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Contested Environmental Futures: Rankings, Forecasts and Indicators as Sociotechnical Endeavours

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To Vale, María and Gustavo, because you have shown the purest forms of love

Abstract

In a world where numbers and science are often taken as the voice of truth and reason, Quantitative Devices (QDs) represent the epitome of policy driven by facts rather than hunches. Despite the scholarly interest in understanding the role of quantification in policy, the actual production of rankings, forecasts, indexes and other QDs has, to a great extent, been left unattended. While appendixes and technical notebooks offer an explanation of how these devices are produced, they exclude aspects of their making that are arbitrarily considered "mundane." It is in the everyday performances at research centres that the micropolitics of knowledge production, imaginaries, and frustrations merge. These are vital dimensions to understand the potential, limitations and ethical consequences of QDs. Using two participant observations as the starting point, this thesis offers a comprehensive critical analysis of the processes through which university-based research centres create QDs that represent the world. It addresses how researchers conceive quantitative data. It pays attention to the discourses of hope and expectation embedded in the devices. Finally, it considers the ethics of creating devices that cannot be replicated independently of their place of production.

Two QDs were analysed: the Violence Early Warning System (ViEWS) and the Environmental Performance Index (EPI). At Uppsala University, researchers created ViEWS to forecast the probability of drought-driven conflicts within the next 100 years. The EPI, produced at the Yale Centre for Environmental Law and Policy, ranks the performance of countries' environmental policies. This thesis challenges existing claims within Science and Technology Studies and the Sociology of Quantification that QDs co-produce knowledge within their realms. I argue that these devices act as vehicles for sociotechnical infrastructures to be consolidated with little debate among policymakers, given their understanding as scientific and objective tools. Moreover, for an indicator to be incorporated within a QD, it needs to be deemed as relevant for those making the devices but also valuable enough to have been previously quantified by data providers. Even more, existing sociotechnical inequalities, power relations and epistemic injustices could impede disadvantaged communities' (e.g., in the Global South) ability to challenge metrics originated in centres in the Global North. This thesis, therefore, demonstrates how the future QDs propose is unilateral and does not acknowledge the myriad possibilities that might arise from a diversity of worldviews. In other words, they cast a future designed to fit under the current *status quo*.

In sum, through two QDs focused on environmental-related, this thesis launches an inquiry into the elements that make up the imaginaries they propose following the everyday life of their producers. To achieve this, I discuss two core elements. First, the role of tacit knowledge and sociotechnical inequalities in reinforcing power relations between those with the means to quantify and those who might only accommodate proposed futures. Second, the dynamics between research centres and data providers in relation to what is quantified. By scrutinising mundanity, this work is a step forward in understanding the construction of sociotechnical imaginaries and infrastructures.

Lay Summary

In a world where numbers and science are often taken as the voice of truth and reason, Quantitative Devices (QDs) such as rankings, metrics, indicators and forecasts represent the epitome of policy driven by facts rather than hunches. Social scientists have researched for a long time the role that numbers play in policy. However, the way QDs are produced has, to a great extent, been left unattended. Those producing these devices offer technical appendixes and notebooks where the interested ones can understand their construction. Nevertheless, these documents exclude aspects of their making that are arbitrarily considered "mundane." These events include what can be called the micropolitics of knowledge production: everyday frustrations, hallway discussions and introspections towards their work. These are vital dimensions to understand the potential, limitations and ethical consequences of QDs, as they could shed some light on the rationale behind these devices.

Using two participant observations as the starting point, this thesis offers a comprehensive critical analysis of the processes through which university-based research centres create QDs that represent the world. A participant observation refers to a research method in which I spent time working with researchers as a way to learn three aspects of their work. First, how do researchers conceive quantitative data? Second, the type of discourses around hope and expectations that are used in these devices. Third, the ethical issues of building devices where the rationale of its producers cannot be fully understood.

Two QDs were analysed: the Violence Early Warning System (ViEWS) and the Environmental Performance Index (EPI). At Uppsala University, researchers created ViEWS to forecast the probability of drought-driven conflicts within the next 100 years. The EPI, produced at the Yale Centre for Environmental Law and Policy, ranks the performance of countries' environmental policies. This dissertation challenges existing claims within Science and Technology Studies and the Sociology of Quantification that QDs frame how issues are understood and discussed. I argue that these devices act as vehicles for sociotechnical infrastructures to be consolidated with little debate among policymakers, given its understanding as scientific and objective tools. The concept of sociotechnical refers to how there is no science without social, political and technological aspects. For instance, the production of a QD depends as much on quantitative methodologies as on institutions with the budget to pay for it, computers and researchers than can convince others about their usefulness. In this same sense, this dependency highlights existing inequalities between developed and developing nations. In particular, who has the technological and political capacities to measure? Without these sociotechnical capacities, metrics can be used to impose particular ways of understanding the world on those who do not have them. This thesis, therefore, demonstrates how the future QDs propose is unilateral and does not acknowledge the myriad possibilities that might arise from a diversity of worldviews.

