could potentially be usefully redeployed. The first relates to instances of possible nonconformity with a particular claim: for example, when the virtual monitoring platforms indicate logging taking place in high-conservation-value forests, fishing in marine protected areas, or fires in carbon offset plantations. In such cases, SSOs could request an immediate strategic audit of the incident as a means to determine what has occurred and remedy any defects. This would require competencies similar to those used in existing routine, annual audits, but apply them in a different way. The second problem will be more challenging: there will be a need to assure all relevant stakeholders that any given virtual monitoring platform is in fact a transparent representation of reality. This will require a technical audit of the entire information supply chain, from data collection through processing to presentation. Although this would require different expertise from that currently found in most environmental audit teams, the necessary capabilities should be available in the ICT audit community.

The abandonment of the annual audit and shift to strategic and data infrastructure audits have the potential to reduce the overall cost of certification, provided that nonconformities do not substantially increase and that the data infrastructure is shared between a reasonably large number of users. This, in turn, could encourage higher participation, especially by small- and medium-sized operators, for whom the costs of the traditional annual certification audit are large in comparison to turnover. A further possibility offered by virtual platforms is that of hosting data pertaining to multiple purposes. There are some indications that this is happening already—for example, Google Earth's engine is being used as the basis for applications ranging from biodiversity tracking to malaria risk mapping, in addition to supporting Global Forest Watch.[16] If it continues, this trend has the potential to offset the factors that currently favor more modest standards that are crafted around narrow issues such as legality verification (Auld et al. 2010). The capacity of new virtual monitoring platforms to aggregate different types of data from many disparate sources and then to present only those issues of interest to different stakeholders may eventually constitute their greatest value added.

This, in turn, suggests that SSOs should cooperate more closely—for example, through initiatives such as the ISEAL Alliance—to develop metagovernance standards for the collection, processing, and presentation of environmental data via direct-to-consumer virtual monitoring platforms. The emphasis of these metagovernance standards would be to ensure that consumers are able to rely on the information presented across different platforms, whether they wish to make use of it to assess environmental sustainability, indigenous peoples' tenure, natural-capital impacts, or other objectives. There may also be a need for governments or international SSOs to take a more active role in supporting such standards, in recognition of the fact that such platforms evidently provide a public good, in the form of information that stakeholders find useful and that is not provided by unregulated markets. A number of supportive voluntary and intergovernmental efforts are already underway (see Potts et al. 2014, 324). Further research could explore these opportunities, or seek to establish an evidence base for any emerging differences between established voluntary sustainability standards and new virtual monitoring platforms in terms of their impacts on both producers and consumers. From a more theoretical perspective, detailed case studies of some of the specific ICT innovations mentioned in this article could improve our understanding of how such technologies "shape the realm of the possible" (Lövbrand and Stripple 2009, 20) in terms of environmental governmentality. Although technological disintermediation is undoubtedly a threat to the status quo, adapting and using it proactively also has enormous positive potential.

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