Responsible Standardisation for a Grand Challenge? Differences across Approaches to Sequestering Carbon in Soil

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DOI 10.3217/978-3-85125-976-6-05

Abstract. As technologies and societies change, so too do standardisation processes. And in a world more digitally-mediated than ever, acknowledging the voices of technology users and downstream publics relative to decisions about features and capabilities of technologies is imperative (de Vries *et al.* 2018; Jakobs 2019). This shift can be supported by "out-of-the-box" thinking in two ways: 1) leveraging theoretical insights from disciplines beyond those focused directly on technological standardisation (de Vries *et al.* 2018), and 2) examining extreme cases highlighting the *de facto* standardisation processes that occur socially and which complement the more formalized processes of standardising specific technological innovations.

This research uses both strategies: it leverages institutional perspectives from social science and examines *de facto* standardisation processes of diverse approaches to a societal grand challenge. The paper summarizes findings from a preliminary investigation into how different sets of stakeholders are mitigating climate change through varied approaches to soil-based sequestering of carbon. Heuristic case analysis (Vaughan 1992) highlight institutional processes of legitimation and diffusion comprising *de facto* standardisation processes that complement more formalized processes of standards bodies and organisations. Theoretical and practical implications are discussed.

Keywords: Responsible standardisation; Stakeholders; Legitimation; Diffusion; Carbon Sequestration

1 Introduction

As the Call for Papers for STS Conference Graz's (2023) session on "(Responsible) Standardisation for (the Digital) Society" indicates:

> Today, standards for the digital domain are developed mostly by engineers and computer scientists, typically employed by large companies. As a result, technical expertise and economic interests guide standardisation and thus technical development; societal issues are hardly considered (if at all).
>
> [There is a need, then, for more research which investigates:]
>
> - Possible contributions of societal stakeholders to standards development
> - The role and representation of societal stakeholders in standardisation […]
> - Legitimacy and influence of different players in standards development

This research addresses that call, although in an unconventional way. Rather than investigating ways of expanding the range of stakeholders contributing input to formalized standardisation processes early in digital transformation processes, the paper emphasises the emergent *de facto* standardisation processes that complement more formal technology standardisation efforts.

In this Introduction, an argument for this alternative research approach is advanced through a brief overview of how technology standardisation processes have evolved and are continuing to evolve, and by noting that the grand challenges facing society today are a critical arena with which standardisation processes should be concerned well beyond the domain of technological innovation per se. A research question is then posed and the rest of the paper is outlined to conclude the Introduction, before results of the exploratory research are presented and discussed.

1.1 Co-Evolving Technologies, Standards, and Standardisation Processes

Technological standards today are typically developed to support interoperability between material artifacts. Yet such standards must also satisfy, however indirectly, requirements for coordination between and across the communities of practice that use the technologies. And as technologies, standards and practices evolve over time, the underlying standardisation processes also evolve (Yates & Murphy 2019; Lindgren, Mathiassen & Schultze 2021). To illuminate this point, I here briefly summarize three phases in this process along with their implications relative to standardisation processes themselves.

1.1.1 1800s-1980s: Technical Systems

Prior to World War I (WWI), most engineers worked as independent professionals who then assembled in committees and organisations to establish technical standards,

considering the needs of the greater public. After WWI, as more engineers began working for private employers, the decision-making and standardisation processes of consortia began to privilege the interests of corporate management, orienting away from the needs of the general public (Yates & Murphy 2019).

1.1.2 1980s-2010s: Networked Systems and End-user Applications

As digital technologies and networks proliferated, corporate and technical *consortia* and standards *bodies* such as IETF and W3C emerged to support *interoperability* across networked technologies. At the same time, user communities and managers, who had already invested in adapting to specific technologies, struggled to change their usage practices and organisational routines to accommodate the new technological capabilities. These changes sparked new areas of research such as work practice studies, sociotechnical systems (STS) and evolutionary economics, all of which continue to be useful in analysing social and organisational change related to "contained technologies with relatively clear boundaries" (Geels & Schot 2007; Lindgren, Mathiassen & Schultze 2021; Truffer 2023). In these cases, governments sometimes became involved, but public policy-makers generally preferred that private organisations manage standardisation processes.

1.1.3 2010s – Present: Digital Transformation

As digitalisation pervades the social world, implications ripple far beyond technical and user communities, impinging upon countless distant social and natural phenomena. Further, these implications intersect with each other, entangling social and ecological processes in increasingly complex and unanticipated ways. In this new age, responsible standardisation must find ways to take into account the increasingly broad and diverse populations and elements through which these implications are diffusing.

1.2 Standardising for Today's Grand Challenges

To understand how standards evolve in dynamic social and organisational contexts, it is important to recognize that any technology designed to provide a specific capability ultimately influences many and varied stakeholders who may see that capability's purpose and effects quite differently. Further, society and technologies are changing rapidly, so that purposes and capabilities at one point in time may differ only a few years later. This is especially true for society's "grand challenges" such as the climate crisis, water resources, peak oil, social inequality and immigration. Gaining insight into responsible standardisation relative to these challenges requires looking beyond the design stage of particular technologies.

Addressing these complex issues calls for extended inquiry into the evolving social contexts surrounding formal standardisation processes. Rather than simply expanding the number and range of stakeholders invited to contribute to existing tech standardisation processes as recommended initially for responsible standardisation, this paper *"flips the script."* It considers how diverse stakeholders are already developing *de facto* standards and standardisation processes to address a particular grand challenge. Instead of focusing primarily on standardising new technologies, this work centres social groupings and processes – and their key concerns – as key drivers of standardisation processes. In this way, it offers an obverse yet complementary view of responsible standardisation.

1.3 Research Question and Outline of the paper

To limit the research to a manageable scope, the paper considers how diverse communities of stakeholders are addressing one small, arguably standardisable aspect of a grand challenge, and defers the question of whether and to what extent technological solutions can be helpful. The grand challenge is climate change and the specific aspect under consideration for "standardising" is soil-based sequestration of atmospheric carbon.

In particular, this research addresses the question of: *"How are diverse sets of stakeholders shaping* de facto *standardisation around soil-based carbon sequestration (to mitigate climate change)?"*

The paper presents emergent findings from a preliminary investigation of different approaches to soil-based methods of sequestering atmospheric carbon. Each stakeholder community is concerned with a different manifestation or facet of the broader issue, has different access to resources, and different longer term priorities.