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List of Frequently Used Abbreviations

BES	Biodiversity and Ecosystem Services
CIESIN	Centre for International Earth Science Information Network
CM ViEWS	ViEWS' Country Monthly Forecast
COP	Conference of the Parties
CROP	Quantifying Conflict Risk of Agricultural Productivity Changes
DPCR	Uppsala University Department of Peace and Conflict Research
EDGAR	Emissions Database for Global Atmospheric Research
EPI	Environmental Performance Index
ERC	European Research Council
ESI	Environmental Sustainability Index
FAO	Food and Agriculture Organisation of the United Nations
IPCC	Intergovernmental Panel on Climate Change
ISO	International Standards Organisation
IUCN	International Union for Conservation of Nature
JRC	[European Commission] Joint Research Centre
MG	MISTRA Geopolitics
NN	Neural Networks
RF	Random Forest
PGM – ViEWS	ViEWS' PRIO-Grid Monthly Forecast
PRIO	Peace Research Institute Oslo
QD	Quantitative Device
SML	Supervised Machine Learning
The Hub	Stockholm Knowledge Hub on Climate Security
UCDP	Uppsala Conflict Data Programme
UML	Unsupervised Machine Learning
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNSC	United Nations Security Council

UPPMAX	Uppsala Multidisciplinary Centre for Advanced Computational Science
V-DEM	Varieties of Democracy
ViEWS	Violence Early Warning System
WEF	World Economic Forum
WDI	World Development Indicators
YCELP	Yale Centre for Environmental Law and Policy
YSE	Yale School of the Environment

"If climate change makes our country uninhabitable, we will march with our wet feet into your living room" [Member of the Bangladesh Centre for Advanced Studies speaking to scientists, lobbyists and politicians in Berlin about the urgency of acting on climate change] (Atiq Rahman, as cited in: Athanasiou and Baer 2002:23)

1 Introduction

In *The Lorax* (Geisel 1971) *Dr Seuss* warns us about how overexploitation of natural resources could lead to the disappearance of entire ecosystems. In this children's book, a greedy Once-ler cuts down a whole forest of *Truffula* trees to produce *Thneeds*. All in search of wealth and ignoring the multiple warnings made by the Lorax - a representation of an environmental advocate. The annihilation of all *truffulas*, together with the pollution produced by the *thneeds*' factories, forces the displacement of all living beings from a place they once called home. The story ends with a message of hope, reminding us that since no one flees their home for pleasure if someone were to care about the natural disaster, creatures could return. While written almost 50 years ago, this children's story remains relevant today. It has become common to read about how the destruction of the environment has increased the number of ecosystems in danger (Brondizio et al. 2019); exacerbated the risks of climate-related forced displacements (IDMC 2020); and, augmented the chances of global pandemics (IPBES 2020). While there is a recognition that tackling and adapting to climate-related issues requires common but differentiated solutions (UNFCCC 1992:Art 3), the quantification of the environment as a base for policymaking has become a standard.

According to a report produced by Swiss RE, a Switzerland-based risk assessing company, 55% of the global GDP depends on Biodiversity and Ecosystem Services (BES). For this company, it is essential to create insurance mechanisms that can protect the investments of those financially benefiting from BES. Within this report, the company developed an index aiming to quantify the risk of assets assuming climate risks. Swiss RE argues that biodiversity is vital for drug discoveries worldwide, implicitly assuming that a decrease in biodiversity is terrible for the market; not for

nature. Along the same lines, a decline of 40% in the biodiversity of insects could represent millionaire losses for the agricultural sector, with pollinated crops representing a market between USD 235-577 billion. Another risk for businesses, driven by the loss of biodiversity, is the rise of armed and political conflicts which could depreciate investments. Therefore, quantification is not about counting; it is a managerial approach towards the solution of problems. Market-driven measures like the report produced by BES depend on the gathering and dealing of large amounts of data, commonly referred to as *big data*, that allow companies and other organisations to develop these types of quantitative devices (QDs).

For the last decades, there has been an increase in the use of indicators rankings, forecasts and other quantitative approaches within public policy. This has been possible through a sociotechnical infrastructure (Edwards 2010; Edwards et al. 2007) of quantification where organisations, actors, norms and technologies are embedded. Alan Irwin argues that while “indicators in themselves do not have effects”, it is crucial to understand how they are given meaning and shape (2017:65). Therefore, it is important to analyse the sociotechnical conditions that allow the production of QDs and the conditions under which different communities have access to these devices. In particular, the development or reinforcement of power dynamics between those who can quantify and those only capable of being quantified.

Focusing on education in Europe, Grek (2014) demonstrates how an increase in the production of data by the OECD boosted the influence of this organisation in framing education in Europe. Even more, Grek argues that the OECD became a relevant actor in global education policy once mobilised by the European Commission. It is also important to highlight that given the current global power dynamics and dominant economic systems, these tools are often designed from the perspective of the Global North and a neoliberal approach focused on managing scarcity. The power of the organisation behind the production of a ranking will also play an important role in their capacity to influence. The OECD, for example, will be in a different position than a university or a think tank to influence global policies (see: Bogdandy and Goldmann 2012; Grek 2014). However, these existing power relations will often provoke the exportation of policies and worldviews without a proper local re-contextualisation or interest in understanding local needs.

1.1 Quantifying the Environment

This dissertation is focused on studying the sociotechnical infrastructure that makes quantification possible and its possible implications for global development. During the construction of the research design for this dissertation, at least these systems of the infrastructure were identified: institutions (i.e., governments, research centres), actors (i.e., researchers, civil society), norms (i.e. data-driven policies) and technologies (i.e. rankings, supercomputers, algorithms, servers).

In particular, I am interested in analysing those systems that make the quantification of environmental-related issues possible. Environmental issues are a broad set of concerns ranging from agriculture to biodiversity, from air pollution to water management. It is important to highlight that they become an “issue” only when they affect human populations. Even in the case of loss of biodiversity as mentioned earlier. Hence, the quantification of all of these elements represents a continuation of the pursuit to *govern nature* (Irwin 2001). Therefore, it is vital to unravel the production of quantitative devices as a way towards transparency and to understand possible unintended consequences over the public and nature.

We hear discourses in the Global North about the urgency towards reducing plastics, consuming less meat or transitioning to fossil fuel-free cars. I highlight that these narratives are part of the Global North not because the Global South is oblivious to them but because they represent discourses that serve the former. As examined by Hickel (2021), these discourses do not challenge existing ways of living in the Global North, instead, environmental degradation is outsourced to the South, where polluting factories are installed, deforestation continues and mining is ensured. If current inequalities and injustices are not considered, rather than aiming to tackle environmental-related issues, the proposed ‘solutions’ will serve as ways in which rich nations not only externalise their problems but exploit others in the process.

