Financially redesigning the Anthropocene: the role of infrastructural work for climate risks and climate impact

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INTRODUCTION

Capital allocation is a powerful way of distributing agency – both diverting and directing it. The consequences of this feature of financial markets have never been limited to only direct market participants but, of course, stretch out into virtually all spheres of societies and environments (e.g. Blok, 2011; Elliott, 2021; Fourcade, 2011; Keucheyan, 2016; Muniesa, 2014; Poon, 2009; Randalls, 2010; Taylor, 2020). To a large extent, the global climate crisis is one of these consequences. We conceptualise the current planetary situation of climate change as a condition of the Anthropocene, i.e., the period of time during which human activities have a lasting environmental impact on the Earth system (Crutzen & Stoermer, 2000; Oldfield et al., 2014; Steffen, Crutzen, & McNeill, 2007; Waters et al., 2016).

Currently, various finance-focused programmes are pursued to actively intervene in the Anthropocene by leveraging the feature of financial markets to *re*distribute – purposefully divert and direct – agency towards more sustainable economies and societies. For example, in March 2018 the EU Commission published an action plan on financing sustainable growth: "One of the objectives set out in that action plan is to reorient capital flows towards sustainable investment in order to achieve sustainable and inclusive growth." (EU, 2020). These programs are thus essentially about instrumentalising the capital markets as the vector of owning and financing (nearly all) operations of economic activity in the 'real economy' and nudging investment behaviour to ultimately only allow those activities to persist that are in line with particular future visions of the Anthropocene, i.e., overall containing climate change to 1.5˚C global warming. These programmes could be described, in other words, as attempts to 'financially re-design' the Anthropocene.

In 'financially redesigning the Anthropocene,' financial market participants and other stakeholders try to actively intervene in the relationship between climate change and financial markets in two ways: The *risk* perspective emphasizes the impact of climate change on financial investments and assets. It distinguishes between two main categories of risk: physical risks arising from climate and weather-related events, such as heatwaves, droughts, floods, storms and sea level rise, and transition risks arising from the process of adjustment towards a low-carbon economy, such as a sudden shift towards renewable energies. Together, physical risk and transition risk can potentially result in large financial losses in the valuation of assets and, as systemic change, endanger the stability of financial markets as a whole. The risk perspective requires financial institutions and their service providers to develop sophisticated scenario analyses, new forward-looking metrics, and new data in order to identify and assess the risks from climate change.

In turn, the *impact* perspective emphasizes the impact of capital allocation and economic activity on the climate change process. For example, investments in fossil fuels will further aggravate climate change, while investments in renewable energy are supposed to slow it down and ideally turn a profit on investments, i.e., climate 'opportunities'. The attempt to actively intervene in this relationship is to be realised via setting targets for climate alignment, i.e., financial institutions set themselves targets, such as 'net-zero' emissions by 2050, in order to contain global warming to 1.5˚C. Together, the risk and the impact perspective are often known as 'double materiality' (EU, 2019), i.e., the material risks to financial assets and financial markets stability as well as the material impact on the Anthropocene.

Both the risk perspective and the impact perspective, crucially hinge on and are realised through a vast repository of data, numerous epistemic devices and regulatory frameworks and voluntary standards. We refer to this collection of data, devices and frameworks as collective 'knowledge infrastructures' (Jackson, Edwards, Bowker, & Knobel, 2007; Susan Leigh Star, 1999) because they provide the basis, i.e., infrastructures, for producing knowledge about the relationship between the climate crisis and financial markets on which basis decisions and action can be made. For example, financial institutions need data about the greenhouse gas (GHG) emissions of companies they invest in, as well as information about the companies' physical situatedness in hazard-prone environments (e.g., flooding, storms, wildfire, etc.) and their exposure to changes in climate policy and technologies (e.g., energy). In turn, financial institutions use epistemic devices, that is, calculative tools and simulation models, to process this data and produce metrics that indicate the climate-related risk to or impact of a given portfolio or investment. In addition, a number of regulatory frameworks and voluntary principles and standards provide guidance on how to identify, assess, monitor and manage climate risks and impact. Through these infrastructures, the current state of the Anthropocene is 'sensed' (e.g., how much GHG emissions are produced?)[1] and future states of the Anthropocene are imagined and 'modelled' (i.e., what are the risks and impacts of different scenarios?).

We speak of infrastructures in plural because the landscape of climate-financial knowledge infrastructures is, at least currently, very heterogenous and highly fragmented. In addition, because the climate crisis is such a complex phenomenon, infrastructures for how to

[1] We understand the 'sensing' of environment loosely in line with Gabrys as interdependent and mediated relationships between the sensed and the sensing (Gabrys, 2016).

produce climate risks and setting climate targets emerge rather than being straightforwardly designed. A vast array of different types of financial investors, policy makers, service providers, NGOs and investor networks grapple with the challenges of producing data and developing devices and frameworks for climate risk assessment and climate alignment. In other words, these actors engage in infrastructural work, that is, creating, designing, putting in place, disseminating and adjusting data, devices and frameworks to produce and manage the Anthropocene by financial means. In this working paper, we ask: ***How does the infrastructural work for climate risk and climate alignment unfold and with what consequences?***

This paper is the beginning of a four-year research project that traces in real-time how the infrastructural work for financially redesigning the Anthropocene unfolds. We take a practice approach (Nicolini, 2012), focusing on what people do in practice, the resources and materials they use and the meanings they give to these activities. Data collection began in November 2020 and employs a multi-sited, team ethnographic approach (Jarzabkowski, Bednarek, & Cabantous, 2015; Jarzabkowski, Bednarek, Chalkias, & Cacciatori, 2019) involving currently two researchers (to be expanded to four) and four organizations (to be expanded to 10 to 12). In this paper, we present emerging insights from our ongoing data collection. We are very interested in hearing from EGOS participants what they find interesting and intriguing in our research and what they think about how our research could potentially contribute academically and practically to sustainability themes in financial markets.

THEORETICAL BACKGROUND

Sustainability and Risk Management in Financial markets

Incorporating sustainability in financial decision-making has thus far happened primarily through the impact perspective, that is, considering the impact that financial investments have on a range of environmental, social and governance (ESG) factors. Research in this area already highlights the importance of data and devices for incorporating sustainability in financial processes. Most studies investigate what form ESG information takes so that it can be most readily be integrated into financial decision-making. Several studies show that ESG information is quantified so that it can be used as 'data' in existing financial analysis (Crane, Graham, & Himick, 2015; Eccles, Krzus, Rogers, & Serafeim, 2012). However, Arjales and Bansal (2018) show that this does not necessarily have to be the case. They show how some equity managers used visuals to incorporate ESG information in their analysis. The visuals

enabled the managers to "analyze the ESG criteria not only for their financial insights, but also for the social and environmental information that could not be financialized" (Arjaliès & Bansal, 2018, p. 691). This indicates that both quantified 'data' as well as other contextual information in other forms are key to informing financial decision-making.

In turn, Beunza and Ferraro (2019) trace the emergence of an ESG calculative device over seven years. The product was developed and marketed by a US-based leading provider of financial data and technology and aimed to provide investors not only with ESG data but also enable them to do different kinds of analysis. Beunza and Ferraro (2019) uncover the ESG product's initial failures to gain traction in the market and how by enrolling key executives of the company, competitors and NGOs, the product over time became more successful. Their findings thus not only point to the importance of calculative devices in the provision of ESG information, but also to the importance of the relations amongst various actors in the development of infrastructural devices.

While the impact perspective has long dominated the approach to sustainability in financial decision-making, the risk perspective that emphasizes the risks environmental, social or governance factors pose to financial assets has only recently come to the fore with positing climate change as a 'material' risk to financial assets as well as the stability of financial markets. Thus, there are so far no academic papers in the area of organization studies that we are aware of that examine what happens when sustainability factors are regarded, measured and managed as material risks.