The remainder of the paper proceeds as follows: First a brief overview of institutional theory as it affords a useful perspective for analysing standardisation processes, is presented. Then an outline of the research approach taken, targeting one prototypical area for standardising technological approaches to mitigating climate change. The third section summarizes results as emergent themes regarding three "ideal types" of soil-based carbon sequestration, outlining for each:

- Description of the approach
- Key stakeholders and communities of practice
- *What* is being standardised
- Key institutional processes of legitimacy and diffusion
- Implications for research on responsible standardisation

The paper concludes with a discussion of implications for understanding how standards and standardisation evolve over time, and recommendations for responsible standardisation in broad societal contexts.

2 Theoretical Approach

Institutional theories are sociological perspectives concerned with stability and change of large-scale social processes and phenomena. Within this vast literature, *organisational institutionalism* is a stream of research which assumes that institutionalisation is an ongoing process of social and organisational change. Researchers are committed to explaining how individual actions interact with macro social processes through organisational and organising activities. They define institution as:

> "more-or-less taken-for-granted repetitive social behaviour that is underpinned by normative systems and cognitive understandings that give meaning to social exchange and thus enable self-reproducing social order. (Greenwood, Oliver, Suddaby & Sahlin 2008:4-5)

Organisational institutionalists consider that "something is 'institutionalized' when it has that rule-like status" (Greenwood, Oliver, Suddaby & Sahlin 2008:5) – a view that corresponds closely with Gey & Fried's (2018:254) view that "standards can be understood as rules".

Institutional theories are well-adapted for research on digital innovation and transformation (Hinings, Gegenhuber & Greenwood 2018), and offer a rich trove of analytical tools and frameworks for examining the processes through which standards are developed and diffused. Exemplary studies characterise the influence of institutional context on the social construction of standards and standardisation (Gey and Fried 2018), standards development organisations as "institutions in the making" (Olshan 1993), development of a Java technology standard (Garud, Jain and Kumaraswamy 2002), and the development of an organisational field grounded in the diffusion of a standardised form (Brooks 2013).

Legitimation and diffusion are institutional processes that explain, justify and influence standardisation processes. As Berger and Luckmann (1967) explain, and Meyer (2019) highlights, a nascent institutional order (such as standardisation) initially manifests through performance of social practices and roles. To become fully institutionalised / standardised, these social practices and roles must diffuse to additional practitioners and new generations. For this diffusion to occur, legitimation is required, harnessing normative and cognitive means of explaining and justifying the practices (Berger & Luckmann 1967; Meyer 2019). Legitimation then, is the process of explaining and justifying an institutional order; it typically entails both language and symbolisation.

Diffusion, a concept originally popularized by Everett Rogers' in classic work on diffusion of innovation, is the process that happens when "an innovation is communicated through certain channels over time among the members of a social system" (1983: 14). While

many studies since then emphasise relational processes of diffusion, Strang & Meyer (1993) find that categories and other abstractions are also highly relevant for diffusion processes. More recently, some theorists have begun substituting the term “translation” in place of “diffusion”, to highlight that whatever is being diffused is also being changed in the process (viz. Czarniawska & Joerges 1996); yet the term “diffusion” arguably remains more relevant for research on standardisation.

3 Research Approach

The goal of this research is to explore social phenomena associated with *de facto* standardisation processes in the digital age. To foreground the needs of societal stakeholders, an extreme case – the grand challenge of climate change – is considered. Research is then focused on one concern around which substantial agreement already exists, and diverse approaches are examined to identify implications for responsible standardisation. Since the research question – *“How are diverse sets of stakeholders shaping* de facto *standardisation around soil-based carbon sequestration (to mitigate climate change)?”* – is a “how” question, qualitative research methods are appropriate.

3.1 Focal Phenomenon: Mitigating Climate Change through Sequestering Carbon in Soil

As a grand challenge, climate change involves a wide range of stakeholders with differing perspectives and approaches. It is therefore a useful context for examining the role and representation of stakeholders, along with their possible contribution(s), to standardisation processes.

The list of problems associated with climate change seems endless: warming temperatures, rising sea-levels, more intense weather patterns (storms, droughts, heat and cold spells), with priorities hard to establish or sustain. However, a starting point for studying standardisation is the general consensus that greenhouse gases (GHG) are a major source of many of these problems. There is also considerable agreement that one simplified version of the GHG problem – excess carbon in the atmosphere, especially CO_2 – ***must*** be reduced for the future of humanity and life on planet. Further, there is agreement that leveraging the natural process through which carbon cycles through air, soil, plants and animals, is a practical means to mitigate many of the harm(s) inherent with climate change. To manageably bound the scope of this preliminary research project, I focus only on organic means of carbon sequestration (i.e., via soil and plants; not in the ocean, nor mechanical extraction or storage in building materials and then buried).