Liboiron (2018) shows how plastic recycling has become a function of colonialism since the Global South has been pushed to receive tons of plastic from the North. While rich nations will promote a discourse of victory in reducing plastic waste, poorer nations will acquire debt to pay (to the Global North) for the machinery

capable of recycling these plastics which they will receive as a promise to improve their local economies. INTERPOL (2020) has identified an increasing influence of transnational organised crime to divert plastic waste towards South East Asia, and a minimum amount towards Eastern Europe. According to this agency, these criminal activities have been largely triggered as a consequence of China banning plastic waste imports, responsible until 2018 for 45% of the world's plastic recycling. This shows that very often the success of national environmental policies in the Global North will depend on mobilising other nations. This allows me to set the first objective of this dissertation, to analyse the narratives of possible futures developed through QDs.

Analyses of the causes and effects of environmental issues should be done recognising their multifactorial complexity, which often includes different time and space scales. A lack of understanding of local ecological and social realities could lead to a fallacy where general individual correlations are assumed from general observations. However, the need to create comparable metrics could force those quantifying the environment to ponder easy-to-communicate numbers detached from the complexity of nature in the name of simple communication. Therefore, as a *second objective* of this research, it is important to **analyse what knowledges are salient during the quantification of the environment**. This objective is justified by how the metrics provided through QDs are required to simplify the measured issue at multiple levels.

The quantification of the environment is not only problematic when delivered as partial representations. Rankings, indices and other QDs appeal to notions of 'transparency' when defending their suitability as policy devices (see: Hegre et al. 2019; Transparency International 2020). The idea of transparency is usually equated to that of replicability when understood as the possibility of reproducing the original results regardless of the location. However, the fallacy of replicability rests on the lack of recognition around the importance of technical capabilities to reproduce a QD outside of its original research centre (Collins 1985; Pinch 2016; Plantin 2018). Therefore, *the third objective* of this research is **to analyse the role of sociotechnical systems and tacit knowledge during the production of QDs in relation to the notion of replicability**.

Institutions depend mainly on programmers to transform datasets into QDs. Far from being merely technical work, programming should be understood as a crafting (Latour 2017) exercise where tacit knowledge is crucial. Rather than advocating for the existence of an *algocracy* (Danaher 2016) where algorithms govern our everyday life, this research aims to go one step backwards and analyse those who create them. Given the importance of examining the everyday life of the construction of these tool, the *fourth objective* of this research is to identify the role mundane activities play during the construction of QDs.

1.2 Case Studies

To analyse the everyday dynamics of producing QDs, I learned from two groups of researchers: the Environmental Performance Index and the Violence Early Warning System. Each of these projects represents an effort to provide policymakers with tools to assess the state of different environmental issues. A more in-depth analysis of both case studies will be discussed in later chapters of this thesis. For now I provide a very succinct description of my case studies and how their characteristics allowed me to analyse the multiple objectives just presented. The objective to analyse the everyday activities of those creating QDs is intersectional as it crosses cuts across all the others.

The **Environmental Performance Index (EPI)**, is a benchmarking tool that ranks the performance of countries' sustainability policies (Wendling et al. 2020). This index has been produced bi-annually since 2001 by the Yale Centre of Environmental Law and Policy (YCELP) and the Columbia University Centre for International Earth Science Information (CIESIN). The World Economic Forum has also been a partner, and incubator, of the project across these years. The EPI evaluates national policies through 32 indicators, across 11 issue categories, covering environmental health and ecosystem vitality. The 2020 EPI, latest iteration, covered 180 countries. The goal of the index is to evaluate, based on self-made indicators, the performance of countries in protecting their environmental endowment. It is possible to already observe that the EPI will represent the environment through a self-designed framework.

The **Violence Early Warning System (VIEWS)** is a tool designed to forecast the probability of violence at the country and sub-national level 36 months into the

future (Hegre et al. 2019). This tool is produced through machine learning techniques at the Uppsala University Department of Peace and Conflict Research (DPCR). ViEWS seeks to provide three types of violence forecasts in Africa: state based, non-state and one-sided. Also, they work on providing forecasts of drought-driven conflicts and migrations. My fieldwork was based on this last project. The creation of forecasts represents the development of futures I am interested in analysing. It also allowed me to analyse the sociotechnical gaps between those researchers working in Sweden and the communities under conflict in Africa.

1.3 Outline

Following this introduction, chapter two discusses existing theoretical and empirical literature that situates this dissertation within particular fields while recognising the gap this research aims to fill. This review has been divided into three sections, each one dealing with the main epistemic frameworks where this research is grounded. First, following a long-tradition of Science and Technology Studies (STS) focused on understanding the local conditions of knowledge production, I review the production of what Jasanoff and Kim (2015) call sociotechnical imaginaries with the core concept of this research: quantitative devices.¹ The goal is to review how these devices have been conceptualised so far and how they could be situated within sociotechnical infrastructures (Edwards 2003, 2006, 2010; Edwards et al. 2011) as well. The second section will review literature focused on environmental justice. I pay particular attention to how discourses towards possible futures and hope are constructed. I will explore literature that shows how processes of quantification rely on eliminating individual stories while at the same time, presenting abstract stories of better futures. The final section will provide a review of the increasing literature focused on the relation between climate change, forced displacement and conflicts.

Chapter three will state the theoretical and empirical objectives of this research in the form of research questions. I will present the methodological approaches that

¹ While the concept of QDs will be discussed thoroughly, for now it can be understood as those devices which production depends on the managing of datasets through quantitative methodologies (e.g. rankings, indicators or forecasts).

were employed to discuss these questions. There will be a particular emphasis on the employment of ethnographic methods as the most suitable way to research the production of knowledge.