Notwithstanding, financial risk management itself is a long-established practice in financial institutions and has been studied extensively. Millo and MacKenzie (2009, p. 638) trace the emergence of financial risk management and show that the "remarkable success of today's financial risk management methods should be attributed primarily to their communicative and organizational usefulness and less to the accuracy of the results they produced." Risk management practices are often highly codified and regulated (e.g., Mikes (2009)) and rely on an array of sophisticated devices (Hall, Mikes, & Millo, 2015). In their study of risk managers at two UK-based banks, Hall and his colleagues (2015) show that risk management is driven primarily by numerous devices such as value-at-risk software, risk-adjusted capital models, risk maps and risk reporting frameworks. They uncover that adopting, deploying and reconfiguring these devices, what they refer to as "toolmaking" (Hall et al., 2015, p. 3), is crucial for risk managers to exert influence in financial institutions.

Together, existing studies on sustainability and on risk management in financial markets thus point to the importance of data, devices and regulatory frameworks that

underpin financial market practices. In actively intervening in the Anthropocene, market participants and other stakeholders leverage both the impact and the risk perspective. Therefore, we can expect that the financial climate knowledge infrastructures that emerge will build on and try to utilize existing ESG data, devices and risk management tools and regulatory frameworks. Indeed, in sustainability issues, such as climate change, the impact perspective and the risk perspective are deeply interrelated. Sustainability risks, and especially climate risks, cannot be managed in the traditional way of financial markets, but require to trace the individual as well as cumulative impact of financial investments on the Anthropocene ultimately on a collective level in such a way that the risks stemming from sustainability issues are limited to what is collectively acceptable while at the same time allocating accountability.

Infrastructures, knowledge infrastructures and infrastructural work

In colloquial language, infrastructure is always used as a substrate, that is, something upon which something else is "run" or "operates." For example, train tracks are the key infrastructural element for railroad transportation. Yet, as Star and Ruhleder (1996, p. 113) point out, "infrastructure is a fundamentally relational concept." Just as a tool that only becomes a tool when connected to a particular kind of activity (e.g., think of a weapon in the hands of an angry person versus a weapon in a museum), "infrastructure is something that emerges for people in practice, connected to activities and structures" (Star & Ruhleder, 1996, p. 112). Star and Ruhleder (1996, p. 113) use the example of a city water system: "the cook considers the water system a piece of working infrastructure integral to making dinner; for the city planner, it becomes a variable in a complex equation." From a relational perspective (Emirbayer, 1997), the question is not so much "what is infrastructure?" but rather "when is infrastructure?" (Star & Ruhleder, 1996).

Star & Ruhleder (1996) point out a number of dimensions that characterise infrastructures in practice. For our purpose, we focus on a few selected dimensions. First, infrastructures are transparent and largely invisible in everyday life, only becoming apparent in moments of breakdown or change. As Jackson et al. (2007, p. 5) write: "many of the infrastructures that support and govern modern lives, societies, and work practices will appear dull, flat, and still. The more settled the infrastructure, the truer this feels […] Once here, effective infrastructures appear as timeless, un–thought, even natural features of contemporary life." For example, in everyday life, we often take the roads, traffic lights and signs for granted until the road is flooded, the traffic sign is dismantled or the traffic light

suffers from an electricity blackout. Established infrastructures can thus be used in a natural, ready-to-hand fashion, but they still require ongoing work, often invisible, to be maintained.

Second, infrastructures are defined by their spatial and temporal reach beyond particular locations (Star & Ruhleder, 1996). They can be used in a ready-to-hand fashion in different locales for different purposes. For example, while I am out for a walk, I can use the mobile network to navigate; in a store, I can use it to access information about products; and while traveling, I can use it to connect with friends and family. Third, since infrastructures only emerge in relation to organized practice, they are deeply linked with the patterns and conventions of everyday life. One can think of the infrastructures of tennis courts, rackets and tennis balls, that are normed and produced according to certain standards and frameworks, as interlinked with the patterns and conventions of playing tennis. Fourth, infrastructures are always embedded in and draw on other infrastructures, social and material arrangements and technologies. As outlined earlier, the emerging infrastructures for climate risk and climate impact assessment are likely to tap into existing financial infrastructures (e.g., risk management frameworks) and ESG infrastructures (e.g., existing repositories of ESG data).

In this broader context of infrastructures, we focus on particular kinds of infrastructures, i.e., knowledge infrastructures. Edwards (2017, p. 36) defines knowledge infrastructures as "robust networks of people, artifacts, and institutions that generate, share, and maintain specific knowledge about the human and natural worlds." In other words, knowledge infrastructures support and enable the production of knowledge. Examples of well-functioning knowledge infrastructures include national census, weather forecasts, and other systems built to monitor environmental changes. Edwards (2017) outlines three common functions of knowledge infrastructures: (1) they monitor features of interests, such as carbon emissions, disease spread, mortality rates etc., (2) they model the systems they pertain to monitor to identify and test causal relationships, and (3) they record data in repositories to be able to track change over time. In that sense, knowledge infrastructures play two crucial roles: they mediate or 'sense' the environment, and they model and simulate this environment for monitoring, management and projection. One of the most well-known and most inclusive knowledge infrastructures is the IPCC (Intergovernmental Panel on Climate Change) whose knowledge base forms the basis for the negotiations under the UN Framework Convention on Climate Change (UNFCCC). This knowledge infrastructure is also drawn upon and used in the current efforts to assess climate risks and climate impact in financial markets.

While established infrastructures are often taken-for-granted and thus become invisible in the work of managers and analysts, they become a site for tensions and struggles when they are in-the-making (Jackson et al., 2007). Because a range of different interests compete in the development of infrastructures, tensions are likely to emerge and the way in which these are resolved will inevitably produce winners and losers. Yet, these tensions do not always have to be barriers. As Jackson and his colleagues (2007, p. 5) point out, tensions can also "become a chief site and source of infrastructural change, innovation, and learning over time." What's important is that in these sites of tensions, initial choices matter and "can continue to reverberate long after the initial conditions which shaped them have passed" (Jackson et al., 2007, p. 6). For example, the QWERTY keyboard that became the ubiquitous standard was partly designed based on feedback by telegraph operators that no longer exist today. In addition, in infrastructural developments there may be certain "sticking points" (Jackson et al., 2007, p. 3) that ground and stall further development, but once released periods of slow and incremental progress will be followed by more rapid and multi-facetted development.

To emphasize the efforts made in both maintaining and developing infrastructures, we use the notion of infrastructural work. While we are not the first ones to use this notion (Kaminska, 2020; McLoughlin, Garrety, Wilson, Dalley, & Yu, 2016), it does encapsulate and highlight the situated human and non-human efforts in creating, designing, adjusting and maintaining data, devices and regulatory frameworks. Since infrastructures always emerge in practice, they require ongoing and continuous work.

METHODS

This working paper is an early result of a four-year research project. The project officially started in October 2020, but it had a long genesis with the first author engaging in a preliminary pilot study between 2016 and 2018 and several exploratory discussions with potential research partners during the grant writing process. The project is funded by the UK Research and Innovation council. It's overarching aim is to trace in real-time over the course of three years of data collection how different organizations develop climate risk and climate impact solutions for financial institutions. The project started with the principal investigator (the first author), a PostDoctoral researcher (the 2nd author) and a PhD student. In fall 2021, we will hire a 2nd PostDoctoral researcher for the remaining three years of the project.