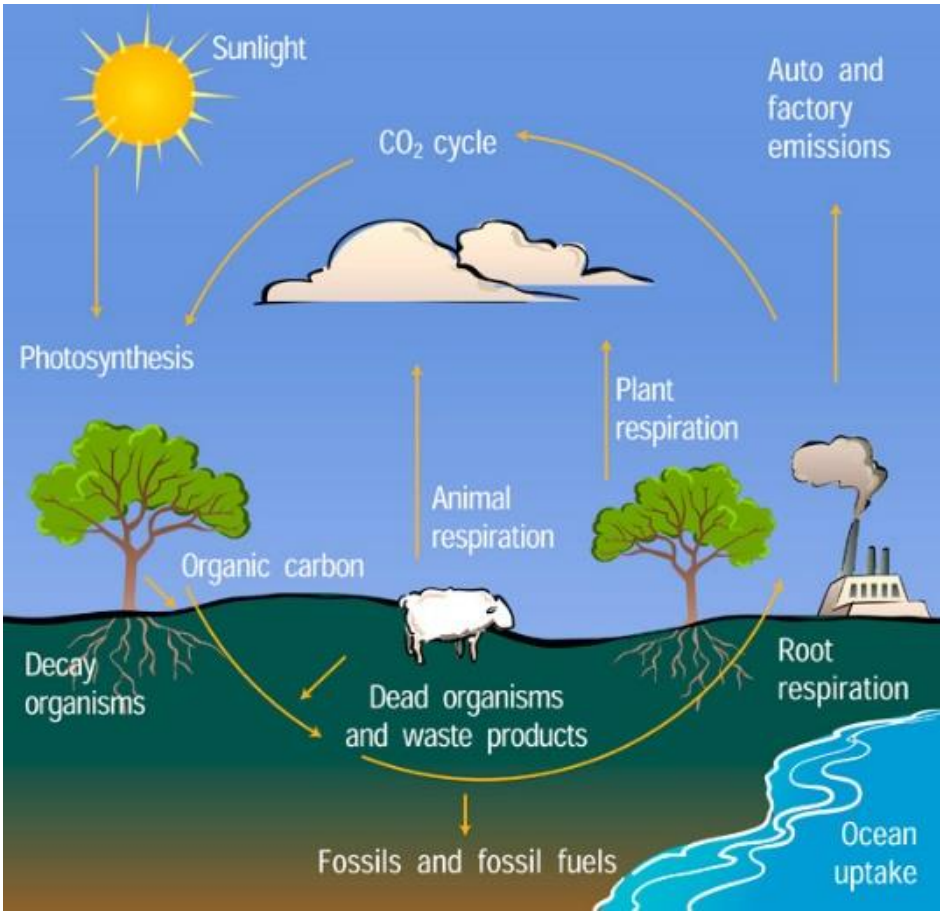

Figure 1: The Carbon Cycle

Image credit: UCAR Center for Science Education

Additionally, since selecting extreme cases is an important means of supporting theory development (Eisenhardt 1989; Seawright 2016; Yin 2009), this research examines several strikingly different approaches, grouped into three main "ideal types": carbon markets (CM), regenerative agriculture (RA), and indigenous "right relations" (RR).[14]

3.2 Data Collection

Data collection was carried out by the principal investigator beginning in summer 2020, initially through working as a volunteer for an environmental education and advocacy non-profit organisation. Data collection is continuing via a scoping literature survey (Arksey & O'Malley 2005) comprised of wide-ranging and publicly available sources including online websites and videos and in-person talks and seminars.

[14] "Ideal type" is a sociological construct that abstracts key characteristics of, and simplifies differences between, empirical instances of a phenomenon. In empirical reality, boundaries between these three approaches are fuzzy along a spectrum. Regenerative agriculture sits in the middle of the spectrum with carbon markets at one end and right relations at the other end of that spectrum.

3.3 Analysis

Data are being analysed through heuristic case analysis for theory elaboration (Vaughan 1992). This approach usefully circumvents presumptions that any one particular organisational form or technical approach is best suited for addressing the challenge; it also supports inclusion of groups commonly under-represented in more traditional standardisation schemes. Analysis includes attention to motivations for the standard / practice / technology (e.g., financial incentives vs. improving ethics and practices vs. improving return on farming efforts), and current means of legitimating and diffusing the standards, technologies and practices (e.g., peer-reviewed publications, certifications, best practice protocols). Emergent themes identified through this analysis illuminate *de facto* standardisation processes unfolding relative to a societal grand challenge. A high-level overview of different approaches to soil-based carbon sequestration is also supported.

3.4 Findings

The following three sections present emergent findings regarding the standardisation processes of approaches to soil-based carbon sequestration. Three ideal types are presented in terms of description, key stakeholders, what is being standardised, institutionalisation processes of legitimacy and diffusion, and key concerns relative to responsible standardisation for each.

4 Carbon Markets

4.1 Description

Carbon markets are an economic institution that enable large corporations with high greenhouse gas (GHG) emissions to offset legal and financial responsibility for the negative impact(s) of those emissions. Carbon markets are

> trading systems in which carbon credits are sold and bought. Companies or individuals can use carbon markets to compensate for their greenhouse gas emissions by purchasing carbon credits from entities that remove or reduce greenhouse gas emissions. (UNDP 2022)

Distinct from the “Cap and Trade” efforts required by federal regulations, these voluntary carbon markets credits can take a variety of forms, one of which is carbon sequestration in soil, the focus in this paper.

4.2 Key Stakeholders

As carbon markets are primarily the domain of large corporations, they interface with existing economic financial institutions, along with professional consultancies and research scientists such as silviculturists and geographers. Smaller entities, called Carbon Projects, focus on the technical aspects of measuring carbon and its sequestration on specific parcels of land. Land-owners and land stewards, typically in third world countries, are involved in these arrangements as well.

According to Becky Dickson of Terra Carbon LLC (2022) the institutional structure of carbon markets is:

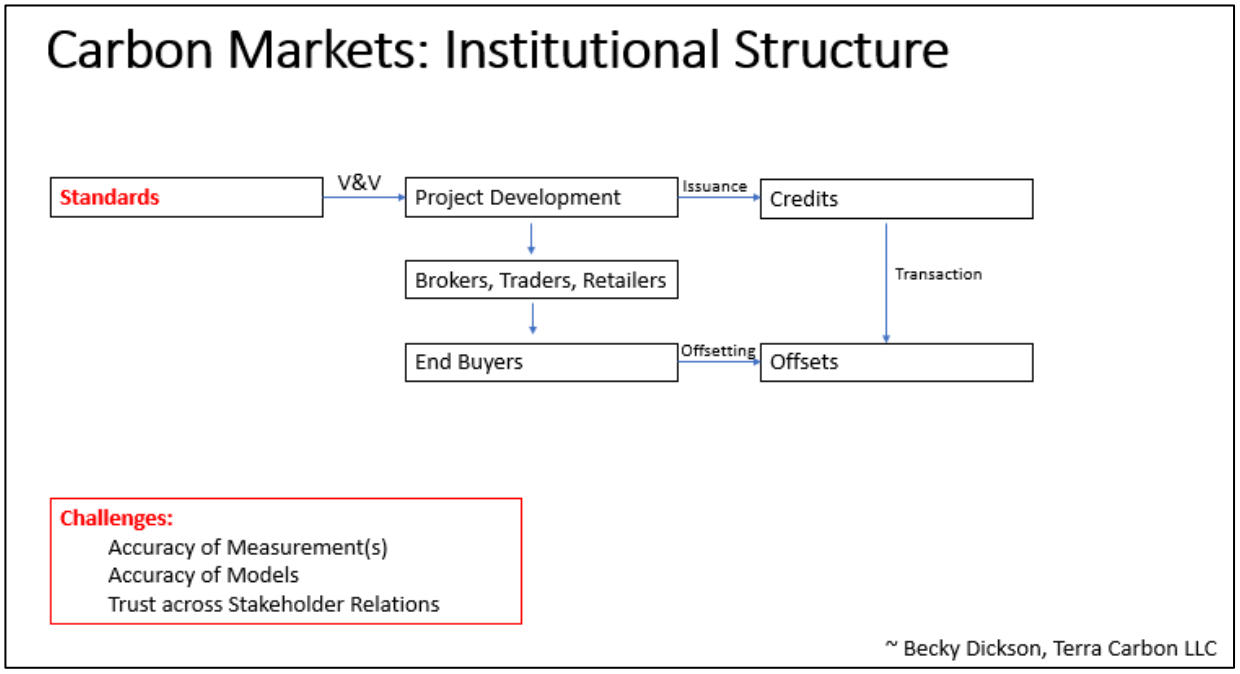

Figure 2: Carbon Markets: Institutional Structure

4.3. What is being Standardised?

The most central "object" in carbon markets is a *Carbon Credit* (or *Offset*) which is a (digital) information standard for one metric tonne of Carbon Dioxide equivalent (CO_2e) that can be bought and sold. Carbon credits are designed and maintained by organisational entities called Carbon Programs, which establish clearly-defined standards – of rules, procedures and methodologies – for accounting, assessing (external verification) carbon sequestration; they also track ownership of the credits via "registries".

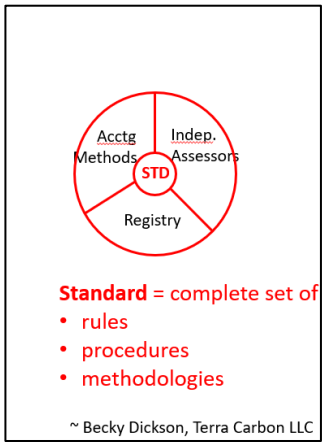

Figure 3: STD

There are four Main Standards, each developed by a different program: Verified Carbon Standard (by Verra), Gold Standard, American Carbon Registry (ACR), Climate Action Reserve.

4.4 Legitimation and Diffusion

4.4.1 Legitimation

Because carbon markets, credits and programs are largely digital and opaque to buyers, trust across stakeholders is a major concern. Stakeholders are concerned with reliability around a range of issues. To validate the economic leverage of reliance on carbon credits, three main parameters have been identified:

- "*Additionality*" – is the sequestered carbon "additional" to any carbon that would otherwise be sequestered anyway? Who determines this, and how? (subjective assessment!)
- *Permanence* – is the sequestered carbon going to stay sequestered permanently? How is this determined?
- *Non-Leakage* – is sequestration working the way it is claimed to be? (as verified by independent assessors)

Additional concerns regarding accuracy of assessment include:

- *Accuracy of measurement* – Precise measurement (testing) of carbon sequestration over large tracts of soil or land is highly cost-intensive and therefore not deployed as often as might be warranted. Instead, carbon markets typically rely heavily on computer models rather than extensive testing, which leads to a second concern...
- *Accuracy of models* – Many issues related to accuracy of the computer models are well-known, although knowledge and concern about these issues is not evenly distributed across the different stakeholder groups involved in carbon markets.

4.4.2 Diffusion

Carbon markets are situated within mainstream financial institutional contexts, affords a strong set of channels for diffusion. Additionally, land-owner associations and policy organisations are instrumental in linking specific plots of land to various carbon credit projects.

4.4.3 Risks and Challenges

Although carbon markets have been operating and expanding for some time, their legitimacy is increasingly being challenged. Distrust between stakeholders around assessments, permanence and additionality have been leading to negative ethical and legal ramifications. Problems with accurate measurement and trust have led to charges of corruption with some of the offsets recently being termed “worthless.” As a case in point, the CEO of Verra (the largest carbon credit program) recently resigned following a media expose which accused the corporation of issuing millions of worthless credits (Guardian 2023).

4.5 Key Concerns and Insights for Responsible Standardisation

Environmentalists have been highlighting that GHG emissions are simply being turned into a “network externality” for some stakeholders, leading to charges of “greenwashing” as a major ethical and potentially legal concern, since carbon is not really being eliminated from the planetary system at all. Activists are also protesting the downsides of mono-crop silviculture in contrast to more biodiverse solutions. As a result of these legitimacy concerns, carbon markets are undergoing major structural change (Haya *et al*. 2023).

5 Regenerative Agriculture

5.1 Description

While there are many different definitions of regenerative agriculture (Newton *et al.* 2020), most include some reference to soil health. One clear definition is:

> Regenerative Agriculture is an approach to farm and ranch management that aims to reverse climate change through practices that restore degraded soils. By rebuilding soil organic matter and soil biodiversity we significantly increase the amount of carbon that can be drawn down from the atmosphere while greatly improving soil fertility and the water cycle. (CRARS-CSU/Chico 2023)

While too immature to be considered an institution in its own right, regenerative agriculture is closely allied with organic farming and permaculture and interfaces with and depends upon other more established institutions (see below).

5.2 Key Stakeholders

5.2.1 Key Occupational Groups

Full-time practitioners of regenerative agriculture include small farmers, employees of demonstration farms (see below) and scientific researchers investigating specific factors that contribute to regenerative agriculture. Most researchers and demonstration farms receive funding from government agencies and/or large corporations through land-grant universities, non-profit research groups and/or educational centers.

5.2.2 Peripheral Institutional Contexts

Currently, most regenerative agriculture practitioners integrate their work with broader local farming communities and distribution channels such as Farmers' Markets, farm-to-table restaurants, and community-supported agriculture programs. Many small farmers are active in national or global networks of peers and educators; these practitioners also typically maintain some connections with local training programs (e.g., community colleges, 4H clubs) and zoning boards. Large food and agricultural corporations may also be involved as partners in research projects, and/or running pilot programs or large-scale field experiments on their own.

5.3 What is Being Standardised?

The greatest concerns around standardisation focus on farming practices commonly employed to support soil health and carbon sequestration (or respiration). These include minimizing soil disturbance, supporting diverse vegetation, rotating crops, maintaining cover crops, applying compost and manure, and managing grazing animals (CRARS-CSU/Chico 2023).

5.4 Legitimacy and Diffusion

5.4.1 Legitimation

Small-scale regenerative agriculture leverages and is dependent upon specialized knowledge of practices and technologies adapted to specific soils, climates and regional landscapes. While practitioners and advocates claim major success, findings are primarily anecdotal; legitimation is typically established via best practice protocols (e.g., Northeast Organic Farming Association's Soil Carbon Grower On-Site Test Protocols and

Data Sheets) and certification programs (e.g., Soil Carbon Initiative's Farm-Level Commitment Programs).