Chapter four invites the reader to follow the everyday work at the Yale Centre for Environmental Law and Policy (YCELP). A group of researchers has been working since the late 1990s in the production of the Environmental Performance Index (EPI). This device is a benchmarking tool ranking the performance of environmental national policies for over 170 countries. The EPI will invite us to situate the production of QDs both at the laboratory level but also as part of larger imaginaries. In this case, the EPI is situated within a capitalist perspective of observing, and dealing, with the environment.

Chapter five invites the reader into the everyday work at the Uppsala University Department of Peace and Conflict Research (DPCR), while continuing the focus on the production of QDs both at the laboratory level but also as part of larger imaginaries. Here, a group of researchers have been trying to forecast the probability of multiple types of conflict including those triggered by droughts. As it will be explored, as a sociotechnical imaginary, forecasting is not a passive activity aimed to present possible scenarios, but an active endeavour where these scenarios clash between cosmologies. Hence, these types of devices should be explored not only at the micro-level, but they should be situated as part of larger ensembles. In this case, the work at DPCR is implicitly part of a Swedish goal to increase their geopolitical influence through the production of QDs.

Chapter six discusses the multiple questions opened during the empirical analysis and the literature review. By focusing on the dynamics among systems within the sociotechnical infrastructure of quantification it is possible to move beyond the work conducted during the participant observations, and also produce speculative reflections concerning the global development implications of my case studies. To achieve this, I have divided the chapter into five broad areas: i), the balance between scientific authority and acknowledging the limitations of statistics. ii) an analysis of the capacity that researchers may have to set the standard between the *is* and the *ought* (Jasanoff 2010:248), in relation to existing imaginaries and infrastructures. iii), I discuss the implications of limited replicability for epistemic justice (Kidd, Medina, and

Pohlhaus Jr. 2017). As I will have argued by then, different types of epistemic injustices (Pohlhaus Jr. 2017) are being exacerbated due to a lack of interaction between those producing QDs and local communities. iv), I discuss the issue of lag of time that exists within QDs due to their dependence in multiple datasets.

Chapter seven, the last chapter, provides the conclusions of this thesis. This chapter presents the findings of the research. I also present possible continuations and limitations of this research. Through a recognition of the usefulness of quantitative devices, I claim the urgency to expand the analyses on how the quantification of the environment. Only by incorporating multiple cosmologies and ways of engaging with the environment, QDs can support sustainable futures, instead of reinforcing power dynamics of exploitation and dispossession.

In sum, through this thesis I invite the reader to reflect on the actions research centres should take to secure a myriad of possible futures, instead of limiting them through forced standards.

2 Contemporary Discussions of Common and Imposed Futures

2.1 Introduction

On the 2nd February 2021, the report "The Economics of Biodiversity: The Dasgupta Review" (Dasgupta 2021) was released. This report, requested by the UK Ministry of Finance, aims to redefine the approach towards growth and development from one where human ingenuity can eventually overcome nature's scarcity, to one where the Earth's limits are recognised. For Dasgupta, rather than assuming worldwide views about the relationship between humans and nature, it is essential to observe people's needs at smaller scales:

Food, potable water, clothing, a roof over one's head, clean air, a sense of belonging, participating with others in one's community, and a reason for hope are no doubt universal needs. Nevertheless, the emphasis people place on the goods and services Nature supplies differs widely. To farmers in South Asia and Sub-Saharan Africa, it could be declining sources of water and increasing variability in rainfall in the foreground of global climate change. To indigenous populations in Amazonia, it may be eviction not just from their physical home, but from their spiritual home too. To inhabitants of shanty towns everywhere, the worry may be the infections they are exposed and subjected to from open sewers; to the suburban household in the UK, it may be the absence of bees and butterflies in the garden; (...) (2021:35).

The Dasgupta review highlights how while it is clear that there is a need for all humans to enjoy a basic set of universal needs (Sen 1999), beyond these, our concerns with the environment are diverse. The way humans relate to nature is unequal and based on structural conditions beyond the environment. Every community will develop different imaginaries (Benedict Anderson 2006) about their relationship with nature. Simultaneously, by using terms like *ecosystem portfolio* and *natural assets*, the Dasgupta Review is part of a larger trend where biodiversity and other environmental elements are translated into economic terms. The economisation of the environment, together with other realms of public life, is part of a long-time

endeavour that sees the quantification of public life as *lingua franca* among policymakers.

Sociotechnical devices are mobilised through infrastructures that enable and frame these devices. Infrastructures represent elements whose operation is granted due to their incorporation into everyday life (i.e. electricity, roads, running water) (Star and Ruhleder 1996). Throughout this research, Star and Ruhleder's (1996:113) description of the characteristics of an infrastructure helped me to frame my approach towards QD:

- *Embeddedness*, infrastructures are part of other structures.
- *Transparency*, the infrastructure does not require to be reinvented every time; it has become *invisible* since its existence is assumed (i.e. access to technology and data).
- *Reach or scope*, its reach goes beyond single events or local practices.
- *Learned as part of membership*, the incorporation into these infrastructures requires a learning process to become *naturalised* with its elements and artefacts.
- *Links with conventions of practice*, infrastructures are shaped by the agreements of the communities involved.
- *An embodiment of standards*
- *Built on an installed base*, infrastructures wrestle with the inertia of the installed base.
- *It becomes visible upon breakdown* the *invisibility* of infrastructures stops when it breaks. We remember the existence of an infrastructure that makes the internet possible when the servers are down.