The project employs an inductive, ethnographic research approach that is based on deep immersion in, and close observation of the work of others (Ybema, Yanow, Wels, & Kamsteeg, 2009). Following the central idea of practice theory (Nicolini, 2012), the focus of

the data collection is on what people actually do in practice, the resources and materials they use and the meanings they give to these activities. In the current context of the pandemic, the data collection had to be adjusted to take place online, with a stronger focus on interviews and documents and participation in selected online meetings.

Because the emerging climate knowledge infrastructures is very much in-the-making, data collection needs to be adapted over time to capture key changes. What's more, it is important to move across multiple organizations to capture the complex web of interactions between organizations. While conventional ethnographic studies focus on studying well-bounded communities and organizations, this project draws on the notion of a mobile ethnography that prioritizes the phenomenon and follows it closely (Jarzabkowski et al., 2015; Marcus, 1995). We have operationalized this mobile approach by splitting the data collection into three waves. Each wave will last one year and at the end of which the project team will meet with an advisory panel to discuss plans for accessing other organizations.

We are currently in the first of the three waves of data collection, and we have selected four organizations as the starting point for data collection, each representing a different kind of actor in the larger ecosystem: (1) InsureCo (all names are pseudonyms) is a large multi-national insurance company, asset owner and asset manager. The company has worked collaboratively with many others to develop new approaches to climate risks, it has set ambitious climate targets and is currently integrating the climate risk metrics and climate targets into its governance, risk management and decision-making processes. (2) ProviderCo is one of the leading providers of climate data, tools and advisory. It is currently developing newly updated models for physical and transition risk assessment including more and new scenarios, new solutions for net zero target setting and new approaches for estimating Scope 3 GHG emissions data. (3) NetworkCo is a leading international investor network that has developed its own climate scenario, has collaborated with other NGOs to promote open-source models for climate risk assessment and that captures changes in the practices of financial institutions through its reporting tool. (4) NatureCo is an international NGO that works closely with investor networks and large asset owners to develop methodologies for climate target setting (e.g., how to become carbon neutral by 2050). Lastly, we have branched out of these four organizations to interview others who are recognized as key actors and knowledgeable experts in the field.

Each co-author is primarily responsible for the data collection at two of these organizations. However, we often also participate in interviews and meetings together to create a common understanding of the phenomenon being studied and of the four

organizations (Jarzabkowski et al., 2015). As we progress in our data collection in the future, we might divide the work more to go into more depth in each of the organizations. So far, in the first wave of data collection, we have collected 70 interviews, 56 observations and 5 public webinars (see Table 1 below).

Table 1: Overview of Data Collection in Wave 1

	InsureCo	ProviderCo	NetworkCo	NatureCo	Industry Experts	Total
Interviews	28	18	10	7	7	**70**
Observations	30	23		3	1	**57**
Webinars			2	1	2	**5**
Total	**58**	**41**	**12**	**11**	**10**	**132**

We aim to close our data collection for wave 1 at the end of July and then spend one or two months analysing our data and determining the focus for our fieldwork in wave 2. In wave 2 and 3, we will expand data collection to include additional organizations, so that in total we cover up to 10 to 12 organizations. However, given the exploratory research design, it remains to be seen whether this is necessary and or feasible.

FINDINGS

A brief history on climate-related financial risks and climate alignment

Efforts at developing and building knowledge infrastructures around climate-related financial risks and climate alignment started to emerge at the latest in 2015 with the Paris Agreement being signed at COP21, the United Nations annual climate change conference, and the landmark speech of Mark Carney, the Governor of the Bank of England. Carney (2015) called climate change the "Tragedy of the Horizon" because "the catastrophic impacts of climate change will be felt beyond the traditional horizons of most actors […] once climate change becomes a defining issue for financial stability, it may already be too late." Recognizing that climate change poses risks to financial assets and financial stability that are currently not priced into the market, the international Financial Stability Board created the Task Force on Climate-Related Financial Disclosure (TCFD). Its aim was to increase the amount of reliable information on corporations' and financial institutions' exposure to climate-related risks and opportunities. The TCFD recommendations were launched in 2017, asking companies and financial institutions to report on climate-related risks in four areas: governance, strategy, risk management, and metrics and targets. At the same time, France passed a law, Article 173, that for the first time required financial institutions to report on

how they take Environmental, Social and Governance (ESG) criteria, including climate change, into account in their risk management and investment policies (France, 2015). In 2018, the Principles of Responsible Investment (PRI), the largest investor network with more than 2400+ signatories, who represent US$89+ trillion in assets under management, asked its members to report on the TCFD indicators on a voluntary basis.

Initially, the focus was squarely on the risk management perspective and on the ability to disclose climate-related financial risks. NGOs like 2DII (2° Investing Initiative) developed open-source tools, such as the PACTA model, to enable financial institutions to assess the climate-related risks in their portfolios for the first time. Methodologies to assess transition and physical risks were in their infancy, as exemplified in the start-up Carbon Delta that aimed to develop a novel methodology for assessing and monitoring climate-related financial risks.

Fast forward to 2021 and the emphasis has shifted more towards impact. The EU Taxonomy requires financial market participants and large public interest companies to disclose whether investments contribute to climate change adaptation or mitigation, that is, how they impact on the climate crisis. Various financial institutions, countries and companies have committed to a net zero target, i.e., the ambition to reduce their GHG emissions to net zero by 2050. Such a net zero target is assumed to be in line with the Paris Agreement to keep global warming well below 2° and ideally to 1.5°[2]. The Net Zero Asset Owners Alliance, an initiative of 42 high-profile institutional investors, has just launched its inaugural Target-Setting Protocol that sets the benchmark for defining near-term targets for achieving net zero portfolio emissions. With the run-up to COP26 in Glasgow, a plethora of additional net zero initiatives have sprung up, including the Net Zero Asset Managers Initiative, the Net Zero Banking Alliance and the Net Zero Insurance Alliance.

At this stage, both the risk and the impact perspective together shape and influence the emerging financial climate knowledge infrastructure. As A125[3], one of our informants at a commercial service provider, explains, "how we see it is they [the risk and impact perspective] are developing in parallel. So the alignment, the impact angle is catching up quickly because of […] the net zero commitments, COP26, everybody wants to make kind of

[2] Net zero can easily be misunderstood as reducing human-caused greenhouse gas emissions to zero. However, net zero means to not emit any NET emissions anymore, that is, those emissions that cannot be avoided or reduced, are taken out of the atmosphere by carbon removal technologies, which, however, are not fully developed yet and it remains highly uncertain whether they can be sufficiently scaled.

[3] To protect anonymity, we have given each of the participants in our research an identifier number from A000 upwards.

big statements and then needs to follow that up. But for all intents and purposes, financial institutions remain driven by risk and return" (Interview, April 6th 2021). Moreover, in terms of data, the line between the risk and the impact perspectives becomes blurred. For example, in their TCFD report, InsureCo uses the measure of its carbon footprint for both assessing risk as well as impact on climate change: "We use [...] carbon intensity data to assess our investment portfolio's sensitivity to an increase in carbon prices [i.e., a measure of transition risk] and our progress to the 1.5°C Paris Agreement target [i.e., a measure of impact]" (InsureCo, TCFD Report 2020).