In research programs concerned with large-scale application of regenerative agriculture techniques, interest is increasing in new, innovative technologies for measuring soil health. Most of these technologies are still under development with some at the venture capital stage. There are also Action Research Projects, such as Rodale's "Southern Piedmont Plateau" research program and California State University at Chico's Center for Regenerative Agriculture and Regenerative Solutions' Soil Carbon Accrual Project, although projects like these are quite expensive and typically depend upon external funding.

5.4.2 Diffusion

Diffusion of small-scale regenerative agriculture is limited because of the locally-specific and highly variable nature of soils, climate and vegetation. Nevertheless, diffusion of highly-effective small-scale techniques still occurs through:

- *Demonstration farms, community college and online educational and training programs (*e.g.*,* https://understandingag.com/).
- *Community organisations* (e.g., Northeast Organic Farmers Association)
- *Non-profit organisations at the national and international levels,* such as the Soil Carbon Initiative's (2023) effort to incentivize Farm-Level Commitment Programs; and the Rodale Institute's *Global Leaders in Organic Agriculture Research* program (Rodale Institute 2023).

Larger-scale approaches to diffusing regenerative agriculture are supported through government-sponsored research efforts (e.g., through US Dept. of Agriculture and National Science Foundation). These programs are oriented toward developing more cost-effective techniques for measuring carbon sequestration (e.g., flux towers, soil probes) over wider areas, or improving soil sampling and laboratory tests. Also on larger-scale efforts, Assessments on larger-scale projects may also be supplemented using infrared spectroscopy and satellite imagery. Other larger-scale channels of diffusion include academic and scientific research organizations (e.g., Center for Regenerative Agriculture and Resilient Systems' Soil Carbon Accrual Project at California State University / Chico; Rodale Institute; Woodwell Institute) and peer-reviewed publications.

5.4.3 Risks / Challenges

For small acreage farms, transitioning to regenerative agriculture represents a major risk to a family's survival which is often a season-to-season challenge anyway – a single seasonal failure can devastate an entire family's economic security. Meanwhile,

regenerative agriculture researchers find themselves caught in a Catch-22: struggling to obtain research funding because of their lack of peer-reviewed publications, hampered by a shortage of peer-reviewers due to limited/scarce research funding. These tensions are exacerbated by the high cost of accurate measurement technology needed to conduct replicable scientific experiments. Replication research is further constrained because so many relevant variables (climate, soil type, native vegetations) are locally-specific, rather than generalizable across larger regional areas and mono-crop-plantings. Some researchers anticipate that new measuring technologies currently under development will translate into success in using carbon credits or offsets to incentivize deploying regenerative agricultural practices on larger tracts.

Currently, the US Department of Agriculture funds a substantial research program on regenerative agriculture ("Climate-Smart Initiative"). However, most funding is directed to larger-scale agriculture pilot programs rather than small farms, with the rationale being that the former provide more "bang-for-the-buck". Fewer recommendations are needed for larger-scale changes (e.g., simple corn/soy rotations), than for smaller, 10-acre farms with more diverse crops and potentially more efficient land use.

5.5 Key Concerns for Responsible Standardisation

The new measurement technologies (e.g., "towers" for monitoring / measuring carbon flux from soil, or "probes" for measuring carbon accrual deep within soil) appear as the most attractive focus for responsible standardisation initiatives. Beyond those, other efforts towards standardisation remain challenging due to 1) local specificity of weather and soil conditions, and 2) risky financial stakes – both for converting traditional farms to regenerative agriculture and for innovative research on novel techniques and practices. Even the large-scale government research programs struggle to attain target outreach goals because of the financial risks facing both farmers and researchers.

6 "Right Relations" Approach

6.1 Description

The "Right Relations" approach has been practiced by indigenous peoples in North America and elsewhere for millennia. This approach understands that the "real solutions" to the climate crisis are in "Right Relations". The approach embodies and reflects a very different orientation than the typical western (European) world view. As Chief Oren Lyons of the Onondaga Haudenoshonee advises, people/humans need to approach the climate crisis with "'common sense' not 'dollars and cents' … there is no mercy in nature, only

the law… If you don't follow the law, you suffer the consequences… [in nature there are] no lawyers, no *habeas corpus*" (2022). Or as Tom Goldtooth, Executive Director of the Indigenous Environmental Network, explains: "Right Relations" entail "Responsibilities in relationship… Relationship to Mother Earth. …. Connecting and respecting all beings" (2022).

Evidence for the efficacy of this approach can be found in a report by the World Resources Institute & Climate Focus (2022):

> Forest lands stewarded by Indigenous people and communities in countries such as Brazil, Colombia, Mexico and Peru sequester about twice as much carbon as other lands, according to the analysis. (Neslen 2022)

Further support exists in general recognition that roughly 85% of most biodiverse land areas are stewarded by indigenous peoples who comprise only roughly 5% of the world's population.

Right Relations is an all-encompassing worldview, a deep and expansive way of being. Full explication is well beyond the scope of this paper; what follows simply highlights several aspects most directly relevant for carbon sequestration.

6.2 Key Stakeholders

From an indigenous perspective, key stakeholders include all people and life on Earth. Further, indigenous people do not view themselves as *owning* land; rather they feel that they *belong* to the land they inhabit. From this perspective then, additional stakeholders also include the earth and all sentient beings including the four elements (earth, air, fire, water).

6.3 What is "Standardised"?

Indigenous practices and approaches have much in common with regenerative agriculture practices and approaches, but predate by hundreds if not thousands of years. One such key practice is "intercropping" – cultivating complementary crops together that naturally support each other's growth (e.g., corn, beans and squash as "three sisters"). Similarly, blending cultivation of trees, plants and grazing animals to improve soil health, reduce weeds and pests (Heim 2020), and strategic burns of forests and prairies (Pyne 2019). Other practices include strategic water management, such as planting crops in mounds of soil to drain excess moisture in humid areas, or establishing dams and irrigation systems in dry climates.