Influenced by Star and Ruhleder (1996:113), Paul Edwards describes infrastructures as reliable systems and services that are standardised and widely accessible to at least specific communities (2010:8). I review the notion of standardisation at the end of this section. The acknowledgement that infrastructures are not universally accessible drives this research, analysing the ethics of infrastructures not manageable by the affected communities. In other words, QDs

affect communities that do not have access to their production. Through the notion of *infrastructural inversion* Bowker (1994) suggested that we should understand infrastructures as relational. This means that we need to analyse how all the features described by Star and Ruhleder (1996) interact and relate to each other. We can think of *sociotechnical infrastructures* as the entanglement between social, political, cultural, legal, economic and moral considerations with processes of creation, development and implementation of technological possibilities (Felt and Öchsner 2018:1429). A practical example of a sociotechnical infrastructure is the Radio Frequency Identification (RFID), discussed by Felt and Öchsner (2018:1429). RFID is a tagging technology that substitutes barcodes (Bonsor and Fenlon 2021) were merchandise, stores, banking systems, algorithms, actors (such as programmers, consumers and regulators) ensemble together.

Paul Edwards (2010; 2007; 2003) invites us to abandon simplistic discourses where technology is only ground-breaking, absolutely new hardware or high-tech as in the case of RFID. Instead, we need to acknowledge that modern science and technology are part of historical trends that include what are now invisible technologies due to their normalisation in our everyday life (i.e. ceramics, paper, television). Edwards moves one step back by following Bowker's (1994) infrastructural inversion, focusing on each element within a sociotechnical infrastructure and understanding their historical and relational context. This implies that the focus is not on entire infrastructures but on the systems that constitute them (Edwards 2003:185). *Sociotechnical systems* incorporate the recognition of the role that organisations and the politics of knowledge production play in its acceptance and reliance (Edwards 2003:188). Edwards (2003:188) makes an essential nuance by recognising that the notion of infrastructure as something *invisible* (Star and Ruhleder 1996) that operates in the background of our everyday life is primarily true only in the Global North. In contrast, in parts of the Global South, limitations in electric power, drinking water or access to a reliable internet connection make these infrastructures very visible. Then, we can start speaking of infrastructures as capable of *co-constructing* (Edwards 2003:189) the relationships between society and technology and among societies. The co-construction of knowledge infrastructures, as noted above, requires communities to gain learn as part of the membership (Star and Ruhleder 1996); this

creates a division on who can construct these infrastructures. This research discusses the inequalities that become visible through the performativity of the infrastructures that allow the quantification of the world.

For Jasanoff (2010:248), representations of the natural world become stable and persuasive by "mutually sustain[ed] interactions between our senses of the 'is' and the 'ought': of how things are and how they should [be]". Continuing with the example of The Guardian's device, the decline of the Earth's vital signs symbolises the "is". The "ought" can be found in the tool's aim: "to act as reference point" (Evans N/A); translated as the type of actions that could let us to *stabilise* the Earth's vital signs. In this sense, the device allows setting in motion more extensive narratives. While sociotechnical devices enable analysts to describe the world, Jasanoff and Kim developed a framework on how futures are imagined and pursued by collectives. Jasanoff and Kim (2009) refer to *sociotechnical imaginaries* as "collectively imagined forms of social life and social order reflected in the design and fulfilment of nation-specific scientific and/or technological projects" (2009:120). For these authors, "attainable futures" aim to be achieved as national imaginaries comprised of policies, institutions and aspirations. Unlike Callon's *sociotechnical ensembles*, Jasanoff and Kim (2009:123) acknowledge that *sociotechnical imaginaries* are not bounded or static systems. For them, given that imaginaries are spaces of contestation, the interest is on why and how some imaginaries become more durable at the national level.

Jasanoff has gone even deeper in analysing how knowledge affects social relations. Unlike the commonsensical definition of *co-production* understood as the construction of knowledge as a democratic process (Callon and Rabearisoa 2003; Wynne 2010), for Jasanoff (2004), the *co-production of knowledge* seeks to represent the *world* in terms of its creators. A difference with the notion of co-construction (Edwards 2003) is that *co-production* seems to assume that new knowledge will be incorporated by all communities regardless of sociotechnical differences. While still positioning national institutions as central in the assimilation of knowledge, she also acknowledges the role of epistemic communities in consenting it as relevant (2012a). Jasanoff equates communities with nations (Jasanoff 2011) to develop the concept of *civic epistemologies*. This concept refers to "culturally specific, historically and politically grounded, public knowledge ways". In other words, how communities

collectively incorporate, question and discard knowledge used for policymaking (Jasanoff 2012a; C.A. Miller 2016). Therefore, *national civic epistemologies* are ways in which communities, at different scales, can become mobilised around particular imaginaries. Miller (2016) shows how the implementation of indicators for sustainable development has replaced previous types of measurements of economic welfare and social demographics. For him, the displacement of the state from the monopoly of statistical knowledge to also include NGOs, citizens, and local officials has increased the possibility of defining "measurement" in new ways; hence, "shifting power and authority from nation-state upward and downward" (2016:425). Also, this power shift has transformed indicators in civic epistemologies.

Soon after the first definition of *sociotechnical imaginaries*, Jasanoff and Kim enlarged it by moving from "nation-specific projects" into "collectively held, institutionally stabilised, and publicly performed visions of desirable futures animated by shared understandings of forms of social life and social order" (2015:4). This revised framework gives greater emphasis to two elements. First, on the "desirable" aspect since these futures are usually framed towards positive outcomes; without ignoring the existence of uncertainty. Second, it moves from a state-centred definition into one that incorporates the private sector, social movements, and other collectives (2015:4) as active elements in the continuous construction of governance. Unlike Callon's *sociotechnical devices*, these imaginaries do not pretend to describe the world but aspire to create a new world. Given that these desirable futures will often be contested arenas, it is vital to incorporate the role of power relations during their establishment. For instance, in the case of biotechnology, Hurbult (2015) discusses the power struggles between scientists and the state to establish what counts as new science worth deliberation.