In the meantime, methodologies for assessing climate risk and climate alignment have become more sophisticated and multi-layered. With a continuously high number of mergers and acquisitions, the commercial service provider market has become more consolidated with large players like MSCI, S&P Global, ISS and others coming to increasingly dominate the market for climate data and climate analytics. Because financial institutions require a seamless integration of these tools and data into their own risk management and portfolio management systems, commercial service providers with their existing platforms retain an advantage over solutions developed by NGOs. Yet, there is still a lot of work-in-progress, as service providers continue to further develop climate risk and alignment methodologies based on their clients' demands. As A125 said: "For the moment I think […] It's developing so fast. I mean it's like that client said "it's an arms race, the positive way" (Interview, April 6th 2021). Many are concerned about the heterogeneity of different approaches to measuring climate risk and alignment and the lack of comparability between them. Especially for climate alignment, "that's more of an open field […] and it's still very unclear what will be kind of the standard to go with" (A125, Interview, April 6th 2021). One potential run-up, for instance, is the Science-Based Targets initiative (SBTi), a framework set up by four NGOs that supports and assesses target setting of corporations – A165 from ProviderCo tells us that SBTi "is not yet seen as the gold standard but, you know, [already] ideally you have a science-based target validated [by SBTi]." (Interview, June 3rd 2021) In a similar way, there is considerable uncertainty and confusion about which climate scenarios to use as a basis for assessing climate risk and climate alignment. Initially, the climate scenarios by the IPCC (the Intergovernmental Panel on Climate Change) and the IEA (International Energy Agency) served as a baseline. However, new scenarios have emerged, such as the PRI's Inevitable Policy Response and the IEA's latest Net Zero Scenario that sets out more than 400 milestones for what needs to be done to reach net zero.

In conclusion, financial climate knowledge infrastructures are emerging, but, as many in the field acknowledge, they will require ongoing work and continuous change in the years to come. In the following, we zoom into these infrastructures-in-the-making and describe a few early insights about how this infrastructural work unfolds on the ground.

Infrastructural work on climate risk and climate alignment

While each of our four research partners engages in infrastructural work in their own ways and in collaboration with others, in the following we describe the picture that emerges when their work is considered together as part of a broader, collective effort at building and shaping the emerging climate knowledge infrastructures. We describe three main observations from our ongoing fieldwork that capture different facets or dimension of infrastructural work.

Observation 1: regulatory frameworks, principles and recommendations, and material data and tools

The efforts of various different organizations in shaping the emerging climate knowledge infrastructures can broadly be clustered into three main modes of infrastructural work: (1) regulatory frameworks (2) voluntary principles and recommendations, and (3) material data and tools. Examples for regulatory frameworks include the EU's Sustainable Finance Disclosure Regulation (SFDR) that requires disclosure of sustainability risks of different financial activities (EU, 2019), the EU Taxonomy for investments in 'green' activities (EU, 2020) and the efforts of various countries to make TCFD disclosure mandatory. Voluntary principles and recommendations include, for example, the TCFD recommendations for how to disclose climate-related financial risks, the NZAOA's protocol for setting net zero targets and principles for how to measure financed emissions for different asset classes that were developed by PCAF, the Partnership for Carbon Accounting. Lastly, examples for material data and tools include the GHG emissions data that is collected and curated by service providers, the climate scenarios that are developed by climate scientists, the models that financial institutions develop to assess their exposure to climate risks and the internal governance, risk management and reporting tools they use for monitoring and managing climate risks and climate alignment.

Put simply, regulatory frameworks stipulate *that* climate risk and climate alignment need to be measured and disclosed; voluntary principles and recommendations suggest *how* this should or could happen; and material data and tools are used to actually *do* the work, i.e., to measure and manage climate risk and climate alignment. In our research, we focus

primarily on the latter two modes, i.e., voluntary principles and recommendations as well as material data and tools. Due to their positioning in the larger ecosystem, two of our case organizations, i.e., NetworkCo and NatureCo, focus mostly on infrastructural work on principles and recommendations, while the other two organizations, InsureCo and ProviderCo, focus mostly on material data and tools – yet, they also engage from time to time in infrastructural work in the other mode. We capture those aspects of regulation that directly pertain and interact with principles and recommendations as well as data and tools, while regulation as a research object itself and as a whole falls out of our study's scope.

Infrastructural work happens in all of these three modes at the same time because, on the one hand, many argue there is no time to lose, i.e., we cannot wait any longer to intervene in the Anthropocene, and on the other hand, because of the high uncertainty around what appropriate solutions actually are, a top down solution cannot be imposed through regulatory frameworks, but will emerge 'organically' over time. Importantly, infrastructural work in one mode is not separate and independent of the infrastructural work in the other modes, but they mutually shape and influence each other. To illustrate this dynamic, we provide the example of the TCFD recommendations and how they evolved over time.

Vignette 1: TCFD recommendations and their evolution over time

The TCFD recommendations started as a voluntary initiative for corporations and financial institutions to disclose climate-related financial risks and opportunities, i.e., they started as *(1) voluntary principles and recommendations*. As several leading financial institutions started to disclose climate risks according to TCFD recommendations, they produced the actual data and reports for climate risks and opportunities (i.e., *from (2) voluntary principles and recommendations to (3) material data and tools*). In particular, investors, such as InsureCo, reported the GHG emissions associated with their investments through a metric that was recommended by the TCFD, i.e., the weighted average carbon intensity (WACI[4]), also often known as the 'carbon footprint' of a portfolio. In doing so, however, the limitations of this metric became apparent: the data used for calculating WACI still had gaps and sometimes raised concerns about quality; it was a backward-looking measure that did not consider how emissions might develop in the future; and, as A226 of a large institutional

[4] The metric measures exposure to carbon-intensive companies by calculating the carbon intensity (Scope 1 + 2 Emissions / $M Sales) for each portfolio company and calculating the weighted average by portfolio weight. Scope 1 covers direct emissions from owned or controlled sources. Scope 2 covers indirect emissions from the generation of purchased electricity, steam, heating and cooling consumed by the reporting company.

investor explained, it was difficult to communicate the measure to clients: “We can’t tell them our carbon footprint changed from this to that. They don’t even know what a carbon footprint is” (Interview, March 4th 2021). As a result, numerous efforts emerged to create and develop better forward-looking metrics, in particular methodologies for ‘implied temperature rise’ that indicate the warming potential of an investment portfolio. Warming potential means that the current portfolio and the companies in it are on a trajectory of achieving a certain degree of global warming, such as, for example, 2.8 or 3.0°C. The main advantage of such a new metric is thus that it can readily be compared to climate targets and easily be communicated to various stakeholders, in particular, clients.

Yet, these methodologies were also highly contested. As A117 at NetworkCo describes “with that there's just such a concern about methodological divergence being so vast that, you know, it would be a meaningless metric” (Interview, May 18th 2021). In addition, the data that is used as input to these models is controversial. A058 from NetworkCo explains that, from what she has seen, the service providers “use data that is estimated top down from climate models. That data doesn’t come from companies; it’s not reported by companies. That’s just plain wrong […] Temperature alignment metrics only make sense when it is fully transparent how they are calculated. And when the data, that goes into the model, is correct [i.e., company reported data]. [The problem is when there is...] garbage in, garbage out and blackbox in between” (Interview, February, 16th 2021).

As a result of these struggles around material data and tools, various actors recognized the need for developing principles and recommendations for forward-looking methodologies and metrics (i.e., *from working on (3) material data and tools to working on (2) principles and recommendations*). For example, the NZAOA has drafted, reviewed and finally published a paper on methodological criteria for forward-looking climate risk and climate alignment methodologies. Similarly, the TCFD has launched several consultations on forward-looking methodologies and metrics and is seeking to publish technical guidance on both appropriate metrics and methodologies in fall 2021.