6.4 Legitimation and Diffusion

6.4.1 Legitimation

Legitimation of this approach has always been strong within indigenous communities via a seven-generation philosophy in which "everyone has a voice." Furthermore, ceremonies are performed recurrently to honour all relations ("Mitakye Oyasin"), thereby legitimating the approach in an ongoing manner. Recently, new research-based claims are emerging to support these original voices, such as via the WRI report mentioned above (Neslen 2022).

6.4.2 Diffusion

Although support for indigenous right relations approaches is growing, major impediments are blocking diffusion of this approach. Internally, indigenous populations are already struggling simply to survive and sustain their way of life amid poverty and threats to their physical and cultural survival. Externally, they face racism, treaty violations and other land sovereignty challenges. As historical targets of genocide and land theft for centuries in the Americas, and likely longer in Europe and Asia, indigenous land protectors remain vulnerable today. They continue to face orchestrated violence on a regular basis – e.g., as pipeline protesters in the US and as environmental activists in Latin America; sovereignty continues to be their greatest concern.

For indigenous populations, sovereignty and survival are inextricably intertwined. As Goldtooth (2022) enumerates in his explanation of right relations: "Sovereignty. Self-determination. Inherent rights and sovereignty of self-determination over ancestral waters, lands and territories …. relationship to food." He goes on to stress:

> Everything I talked about is like serious. It's serious life and death stuff. It's right there, confronting us. You know, when we started to dig deep – dig deep into looking at climate change and looking at what solutions that the system was telling us. They even were tempting our people, to give us big money – millions of dollars if we participate in using our trees and our ecosystem for carbon offsets…. you know. … And it's like money is so tempting, you know, and I remember some friends of mine down in Ecuador in the Amazon, the Sarayaku. You know, they said, "We don't need money to protect our trees. We just need to be left alone and give us our title to our land. … Recognize our rights. We know how to live in this system, we don't need money." And you know, I liked that; that resonated.
> (Goldtooth 2022)

Yet it can be nearly impossible for indigenous spokespeople to even make themselves heard at global decision-making events around climate change. According to Minnie Degawan, a Kakaney/Igorot activist from the Cordillera region of the Philippines and a member of the International Indigenous Forum on Biodiversity (IIFB), "when discussions

take place about environmental protection, we are always ignored. That's a huge mistake" (Degawan 2023). Furthermore,

> …when it comes to the money, Indigenous peoples are being left out in the cold yet again. While the [UK government-sponsored meeting held in February 2023 to discuss generating more finance to conserve and restore nature brought] together private, public sector and philanthropy groups, we have no seat at the table. That's a mistake. Addressing this crisis is not simply about getting the numbers right. The question of how these funds will be spent should be part of the agenda too, including who will spend them. (Degawan 2023)

6.5 Key Concerns for Responsible Standardisation

Environmental justice issues are clearly at stake here. Indigenous populations have been historical targets of genocide and land theft. Yet as one analyst argues, if indigenous relations with land are not honoured, the Paris Climate Agreement will fail:

> To maximise the scope for Indigenous land protection, the WRI study calls for equivalent land ownership rights, legal recognition of Indigenous territories and community rights to free, prior and informed consent over forest projects. (Neslen 2022)

The right relations perspective that "everyone has a voice" is virtually identical to responsible standardisation's concern that all stakeholders should have input. Indigenous perspectives bring to the fore issues of role and representation of stakeholders. The central-most question for responsible standardisation then becomes which players in standardisation processes are considered legitimate enough to exert influence, and which not. How to include these voices of indigenous populations and non-human stakeholders?

Pursuit of this approach, however, raises concerns that its non-technical processes and consensual decision-making are generally more time and resource intensive (not as "efficient") than the more focused and quickly implemented trajectories of carbon markets and large-scale regenerative agriculture.

7 Commonalities and Differences across Carbon Sequestration Approaches

While characterisation of these three "ideal types" reflects an emergent theme of preliminary analysis, in actuality, boundaries between the three approaches to carbon sequestration are overlapping and porous. Many commonalities and differences extend across and through these approaches. For example, both carbon markets and

regenerative agriculture researchers are interested in innovation of cost-effective technologies for measuring soil carbon, while both small scale regenerative agriculture practitioners and indigenous communities share much in the way of practices and concerns.

Yet differences in economic scale across the approaches remain obvious. The financial power of carbon markets and research funding institutions contrasts sharply with the basic survival needs of indigenous communities. Meanwhile soil health scientists are seeking and developing more precise methods of testing soil carbon so they can produce the peer-reviewed research essential for obtaining continued funding, and perhaps more importantly, for legitimating and diffusing regenerative practices, to both carbon markets and small farmers.

Differences in governmental regulation are also significant: from the large government agencies regulating carbon markets, to local zoning boards approving small organic farms, to traditional peoples' struggle for sovereignty of land they have already inhabited for millennia.

More fundamentally, epistemological and ontological differences undergird these apparent differences. Carbon market programs and projects depend heavily upon modelling, whereas small-scale regenerative agriculture practitioners rely primarily on anecdotal evidence and observation to assess the quality of their flora and fauna. And while market institutions recognize carbon as a chemical element to be managed effectively for financial and legal ends, indigenous communities understand right relations as the only viable approach to sustaining life on Earth.

8 Discussion

8.1 Evolving and Competing Standardisation Processes

This preliminary study has leveraged institutional perspectives and heuristic case analysis to investigate and analyse standardisation processes around soil-based sequestration of carbon across diverse sets of stakeholders and communities. The study reveals that multiple *de facto* standardisation processes – understood as nascent institutionalisation processes – are already underway, influencing and influenced by multiple and diverse stakeholders and communities. And each set of stakeholders not only entails differing practices and resources, but has different understandings, goals, and interdependencies, as well as views of and relations to the natural environment. Analysis further suggests that these *de facto* standardisation processes continue to counterbalance some deficiencies of the more clearly-bounded technology

standardisation processes. This research thus re-orients us to intrinsic inseparability of formal and *de facto* standardisation processes.

Results of this study also confirm that existing social norms and resource allocation processes are privileging dominant financial institutions over other stakeholders in the economy (Davis & Kim 2015). This imbalance shapes standardisation processes through positioning financial resources controlled by powerful institutions (e.g., carbon markets) against the practical and efficacious knowledge of small-scale farmers and indigenous communities. These dynamics between institutional power and grassroots practicality will most likely continue to play out over the coming decades, and responsible standardisation research will benefit from taking this into account.