Continuing with Jasanoff's idiom of co-production, Rodriguez-Medina et al. (2019:565) claim that co-production remains ambiguous in at least two ways: a) lacking sensitivity towards existing power relations between local and international knowledge producers, and b) assuming that all actors within the co-production of knowledge have the same capacity to affect their outcomes. Rodriguez Medina et al. (2019:583) show how the asymmetries in access to material, cognitive and symbolic resources between local stakeholders and scientific experts influenced the degree of

reflexivity and contestation when addressing policy issues. When local stakeholders are *simply* considered *handlers of localised knowledge*, their policy issues remain anecdotal. This brings back Edwards' (2010:8) recognition of the limitations of sociotechnical infrastructures due to technical capacities in the Global South.

Dynamics between centre and peripheries are not limited to global relationships, but they also occur within national boundaries (Murphy and Smith 2013). Through an analysis around renewable energy projects in the Scottish Highlands and Islands, Murphy and Smith discuss the interactions between dominant regimes, niche projects and local emotions, meaning and experiences experienced by the periphery (2013:695). In this sense, the authors call to abandon simplistic comparisons between community-owned and corporate-led sustainability projects; instead, they recognise the importance of hybrid schemes that identify the particularities of each *place* (2013:695) by recognising the possibility of multiple pathways towards sustainability. This highlights the importance of guaranteeing that the visions of those in the peripheries are considered and seeking infrastructures that can be used by communities independently from specialists (Rodriguez-Medina et al. 2019:565).

In the case of climate change and environmental issues, quantification occurs across time and space. While some QDs are focused on measuring environmental policies' performance, other QDs are interested in the effect of humans on the environment (i.e. measuring deforestation or fish stock depletion). At the same time, quantification seeks to decrease the uncertainty of the future. For example, climate change science has focused on forecasting scenarios whose occurrence depends on the paths stakeholders decide to follow. Based on the IPCC Emissions Scenario Report (Nakicenovic 2000), these scenarios develop narrative storylines to describe the relationship between emission driving forces and demographic, social, economic, technological and environmental developments (2000:3; Moss et al. 2010). They have been used in areas such as food security (M. Parry et al. 1999), water scarcity (WWAP 2012) and biodiversity (CBD 2020), where do not only represent possibilities, but *instruments of imagination* Beckert (2016), used to mobilise communities at present to carry desired futures of particular communities (L.A. Astuti et al. 2018). The aim of these reports is not only to show "what could be", but by doing so, guide actions to avoid worst-case scenarios from happening.

Societies can eventually become constrained by what sociotechnical infrastructures have defined (Winner 1980:127). Following Winner's focus on urban infrastructure, it is possible to claim that QDs have become embedded within civic epistemologies. The clearest example of this is how governmental apparatuses have been reorganised to fit within the categorisations of a single device. Such is the case of Germany, whose low ranking in the first Programme for International Student Assessment (PISA) report pushed the country to reorganise the education system (Bogdandy and Goldmann 2012). A proliferation of valuation metrics within academia has triggered behavioural changes in reaction to how people are evaluated, measured and observed (Espeland and Sauder 2007; Alberts et al. 2014).

For Merry, Davis and Kingsbury (2015) indicators, a type of QDs², not only measure something but *build a theory of what constitutes* whatever they are measuring. This means they will offer a framework of what can be perceived as the *correct standard*. These authors (2015:10) also argue that this framework includes the *ideal* and the steps to achieve it. Hence, QDs can be seen as devices that, by promoting specific ways of acting to make a "proposed end", can influence the governance of their agendas. If understood as QDs, indicators used for problem-solving will carry the imaginaries of the sociotechnical infrastructures they are part of.

An essential concept for the understanding of the processes of quantification and the performativity of sociotechnical systems and imaginaries is that of standardisation. Throughout this research I will refer to standards as classifications that seek to be established as homogeneous rules among more than a single community. These classifications are spatial, temporal or spatio-temporal orderings of the world (Bowker and Star 1999). Therefore, it is crucial to recognise that standardisation processes often imply the need for harmonisation among heterogeneous sociotechnical infrastructures, which denies the existence of multiple ways of 'doing things right' (Jansen and Roquas 2005:152-253; Irwin 2001:128-130). This harmonisation includes adopting international standards, procedures and good practices by those wishing to collaborate with other systems (Jansen and Roquas

² In this context, indicators should be understood as the compilation of information that allows knowing any given issue's status. Indicators can be compiled in multiple ways and through multiple statistical techniques to provide more robust tools.

2005:152). An example of this is the establishment of the International Organisation for Standardisation, better known as ISO³. Once established, standards become very expensive or difficult to change (1999:14), decreasing the incentives for change. More often than not, these standardisations will benefit dominant structures (Murphy, Levidow, and Carr 2016). This has been proven by how the 'standard subjects' in psychology and behavioural research are the "Weirdest people in the world" (Henrich, Heine, and Norenzayan 2010) referring to individuals from Western, Educated, Industrialised, Rich and Democratic (WEIRD) societies. From data of these subjects, generalisations will seek to be applied.

While the de-standardisation and individualisation of labour are one of the main consequences of industrialisation (Beck 1992), workspaces are often filled with individuals whose biographies (i.e. education and family backgrounds) offer little diversity. The production of knowledge at institutions with the means to establish "best" practices and standards, and whose conformation is of individuals from WEIRD societies (Henrich, Heine, and Norenzayan 2010), brings us back to the discussion around epistemic justice. In this case, the value of epistemic diversity (Kotzee 2017; Siegel 2006) is a way to ensure that issues are questioned, researched and approached through multiple experiences and perspectives.

On the one hand, Jasanoff and Kim (2015) position the state at the centre of designing and guiding the creation of social endeavours. NSAs are seen as peripheral entities that accommodate given designs for these authors. Edwards (2010:17), on the other hand, is more interested in how organisations and institutions (private and public) create science through standards, norms and values. Edward's position contradicts Jasanoff and Kim since he understands the state's role mostly uniquely as a funder of national agencies. However, both frameworks share an interest in understanding how particular scientific knowledge comes to occupy a powerful position in framing other people lives.