There are at least two other consequences of the increasing disclosure according to TCFD and the efforts of financial institutions to measure and manage climate risks and climate alignment. On the one hand, most financial institutions, if they disclose their climate-related financial risks use the WACI metric to measure their carbon footprint because, despite its limitations, it is the metric that can be calculated most readily. As a result, WACI has “kind of take on a momentum and become like the standard. And so whether you like it or not, you have to work within that system” (A117, Interview, May 18th 2021) (i.e., *from (2)*

proposed principles to (2) enacted principles/ a de facto standard). In addition, as disclosure according to TCFD on a voluntary basis is becoming more widespread with more than 2,000 corporations and financial institutions already disclosing according to TCFD recommendations, regulators are seeking to make TCFD disclosure mandatory (i.e., *from (2) voluntary principles and recommendations to (1) regulatory frameworks*). In 2020, the UK announced to make TCFD disclosure mandatory by 2025. Switzerland, Hong Kong and New Zealand soon followed suit. At the beginning of June 2021, the G7 nations mandated climate reporting in line with the TCFD recommendations (Mair, 2021). Changes in regulatory frameworks will again spur new developments in material data and tools, as more corporations and financial institutions will seek and work with climate data and climate risk and alignment tools. These dynamic interrelations between infrastructural work in these three modes can be expected to continue in the coming years.

Observation 2: Infrastructural work unfolds through material and social relations

The material and social relations between different people, materials and organizations are key to how infrastructural work unfolds. In the following, we recount the example of GHG emissions data, how it is collected and curated at data providers (taking ProviderCo as an example) and how it is used and processed at financial institutions in order to measure the carbon intensity of a portfolio (taking InsureCo as an example). This is thus an example of how infrastructural work in the mode of material data and tools unfolds amongst different people, devices and organizations.

Vignette 2: Collecting and curating emissions data at ProviderCo (June 4th 2021)

A082, the head of the data collection team at ProviderCo, meets on Microsoft Teams with new members of his team to discuss how to go about collecting GHG emissions data for the year 2020. In their internal database, he pulls up a European foodservices company that he describes as "not so straightforward." He accesses the company's website on the Internet and checks for the latest sustainability report. There he searches for the keywords "emissions" and "CO2" and the search directs him to a page with a table depicting different measures of emissions. The team tries to make sense of the numbers, but there is information that do not sum up and some underlying assumptions are not explained. In particular, the company appears to estimate emissions data by making assumptions about how many CO2 emissions are produced per kWH in each of their restaurants – this estimate doesn't make sense to A082. He concludes that "this looks very unreliable to me." He goes to Bloomberg Terminal

to cross-check what Bloomberg reports on emissions, but Bloomberg does not provide reported emissions data either. CDP (the Carbon Disclosure Project), another data source for emissions reported through the CDP framework, has not yet published the emissions data for 2020. A082 concludes that the company's reported emissions are not reliable and that they should go for estimating emissions data based on their internal regression models, like they did last year. He makes the appropriate changes in the database and leaves a comment as to why he decided to estimate emissions data for this company. The team then moves on to discuss other difficult cases of collecting emissions data.

Vignette 3: Using emissions data to measure the carbon intensity of an investment portfolio at InsureCo

InsureCo uses a different data provider to access emissions data, but the process would be fairly similar to ProviderCo's clients as we gather from initial conversations with InsureCo's provider. InsureCo accesses its provider's emissions data through an Internet platform, similar to the one that ProviderCo provides to its clients. Usually, A006 from InsureCo's group climate risk team uploads an Excel spreadsheet with a list of its assets (e.g., equities and credit) and the system generates the carbon emissions for each asset by matching the ISIN (International Securities Identification Number) number in the Excel spreadsheet to the ISIN number in the provider's system. A006 then downloads this emissions data and feeds it into InsureCo's proprietary climate model. Yet, not all of the assets in InsureCo's portfolio are readily available. For example, information about the assets that InsureCo holds on behalf of its customers, are not readily available in a database and A083, another member of InsureCo's climate risk team, is liaising with various other people across InsureCo's business to get that information and be able to feed it into their climate risk model (Observation, June 11th 2021).

On May 7th 2021 (Observations), InsureCo's climate risk team meets for its weekly climate stand-up. A123 reports on the progress she has made on producing the numbers for the first quarter (Q1) for the quarterly business reporting. This is the first time, InsureCo includes climate-related metrics in its business reporting because last year InsureCo has set carbon reduction targets as part of its business plan. A006 has helped A123 produce the metrics by running the climate model and calculating the weighted average carbon intensity of InsureCo's portfolios. A123 is concerned that for some business units of InsureCo the carbon intensity has increased rather than decreased. A123 suspects that there have been changes in the exposure and she wants to make sure that the assets they used at year-end

2020 to measure carbon intensity are the same kinds of assets that they use for the Q1 metric production. In other words, she wants to make sure that they are comparing "like for like." A006 is still working on the analysis of change, which breaks down the changes in the carbon intensity metric into (a) changes in exposure, i.e., the underlying assets, and (b) changes in emissions score of companies. When there are surprising "jumps" in the numbers, A006 and A083 have to do a deeper analysis to find out where changes in carbon intensity come from. On May 7th, InsureCo's climate risk team discusses talking to others at one of InsureCo's business unit to better understand changes in exposure. In other instances, it involves going back to InsureCo's data provider to inquire why the emissions scores for a particular company have changed.

Analysis of the two vignettes

The two vignettes reveal how producing a single measure of climate risk, as materialized in the carbon intensity metric of a portfolio, is not straightforward, but requires a lot of work that unfolds between different people (e.g., between A082 and his team; A006, A083, A123 and other InsureCo members), different devices (e.g., ProviderCo's database, company sustainability reports, InsureCo's database of assets) and organizations (e.g., ProviderCo and its clients, InsureCo and its data provider).

In addition, the two vignettes also reveal three aspects of these social and material relations that we have identified as prominent in shaping how infrastructural work unfolds: (1) market and competitive dynamics, (2) epistemic dynamics, and (3) material dynamics. Market and competitive dynamics refer to the competitive interests of firms and other institutions, such as, securing profits, survival, market positioning etc. One way in which the market dynamics manifest themselves is in the need for data providers to be able to cover the GHG emissions of a large universe of companies. "Coverage is everything, and coverage can only be achieved with a lot of people" as A144, the executive of ProviderCo's climate team, notes (Interview, May 17th 2021). The team's data research lead adds, that it is critical to "have a very good number in terms of coverage. You know, that's a good number to brag about, saying we have [X thousand[5]] companies for which we have data" (Interview, May 31st 2021). Similarly, A134 from InsureCo explained that when they search for a data provider for GHG emissions, one of the key criteria, besides methodology and data sources, is the scope of the companies and financial instruments that are covered by the data provider

[5] Due to confidentiality reasons, we do not disclose the exact number of companies ProviderCo covers.

(Interview, May 20th 2021). Competitive dynamics also become visible in InsureCo's business plan where it has set targets for reducing the carbon intensity of particular asset classes and portfolios. Because senior management is now responsible for achieving these targets and these are reflected in their renumeration, A123 from InsureCo's climate risk team asserts that, if the numbers are not going in the right direction "we need to be certain […] and we need to understand what drives these changes" (Interview, June 7th 2021).

Epistemic dynamics refer to the complexities in how knowledge is produced. These are visible in various places in Vignette 1 and 2. For example, A082 needs to make informed judgement calls as to whether reported emissions data is reliable or not. These judgement calls are, on the one hand, grounded in his previous industry experience as an engineer assessing sustainability aspects of on-the-ground industrial sites and sustainability projects. On the other hand, he looks back at several years of GHG emissions data collection and the setting up of ProviderCo's internal emissions database, which equips him not only with considerable knowledge on the various ways emissions data manifest in firms' reporting but also on the delicate relationships of those data with other, connected datasets throughout ProviderCo's other databases.