8.2 Theoretical Implications

8.2.1 Responsible Standardisation

In contrast to technology-centred views of responsible standardisation, this exploratory study expands that purview to include the *de facto* standardisation processes complementing the better recognized, formal processes of standards bodies and consortia. Through supporting inclusion of a wider array of stakeholders and concerns, the study contributes to understanding how standardisation processes themselves are evolving over time and demonstrates how an institutional perspective contributes value for analysing these processes. It also implies that research on responsible standardisation is likely to benefit from continuing to consider how standardisation processes change over the longer term.

8.2.2 Digitalisation and Grand Challenge

The institutional perspective used here helps point to the possibility of inherent limitations to digitalisation approaches to a grand challenge, at least for soil-based carbon sequestration. While diffusion occurs through both relations and abstract concepts or categories (Rogers 1983; Strang & Meyer 1993), fundamental contradictions between these may result in significant impediments to diffusing digital “solutions” to grand challenges: On the one hand, grounding abstract categories such as carbon credits in digital technologies makes them more readily diffusible across existing financial and economic institutions. On the other hand, the same digitalisation that enables carbon credits to diffuse efficiently is leading to major relational issues regarding its effectiveness. Relational trust between carbon market stakeholders seems is coming apart, precisely because the relationship between a single abstract standard (i.e., a carbon credit) and the multifaceted phenomenon it is purported to represent (i.e., carbon sequestration across different soil types, climate regions and agricultural practices) is not easily nor accurately characterizable.

8.3 Practical Implications

While the tenets of responsible standardisation appear desirable in the abstract, re-orienting them toward responsible standardisation for a grand challenge reveals that many of these tenets could be quite challenging to implement in practice. Institutional rigidity and resource allocation biases are contentious in any standardisation process, and stakeholders, funding, politics and resources are not always clearly identifiable or readily accessible. Even identifying a complete set of stakeholders can be challenging because differences in language and priorities are not always discernible from a distance. Nor is it reasonable to assume that standardisation bodies and processes will always have the requisite power or authority to invite relevant affected but non-central stakeholders, or to convene all stakeholders at the same time, or that stakeholders can agree on what needs to be standardised.

Results suggest instead that the tenets of responsible standardisation will need to be "tuned" for application to specific empirical cases. And addressing these issues becomes even more crucial in grand challenges when hierarchical management or explicitly-negotiated consensus are no longer feasible (Acemoglu & Roberts 2008; Banerjee & Arjalies 2021).

Given these concerns, two recommendations are offered:

1) Efforts to standardise standalone digital technologies may be more effective at reaching consensus through use of a modular approach and generating short-term working prototypes (Brooks, Carroll & Beard 2011) for testing out diffusion possibilities, as is occurring with soil carbon measuring technologies.

2) For including stakeholder input into early design decisions, conducting a *series* of public hearings may be most expedient. Rather than trying to convene diverse sets of stakeholders at a single place and time, these hearings could be advertised in advance across different communities, and facilitated through strategic negotiation processes such as open strategy and organisational democracy (Adobor 2019; Hansen et al. 2022; Hautz, Seidl & Whittington 2017; Seidl, Von Krogh & Whittington 2019). Establishing these hearings would need to consider relative advantages of standardising on technology or standardising on consultation and decision-making processes, or both? (viz. Brooks & Rawls 2012).

The hearings could solicit input and decisions around rules and recommendations for:

- Who negotiates / establishes standards and how?
- Whether and how an object of standardisation can be identified / measured?
- What could be standardised?

8.4 Limitations and Future Research

This exploratory inquiry is obviously limited in scope and generalizability; further research – both empirical and theoretical – is needed. On the empirical side, results from this preliminary exploration will be used to identify a more representative sample (Glaser & Strauss 1967) for further study. Theoretically, the institutional perspective on research in responsible standardisation may be strengthened through integration with other recent theoretical work on dialectics of technology standardization (Lindgren, Mathiassen & Schultze 2021), entanglement of long-term processes and digital social change (Büchner, Hergesell & Kallinikos 2022) and critical realist perspectives for understanding socio-technical transitions (Geels 2022).

Acknowledgements

This paper has benefitted substantially from comments by STS-Graz reviewers and Deborah Soule.

References

Acemoglu, D., & Robinson, J. (2008). The role of institutions in growth and development, Vol. 10. . Washington, DC: World Bank.

Adobor, H. (2020). Open strategy: role of organizational democracy. Journal of Strategy and Management

Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. International Journal of Social Research Methodology, 8(1), 19-32.

Banerjee, S. B., & Arjaliès, D.-L. (2021). Celebrating the End of Enlightenment: Organization Theory in the Age of the Anthropocene and Gaia (and why neither is the solution to our ecological crisis). Organization Theory, 2(4), 26317877211036714.

Berger, P., & Luckmann, T. (1967). The Social Construction of Reality. New York: Garden City

Brooks, J. M. (2013). Growth of an Organizational Field for Infrastructure: US State and Local Fusion Centers, 2001-2012; Research-in-Progress. Paper presented at the Nineteenth Americas Conference on Information Systems, Chicago, Illinois. August 15-17.

Brooks, J. A. M., & Rawls, A. W. (2012). Steps toward a socio-technical categorization scheme for communication and information standards. In Proceedings of the 2012 iConference, Toronto, ON, 407-414.

Brooks, J. M., Carroll, J. S., & Beard, J. W. (2011). Dueling stakeholders and dual-hatted systems engineers: Engineering challenges, capabilities, and skills in government infrastructure technology projects. IEEE Transactions on Engineering Management 58(3), 589-601.

Büchner, S., Hergesell, J., & Kallinikos, J. (2022). Digital transformation(s): On the entanglement of long-term processes and digital social change; an introduction. Historical Social Research 47(3), 7-39.

CRARS, C.-C.-C. f. R. A. a. R. S. (2023). Regenerative Agriculture 101 [Electronic Version]. Retrieved 6/10/23 from https://www.csuchico.edu/regenerativeagriculture/ra101-section/index.shtml.

Czarniawska, B., & Joerges, B. (1996). Travels of ideas. In G. Sevon & B. Czarniawska (Eds.), Translating Organizational Change (pp. 13—48). Berlin: de Gruyter.

Daley, C., LaSalle, T., Johnson, D., & Tuvell, P. (2019). Center for Regenerative Agriculture & Resilient Systems Annual Report 2019: California State University, Chico.