2.1.1 Statistics as objectivity

³ ISO is not an acronym, but it derives from Greek word *Isos* meaning equal (ISO N/D).

One of the main characteristics of a QD is their dependence on numbers and statistical methods. Within STS a body of research that can be brought to bear on our understandings of QDs, are sociological studies examining statistics' production and socio-political dynamics as objectivity. Through the Sociology of Scientific Knowledge (SSK), Donald Mackenzie (1981) analysed the relationship between eugenic beliefs and statistics in Britain in the late nineteenth and early twentieth centuries. He demonstrates that statistics may not be as "neutral" as perceived. Instead, its production results from methodologies and social interactions and beliefs their producers carry—the rise of probability as the calculus of reasonableness for a world of imperfect knowledge. Porter (2020a:71) shows the effort not only to provide order but also to predict the general trends of populations. Since the 18th century, statistics have expanded from the state's language to govern (Foucault and Gordon 1980; Porter 2020a), to almost every scientific field.

The trust in quantification is rooted in the idea that numbers and statistics standardise people, processes and discourses (Porter 1995:85-86, 228). These quantitative approaches have also been welcomed across disciplines, given the capacity to scrutinise and validate experimental knowledge. However, this increase of quantification as standardisation has taken place at the expense of black-boxing or even the falsification of results. Such is the case of Pasteur and Mendel, where historians have uncovered how this scientist "fitted" or "cooked" their statistical results to fit into valid evidence (McCloskey 1998:152). Deborah Stone notes how the quantification of everything has triggered a "numbers versus stories" (Stone 2020 "XII-XIII) issue, where facts (numbers) are expected to substitute experiences (stories). Alonso and Starr (1987) argue that statistics are the products of social, political and economic interests often in conflict. These two arguments are at the core of this research, to unpack the stories hidden within quantitative data, both of its producers and of those being quantified.

For the past decades, private companies and non-state actors (NSAs) have increased their interest in collecting data. Some of the most extensive databases

related to development, for instance, are managed by FAO or the World Bank.⁴ I say *managed* because these international organisations rarely collect data, instead, their depositories depend on states providing it periodically. However, the transfer of demographic data between states and NSAs does not always occur swiftly. During an event organised by the Mexican National Statistical Office (INEGI), Andreas Georgiou (2020), former Director of the Greek Statistics Office, claimed that national statistics should be considered a "global public good." For him, while an array of stakeholders should do data collection, national statistical offices should be the ones guiding and deciding what is collected. This is not to deny the work conducted by NSAs that on occasions provide data countries are incapable of collecting. For example, of the data available about Haiti in the World Bank data depository, none was provided by its government. Instead, all data was provided either by UN agencies, including UNESCO or the UN Statistics Department, or other governments, including the US. In some contexts, impoverished countries will be quantified by others.

Following Collins, it is possible to provide a more profound critique of replicability as evidence of truth and objectivity. Given the interest of scientists in coming up with new discoveries, the incentives these will have to 'just' prove that what other scientists did was right, are low. This lack of interest in proving others wrong resembles a ship in a bottle (1985:5-6). This metaphor is helpful for me since it allows to analyse how once scientific knowledge has been validated, it tends to be enclosed in such ways that it is inconceivable to de-construct it.

Simultaneously, nature is not only not uniform, and the replicability of scientific processes is anything but easy (Porter 1995:13). Researchers producing QDs will seek to strip as many singularities from nature as possible as a way of making replication possible. I refer to *singularities* to mean historical, political and economic conjunctures (Pálsson and Rabinow 2007:94). However, nor replication nor uniformity might be achievable. Nonetheless, given the current post-truth times in which we live, rather than moving to discredit the use of metrics, we should aim to fully understand the claims made through them (Tichenor et al. 2020).

⁴ Private companies tend to be more focused on individualised data that can then be exploited for commercial or political reasons. One of the clearest examples of this was the Cambridge Analytica scandal (see: Cadwalladr and Graham-Harrison 2018).

In sum, and following Hajer's (1997) defence of environmental policymaking as a socially acceptable answer to the ecological crisis, we need to consider the usefulness of quantification processes while highlighting their limitations in terms of replicability and representation of policy issues. A measured issue is a technical matter that has to be solved through policymaking, but they require incorporating the explosive social conditions (Beck 1992). When the *side effects* of modernisation (i.e. environmental degradation, market collapses or expropriations) reaches the collective, these risks enhance an explosive reaction against social, political and economic structures (1992:177). In this same sense, the quantification of everything, as part of modernity, could trigger reactions against the same infrastructures that make it possible.

2.1.2 The Future is Now

As reviewed so far, QDs are not limited to measuring issues, but they provide tales of what the future could or should be like. Forecasting techniques have existed since the beginning of humanity; seers, oracles, prophets (Beckert 2016:219). In more contemporary societies, macroeconomic forecasting often creates expectations of what the future might be. This means that forecasting is a form of expectation building. The sociology of expectations has focused on studying the performativity of expectations, meaning how the future is performed at the present time. MacKenzie (2006); MacKenzie, Muniesa, and Siu (2007) distinguish among three levels of performativity: *generic performativity*, when theories are practised but with limited effects. *Effective performativity*: where the use of theories does "make a difference." And *Barnesian performativity*, where outcomes are "altered" to correspond to existing theories models. The last proposed level of performativity refers to Merton's self-fulfilling prophecy where "public definitions of a situation, become an integral part of the situation" affecting its development (1997:195).