Where data is not reported reliably or is not reported at all, ProviderCo, similar to other data providers, uses regression models that estimate the GHG emissions of a company. These regression models in turn are calibrated through the reported emissions data that ProviderCo has collected and their correlated relationships with other company data such as revenue or number of employees. In other words, 'actual' GHG emissions data, other company data, and regression models and estimated GHG emissions are epistemically deeply, yet sometimes ambiguously, entangled. This entanglement of data and models is also visible in company's reported emissions data because very often this data is not directly measured through sensors, but also estimated based on methods and metrics from different frameworks, such as the GHG Protocol. For example, the reported emissions data of the food company in Vignette 2 was estimated by the company using assumptions about GHG emissions per kWH of electricity consumed.

Yet, epistemic issues do not stop with the collection of GHG emissions data, but they are carried forward into the work of financial institutions. At InsureCo, for example, the 'analysis of change' has become a crucial tool to understand where changes in the carbon intensity of a portfolio come from. If there are changes in carbon intensity that are not in line with expectations (i.e., not decreasing in line with targets), it requires additional work to trace these changes back to changes in either exposure or emissions data (and their underlying

estimation methodologies), to develop appropriate explanations and to make expert judgements as to how data and/or models need to be adjusted to accurately report the carbon intensity of a portfolio.

Lastly, material dynamics refer to what data and tools are readily available and what is not, and the material challenges of integration of current or to-be-developed combinations of data and tools. For example, as ProviderCo's data collection team works to increase the scope of the companies that it covers in its GHG emissions database, A082 realized that language can be a barrier to collecting emissions data from sustainability reports that are published in specific languages with non-Roman letter systems. While sometimes using translation software helps understand some languages, the word search function in the many pages-long reports for terms such as 'carbon dioxide', 'emissions' or 'methodology' does not work here. A082 tries to work with ProviderCo employees in other regions to gain access to these reports, which for instance in the case of a Taiwanese company was fortuitous since there happened to be a Taiwanese speaking colleague in an Australian office – this is also where epistemic dynamics bleed into material ones.

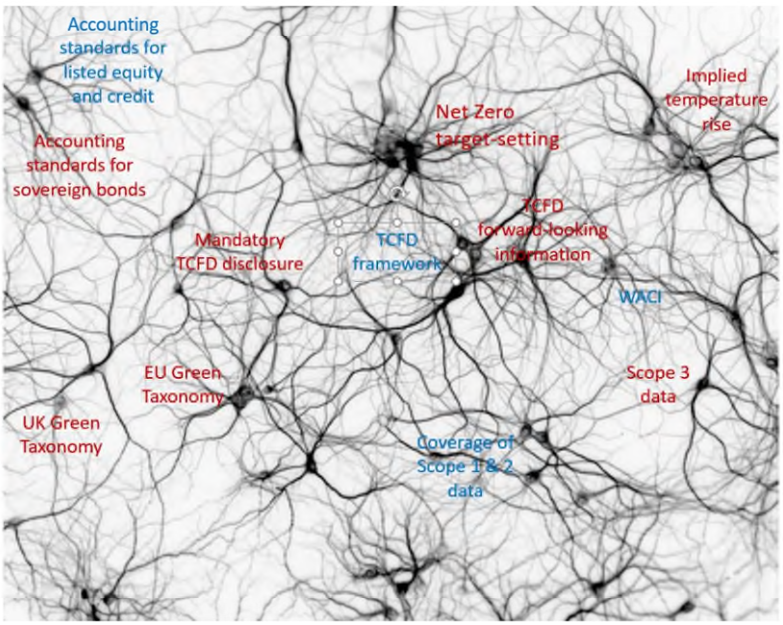
Another example for material dynamics are the various databases at ProviderCo, which feed into one another for a number of data points. For instance, from an investment perspective, emissions of subsidiaries of larger conglomerates need to be matched to those parent holdings. ProviderCo has a separate database which holds and tracks ownership relations between economic entities (both firms and issued financial instruments) and was originally set up to for corporate governance analyses, not for climate-related functions. These shares in sometimes joint ownership relations need to me matched with emissions data shares which are, for instance, sometimes not updated at the same time and result in problems of emissions data attribution. At InsureCo, the information about some assets is readily available in a database, but other information, such as, about funds that InsureCo holds on behalf of its customers, is not readily available. As a result, A083 needs to work with others at InsureCo to create a data feed that can bring that information into the climate model and make it available for measuring carbon intensity. These material dynamics, although they may appear mundane, can be significant in shaping how climate risk is measured, monitored and managed.

Observation 3: Infrastructural work as rhizomatic work

When we zoom out to understand how infrastructural work unfolds on a larger scale, we see a rhizome-like interlinking of different areas or nodes of infrastructural work[6]. A rhizome is a subterranean plant that grows underground horizontally and sends out roots and shoots from its nodes. In a similar way, in the emerging financial climate knowledge infrastructure we observe several nodes that are the focus of infrastructural work and that are interlinked through various connections. In this infrastructural landscape, there is no center, but the various nodes rely on each other for growth and sustenance.

Similar to a rhizome that continuously grows and extends horizontally, forming new nodes as it grows, the emerging knowledge infrastructure is continuously changing, with new areas of work emerging and new connections forming between existing nodes. As new nodes and connections emerge, existing nodes also transform and change. Some nodes may become 'hot', as infrastructural work in that area concentrates and accumulates whereas other nodes may grow 'cold', as there is less focus and attention on them.[7] In other words, a 'hot' node is an object of concern and struggle for many different actors, whereas a 'cold' node has become more stabilized and taken-for-granted. Figure 1 illustrates a few, albeit by far not all, of the nodes we have identified in the emerging climate knowledge infrastructure and whether we consider them 'hot' nodes (depicted in red) or 'cold' nodes (depicted in blue).

Figure 1: Rhizomatic landscape of emerging climate knowledge infrastructures



[6] Here we use the rhizome purely as a metaphor for our observations. The rhizome has also been used theoretically by academics (e.g., Deleuze and Guattari (1988)). We will explore these resources going forward.
[7] With the notions of 'hot' and 'cold' nodes we loosely refer to what Callon (2009, p. 541) has called 'hot' and 'cold sources' as manifestations of experimentation in early carbon markets and to what Latour (2004) has referred to as 'matters of concern' and 'matters of fact.'

Because the rhizomatic infrastructural landscape continuously changes, what used to be a 'cold' node can quickly become 'hot' and vice versa. The important point is that things keep changing. To illustrate some of the dynamics that emerge in the rhizomatic landscape, we explore the node of net zero target-setting that has only emerged recently but that has quickly become very 'hot'.

Vignette 4: The debate and ongoing struggles around net zero target-setting

As indicated in our brief history of the field, net zero target-setting emerged in the financial climate knowledge infrastructure as a noticeable node in the first half of 2020 when the Net Zero Asset Owners Alliance (NZAOA) began its work and slowly more and more financial institutions started to make net zero commitments. By now, it has become almost unfashionable for financial institutions not to have a net zero commitment. The hype around net zero has become intensified through the launch of a "Race to Zero Campaign" by the United Nations that aims to mobilize commitments to half emissions by 2030 and achieving net zero emissions as soon as possible and by 2050 at the latest. Beyond the 'hype', however, there are real infrastructural challenges. As A176, the Head of Sustainability of a large Nordic asset owner, points out: "Yes, we are all committed to net zero, but then […] as a broad, universal investor, how do you do this [setting targets]? What methodologies exist? How do you steer your portfolio, etcetera?" (Interview, June 15th 2021). As A144 from ProviderCo during an internal session on the current landscape of net zero initiatives points out, "I mean, it's quite a jungle for financial institutions to find their way through these different net zero commitments and requirements and frameworks." (Observation, May 20th 2021). Especially those firms who have so far not been at the forefront of ESG and climate themes, they "need someone to hold their hands at the moment", as one of ProviderCo's client manager told us (Interview, June 6th 2021).