Davis, G. F., & Kim, S. (2015). Financialization of the Economy. Annual Review of Sociology, 41, 203-221.

de Vries, H., Jakobs, K., Egyedi, T., Eto, M., Fertig, S., Kanevskaia, O., et al. (2018). Standardization: Towards an agenda for research. International Journal of Standardization Research, 16(1).

Degawan, M. (2023). Indigenous people are Earth's greatest champions. Listen to us – and watch biodiversity thrive. The Guardian. Fri 17 Feb 2023 05.30 EST. https://www.theguardian.com/commentisfree/2023/feb/17/indigenous-people-earth-biodiversity-environmental-protection

Eisenhardt, K. M. (1989). Building theories from case study research. Academy of Management Review 14(4), 532-550.

Garud, R., Jain, S., & Kumaraswamy, A. (2002). Institutional entrepreneurship in the sponsorship of common technological standards: The case of Sun Microsystems and Java. Academy of Management Journal, 45(1), 196-214.

Geels, F. W. (2022). Causality and explanation in socio-technical transitions research: Mobilising epistemological insights from the wider social sciences. Research Policy 51(6), 104537.

Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. Research Policy, 36, 399–417.

Gey, R., & Fried, A. (2018). Metastructuring for standards: How organizations respond to the multiplicity of standards. In K. Jakobs (Ed.), Corporate and Global Standardization Initiatives in Contemporary Society. (pp. 252-276): IGI Global.

Glaser, B. G., & Strauss, A. L. (1967). The Discovery of Grounded Theory: Strategies for Qualitative Research: Aldine de Gruyter.

Goldtooth, T. (2022). Establishing Right Relations: Real Solutions to the Climate Crisis and the 6th Extinction Event. On Institute for Social Ecology's ongoing series on race, ecology and climate justice [Video]. [Vermont]: Institute for Social Ecology.

Greenfield, P. (2023, Wed 18 Jan 2023). Revealed: more than 90% of rainforest carbon offsets by biggest provider are worthless, analysis shows. The Guardian.

Greenwood, R., Oliver, C., Suddaby, R., & Sahlin-Andersson, K. (Eds.). (2008). The Sage Handbook of Organizational Institutionalism.: Sage.

Hansen, J. R., Pop, M., Skov, M. B., & George, B. (2022). A review of open strategy: bridging strategy and public management research. Public Management Review, 1-23.

Hautz, J., Seidl, D., & Whittington, R. (2017). Open strategy: Dimensions, dilemmas, dynamics. Long Range Planning, 50(3), 298-309.

Haya, B. K., Evans, S., Brown, L., Bukoski, J., Butsic, V., Cabiyo, B., Jacobson, R., Kerr, A., Potts, M., Sanchez, D. L.(2023). Comprehensive review of carbon quantification by improved forest management offset protocols. Frontiers in Forests and Global Change 6, 958879.

Heim, T. (2020). The Indigenous Origins of Regenerative Agriculture [Electronic Version]. National Farmers Union - Climate Blog. Retrieved 6/10/23 from https://nfu.org/2020/10/12/the-indigenous-origins-of-regenerative-agriculture/.

Hinings, B., Gegenhuber, T., & Greenwood, R. (2018). Digital innovation and transformation: An institutional perspective. Information and Organization, 28(1), 52-61.

Jakobs, K. (2019). Shaping the Future through Standardization: IGI Global.

Lindgren, R., Mathiassen, L., & Schultze, U. (2021). The dialectics of technology standardization. MIS Quarterly, 45(3), 1187-1212.

Meyer, R. E. (2019). A note from a phenomenological institutional perspective." Institutions and organizations: A process view (2019): 33. In T. Reay, T. B. Zilber, A. Langley & H. Tsoukas (Eds.), Institutions and Organizations: A Process View: Sage.

Neslen, A. (2022). Protect Indigenous people's rights or Paris climate goals will fail, says report. The Guardian. (Thu 31 Mar 2022 09.00 EDT) https://www.theguardian.com/world/2022/mar/31/protect-indigenous-peoples-rights-or-paris-climate-goals-will-fail-says-report

Newton, P., Civita, N., Frankel-Goldwater, L., Bartel, K., & Johns, C. (2020). What Is Regenerative Agriculture? A Review of Scholar and Practitioner Definitions Based on Processes and Outcomes. Frontiers in Sustainable Food Systems, 4.

Olshan, M. A. (1993). Standards-making organizations and the rationalization of American life. The Sociological Quarterly, 34(2), 319-335.

Pyne, S. J. (2019). Fire: A Brief History (2nd ed.): University of Washington Press.

Rodale Institute. (2018). Regenerative Organic Agriculture and Climate Change: A Down-to-Earth Solution to Global Warming. Kutztown, PA.

Rodale Institute. (2023). Rodale Institute - Global Leaders in Organic Agriculture Research.

Rogers, E. M. (1983). Diffusion of Innovations. Detroit: Free Press.

Seawright, J. (2016). The case for selecting cases that are deviant or extreme on the independent variable. Sociological Methods & Research, 45(3), 493-525.

Seidl, D., Von Krogh, G., & Whittington, R. (2019). Defining open strategy: Dimensions, practices, impacts, and perspectives. In Cambridge Handbook of Open Strategy (pp. 9-26).

Soil Carbon Initiative. (2023). https://www.soilcarboninitiative.org.

Strang, D., & Meyer, J. W. (1993). Institutional conditions for diffusion. Theory and Society, 22, 487-511.

Truffer, B. (2023). Urban planning meets socio-technical transitions: Informal settlement upgrading reconfiguring the infrastructure-livelihood nexus (comment during Q&A after talk): International Lecture Series: Planning in Transition.

UNDP (United Nations Development Programme). (2022). What are carbon markets and why are they important? . https://climatepromise.undp.org/news-and-stories/what-are-carbon-markets-and-why-are-they-important . Accessed 20 October 2023.

Vaughan, D. (1992). Theory elaboration: The heuristics of case analysis. In C. C. Ragin & H. S. Becker (Eds.), What is a Case? Exploring the Foundations of Social Inquiry (pp. 173-202): Cambridge University Press.

World Resources Institute & Climate Focus. (2022). Sink or swim: How Indigenous and community lands can make or break nationally determined contributions. Forest Declaration Assessment.

Yates, J., & Murphy, C. N. (2019). Engineering Rules: Global Standard Setting since 1880. Baltimore: Johns Hopkins University Press

Yin, R. K. (2009). Case Study Research: Design and Methods: Sage