One area of intense work around net zero lies in setting out principles and recommendations for setting targets, including what climate scenarios, metrics, base year, time horizon and asset classes to use in order to set-targets and measure progress. The NZAOA with its net zero Target Setting Protocol has laid some ground work for target-setting, but other initiatives, like the SBTi-Finance and the IIGCC Paris Aligned Investment Initiative similarly have developed principles and recommendations. An example for the intense struggles and negotiations evolving around these principles and recommendations is the NZAOA's suggested target for carbon reductions by 2025. Setting carbon reduction targets for 2025 was a cornerstone for the NZAOA's Protocol because it was the means by

which the high-level net zero commitments were supposed to be translated into short-term targets by which financial institutions can be held accountable. As A094, a representative of InsureCo at the NZAOA, recounts: “So, initially, the target that the Alliance was about to suggest was minus 27% because we wanted to be very ambitious. But then there was like, some of the asset owners, […] they pushed back quite a lot […]” A094 explains that those asset owners felt with this target they would have to divest massively with some unintended consequences. “And whatever target the NZAOA set, it shouldn't conflict with investment priorities and engagements [This] is really the way to achieve the target. So after that discussion, there was a compromise to say that asset owners can choose between -16 to minus 29%” (Interview, June 22nd 2021).

Moreover, struggles around principles and recommendations for net zero target setting are also deeply interconnected with the material data and tools. NatureCo, for instance helped create an alignment tool that incorporates specific principles they want financial institutions to integrate in their target setting and investment decision making. Here, having practical knowledge and experience in the investment industry is central for NatureCo’s ‘injection’ of their criteria into financial practice by material and relational infrastructural work. A042 of NatureCo explains that “if you've been in that industry, you realize that no one will use that [NatureCo’s alignment tool] of the people who actually matter in the decision making process, the portfolio managers and the analyst, they will try it out and then they won't use it.” Tools need to be integrable in principle and integrated materially onto existing, more stable infrastructures in order to have an effect: “you need to have it on your Bloomberg Terminal, that's where it needs to be because that's where the decision is made. And therefore we sort of included a lot of service providers in this development process around the tool.” (Interview, June 3rd 2021).

What work can be done within the net zero node is influenced and shaped by the work that is happening in other nodes in the infrastructural landscape. For example, the Protocol of the NZAOA posited that “the asset classes that should be included in the sub-portfolio target are listed equity, publicly traded corporate bonds, and real estate, because carbon emissions data are more readily available for these asset classes [… and] the metrics supported by organisations around the world are readily available to be used by the Alliance […]. The carbon emissions included in the first iteration of the Alliance portfolio target are the Scope 1 and Scope 2 of the portfolio companies (as the consistency of Scope 3 data is not robust enough to be used by members of the Alliance for target setting)” (NZAOA, 2021). In other

words, because Scope 1 and 2 emissions data[8] and carbon accounting standards for public equity, bonds and real estate have seen significant infrastructural work in the past, they can now be readily incorporated into the work of the net zero node.

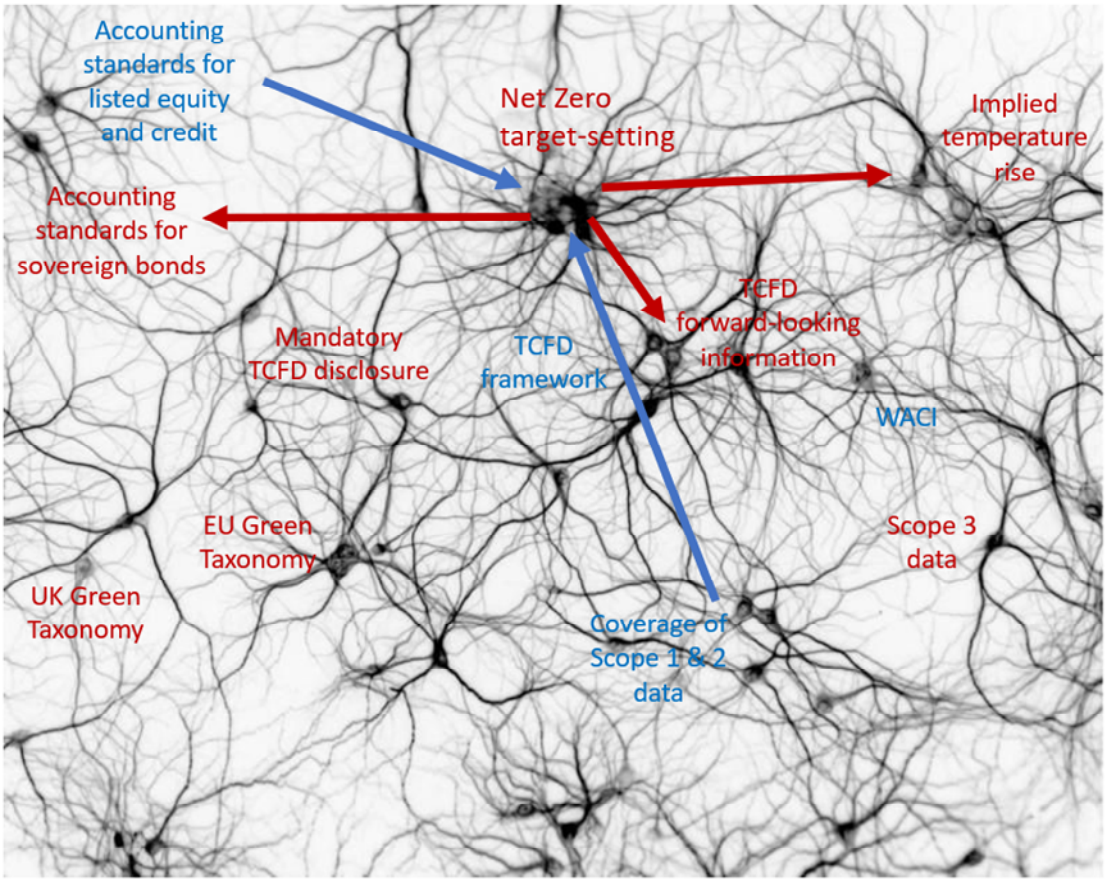
Yet, the reverse relationship is equally important: As work on the net zero node intensifies, this also has repercussions and consequences for other nodes in the emerging infrastructural landscape. For example, A176, who is also a member of the NZAOA, describes how the Alliance "decided that […in] 2021, we should address sovereign bonds and infrastructure, i.e., defining methodologies and principles for how to set targets in these types of asset classes so we can include them in the protocol […] We launched a kind of sovereign bond working group in the Alliance and we realized that, OK, what is the first thing you need? Well, you need a proper carbon accounting methodology for sovereign bonds. And naturally, then we go to PCAF and PCAF was thinking about the same thing, that we need to include sovereign bonds in our standard." (Interview, June 15th 2021). As depicted in Figure 1, carbon accounting standards are another node in the emerging knowledge infrastructures that had existed before the net zero node emerged, but its work is now intensified through the infrastructural work that is happening at the net zero node.

A058 describes another shoot that emerged from the net zero node and interlinked with efforts at revising and updating the TCFD principles and recommendations: "What we need from companies is their targets, in the medium and long-term. Here we are engaging very closely with TCFD; that TCFD disclosure also includes forward-looking target setting, ideally in a standardized way. So that we have disclosure, not only of the [current] footprint, but also forward-looking pathways" (Interview, February 16th 2021). Lastly, work on the net zero node also reinforces the work that is being done on implied temperature rise methodologies. Even though the NZAOA recognizes the many limitations to the carbon footprint approach and they saw a great potential in implied temperature rise methodologies, they also felt that the problems with the underlying data and the divergence in methodologies as described in Vignette 1 meant that currently implied temperature rise methodologies were not yet mature enough to be included in the first iteration of the target-setting protocol. The NZAOA has established a working group on implied temperature rise methodologies that

[8] The GHG Protocol, the most widely-used and recognized international accounting standard, categorises GHG emissions into three groups or 'Scopes'. Scope 1 covers direct emissions from owned or controlled sources. Scope 2 covers indirect emissions from the generation of purchased electricity, steam, heating and cooling consumed by the reporting company. Scope 3 includes all other indirect emissions that occur in a company's value chain, such as, emissions from purchased goods and services or from upstream and downstream transportation and distribution.

liaises with others working on that node in the infrastructure. Figure 2 visually depicts the interlinkages between the net zero target-setting node and other nodes in the emerging climate knowledge infrastructure.

Figure 2: Linkages between the net zero target-setting node with other nodes



A note on cold nodes: As depicted in Figure 1 in blue and described in Vignette 4, some nodes in the rhizomatic infrastructural landscape can currently be considered rather 'cold.' For example, as described earlier, WACI has become a widely accepted and taken-for-granted metric for measuring the carbon intensity of an investment portfolio. Similarly, carbon accounting standards for listed equity and credit investments (as published by PCAF) are settled and widely accepted. Scope 1 and 2 emissions data is also less of a concern for most participants. As A134 from InsureCo describes: "So scope 1 and 2 in high impact sectors in developed markets, the data is actually pretty good" (Interview, May 17th 2021). Even though these nodes are somewhat 'colder,' they will only become fully stabilized data infrastructures once they are deeply integrated into other existing and stable infrastructures, such as Enterprise Resource Planning (ERP) systems by, for instance, SAP. Similar to A042 of NatureCo and how they use existing infrastructures to stabilise newer ones, A082 of

ProviderCo explained to us, “somebody comes up with a solution which is easy to integrate into all these corporate reporting frameworks, which are already existing, simple software that can be plugged into their existing reporting mechanisms.” Thus, as nodes become ‘cold’ they take on the infrastructural properties of established infrastructures: they become “un-thought, even natural features of contemporary life” (Jackson et al., 2007, p. 5). However, just because these infrastructural elements move more into the background does not mean they become less important: in fact, because they have developed stronger infrastructural properties, they serve as standardising elements throughout the infrastructure and powerfully shape and structure practices.

In conclusion, the rhizomatic perspective on infrastructural work reveals how this work unfolds through various interconnected nodes that continuously change over time and influence and shape each other. Currently our ongoing fieldwork traces and maps these different nodes and connections and how they evolve over time.

Consequences of infrastructural work: Influxness, Financial Anthropocene and multiplicity

The dynamics of infrastructural work that we have described in the previous section, have consequences, both for financial markets and their relationship to the climate crisis. Here we will focus on three consequences that stand out for us. First, currently there is a *high degree of influxness*, whereby things are constantly changing and sometimes very rapidly. As the Vignettes in the previous section depict, influxness is driven by the fact that infrastructural work in different areas or modes influence each other (e.g., developments in terms of material data and tools have repercussions for the development of principles and recommendations), that infrastructural work unfolds through the relations between different people, devices and organizations and that infrastructural work is rhizomatic, with work in one node influencing and shaping work in other nodes and vice versa. On a practical level, the high degree of influxness means that all stakeholders remain very vigilant and closely trace the dynamics that unfold in the larger field. To some degree, it also undermines the development of the field, as A125 points out: “I also have to say that it doesn't necessarily help trust because it gets them [i.e., financial institutions] so confused and they're like, OK, but these people are doing that and that and that. And what should I trust? And that's hard because, of course, essentially they don't know anything about climate yet. And then there's a big danger that they kind of wait and wait and wait and wait because they want to see what's happening” (Interview, April 6th 2021). For our research project, the high degree of influxness presents

particular methodological challenges because it is difficult to pin down what exactly we want to trace and how.

Second, the emerging financial climate knowledge infrastructure produces a particular version of the Anthropocene, that is, a '*Financial' Anthropocene*, that is shaped and influenced by competitive dynamics in financial markets and the broader economy. For example, Vignette 4 describes how competitive dynamics between different asset owners shaped the acceptable range of carbon reduction targets of the NZAOA for 2025. This acceptable range of carbon reduction targets in turn will have material consequences once asset owners commit to these targets and start to take action in line with them. It is important to recognize that knowledge production in the context of competitive markets is never value-free or value-neutral but necessarily driven by particular goals (e.g., profits, survival, market positioning). The aim in producing knowledge about climate risks and climate impact is not to produce a generalisable truth but to enable competitive economic action within markets. Even though, of course, that is the underlying premise for leveraging financial markets to intervene in the Anthropocene in the first place, it is nevertheless important to recognize the consequences of such choices for the development of the Anthropocene. Also, whether and how a 'financial Anthropocene' will converge into an 'actualised' Anthropocene 'reality' remains to be seen and is at the moment highly uncertain.

Third, we observe a *high degree of multiplicity* in data, in models, in climate scenarios and in regulatory frameworks. This multiplicity is a direct consequence of infrastructural work unfolding through different social and material relations and a direct consequence of the varied market and competitive interests shaping infrastructural work. For example, in collecting and curating GHG emissions data, the employees of service providers draw on varied sources, rely on different expertise, use different regression models and make varied interpretive judgements, resulting in variation in how the GHG emissions of a particular company are reported or estimated. Similarly, when financial institutions measure climate risk and the alignment of their portfolios to climate targets, they draw on different sources, use varying models and make different expert judgements depending on the people involved in the discussions. What we thus have is a multiplicity of climate risks and climate impacts (i.e., a multiplicity of representations of the current state of the Anthropocene) and a multiplicity of future projections of the Anthropocene.

To some extent, multiplicity is desirable and an underlying premise of using markets to intervene in the Anthropocene. Multiplicity is perceived as beneficial because it enables the genesis and survival of different business models, it spurs innovation and it reduces

systemic risks. At the same time, multiplicity is also a characteristic feature of practice, not just in competitive markets but also in other spheres of society (e.g., Mol, 2002). Because the practices in one locale differ from the practices in other locales, they will necessarily produce different versions of the same thing, i.e., multiplicity.

At this stage in the research, we are puzzling over the consequences of this multiplicity. If the Financial Anthropocene is partly about allocating accountability and ownership – for example, an investor is accountable for the GHG emissions that its portfolio produces – then what are the consequences of multiplicity for this accountability? What repercussions will it have for who 'owns' the climate crisis? Likewise, current programs of financially redesigning the Anthropocene are aimed at producing different versions of Anthropocene futures, i.e., different climate scenarios as projections of the climate crisis in the future and their individual contextualisation as by financial institutions, service providers, etc. Yet, what are the consequences if financial institutions draw on multiple and varying projections of the future? As A176, the Head of Sustainability at a large Nordic asset owner, explains, the question of multiplicity in climate scenarios "is extremely important because normally when we talk about climate scenarios, everybody has been saying that standardization cannot be done. And I'd say that it can be done, depending on the objective. If the objective is […] 1.5°C, you need standardization because otherwise, if the financial sector is not taking action in a collective way with the same assumptions, you don't have the impact" (Interview, June 15th 2021).

Conclusion

In this working paper, we have laid out some initial observations from our ongoing fieldwork on current attempts in financial markets to intervene in the Anthropocene by measuring and managing climate risks and climate impact. We hope that our research will yield new insights for practice, that it will help to better understand how the relationship between sustainability and financial markets is currently changing and that it uncovers some of the underlying mechanisms and dynamics when a multitude of different organizations and stakeholders are addressing a large issue that is beyond the control of any one organization. We particularly look forward to your ideas and comments about where our research could go in the future and what it's potential contribution could be to varying matters of concern.

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