Moving towards the individuals, and following Butler (2006), performativity should be understood as an expectation that confirms a described phenomenon. It is a continuous individual ritual that can become the accepted outcome after constant repetition. Together with a unique understanding of performativity, given the nature of

my case studies, the notion of *teams' performativity* (Goffman 1973:83-108) allows me to pay attention to both: the individual acts when researchers 'follow their script' (1973) to fulfil what it is expected from them, and to understand the dynamics through which teams interact, follow the rules and present themselves to the outside world.

A sociological study of the future should consider the concept of *future presents*: a standpoint of the future that allows us to understand how present actions could have consequences on future generations and how they will have to cope with it (Adam and Groves 2007:176). This appreciation allows us to "accompany" the present, and its consequences, into the future. Bennett (2015:126) argues that these reflections are a novelty of our time. For him, we live in constant uncertainty about how the future will no longer be as certain as, allegedly, it has been so far. Instead, and adding to Adam and Groves' point, we are uncertain about how much our present decisions will affect the future. Therefore, the future is an endless series of probabilities needed to be calculated and predicted if we are to manage it.

A vital characteristic of the future(s) is the belief that there can be an improvement compared to the present time. However, on most occasions, these futures are built by communities whose "improvement" does not consider external groups. For Moore (1966:766), sociologists have a stake in ensuring that possible futures are better than in the present time. In this sense, STS has an ontological interest in the idea that "it could be otherwise" (Woolgar and Lezaun 2013:322). Hence, there is an interest in understanding how the future was created and why it was not otherwise. For Tutton (2017), an occurred future should consider those that did not happen. By doing this, we can investigate the actions taken at present to "avoid undesirable futures" (2017:487). These actions involve a re-arrangement towards alternative futures and environments (Irwin 2001:159).

Following Moore (1966:769), it is possible to observe that there is no distinction between predicting and inventing the future since both are utopias that emerge from particular ideologies.

In sum, while the interest in being prepared for the future is not something new, an increase in technical capacities has increased the gap between those who can propose futures and those who might be destined to follow them. The sociology of expectations is a subfield that offers to study how the future is contested at present

time through the creation of imaginaries. This research will incorporate the discussions around expectations when analysing the imaginaries and expectations created through QDs. For this, the power relations that allow some actors to design possible futures through these devices are essential to be considered.

2.1.3 Conscious Understanding as Epistemic Justice

So far, I have reviewed existing academic discussions that demonstrate how the future represents an arena where power relations are exercised. It is crucial to understand injustices that develop during knowledge production and how an increase in the democratisation of science could help. This research was conceived under the understanding that citizens have the right to be involved in developing decision-making tools (see: Elstub and Escobar 2019) given that decisions based on these devices may affect their lives (Bal, Bijker, and Hendriks 2004). This includes ensuring that scientific and technological projects are explained and debated in non-technical languages and under the cosmologies of those whose life chances are affected (Visvanathan 2005:84). This claim originates from the acknowledgement that the production of dominant knowledge is done from positions of power, making knowledge practices and theories far from democratic and usually only reinforcing the credibility of the situation of privileged groups (Tuana 2006:13). This is exemplified by situating how knowledge about women's bodies has been ignored, withheld and denied to continue dominant epistemic frameworks (2006:13).

Mirandas's Fricker (2013, 2007) seminal work helps me situate the production of quantitative devices as elements that support the continuation of existing epistemic injustices. Starting from a position of *distributive epistemic injustice*, Fricker reminds us that the production of knowledge is done through an unfair distribution of epistemic goods such as education or technology" (2013:1318). This unequal access to the same possibilities to participate in the production of knowledge provokes a *discriminatory epistemic injustice*, which Fricker divides into two categories: testimonial and hermeneutic injustice. *Testimonial injustice* refers to individuals or communities (as speakers) receiving less credibility from the hearer than they should. An example of this is the racial prejudice when the police detain black drivers, and

their arguments are *a priori* deflated (2013:1319). However, understanding credibility through the lenses of distribution could lead us to assume it as a finite good, where the unjustifiably low credibility that oppressed groups experience is linked to the unjustifiably high credibility of privileged groups (Coady 2017:63) rather than dealing with the social structures that make this possible. The second category, *hermeneutical injustice*, which is previous to the action of communication, refers to the "failed or semi-failed attempt to render an experience intelligible, either to oneself or communicatively to another" (Fricker 2013:1319). In other words, it denotes how specific communities that suffer hermeneutic marginalisation are put at a disadvantage in their capacity to make sense of their social experiences (2013). In the case of science, this limitation experienced by subordinated groups, is due to the lack of existing conceptual resources required for such understanding due to a historical interest to only research what benefits the privileged (Grasswick 2017). This is exemplified by how while men, white people and politicians have greater hermeneutical power, other social groups have their own experiences misunderstood, which often harms them while this happens (Coady 2017). In medicine's history, the constant reinterpretation of women's experiences by males (Snow 2018) has served to keep empowering the later more than benefiting the former (Poovey 1986). Still, and through the extreme example of neo-Nazis, Coady (2017:65-66) warns us against pursuing an egalitarian principle suggesting that there are groups who do not deserve to have as much hermeneutic power as others and should remain marginalised. In later chapters, I discuss how while there needs to be an expansion of who is considered a reliable data producer, we also need to be careful in replicating purposefully flawed data.

It is possible to speak of the existence of epistemic oppression when individuals are denied their *epistemic agency*: the ability to participate in the production of knowledge by engaging with epistemic resources within a community of knowers (Dotson 2014). Dotson (2014) identifies that these oppressions are enabled at three levels. First, through relations of epistemic power which result from historical, political and social processes. Second, a lack of shared epistemic resources where knowledge that primarily benefits the disempowered is ignored, unresearched or erased. This includes ignoring experiences and visions of the world not accepted by the dominant groups. Third, is the lack of credibility and over interrogation faced by disempowered

actors. According to these types of oppression, it is possible to conceptualise the notion of *epistemic injustice* in two broad categories: first, "structures of inequitable relations among knowers" (Pohlhaus Jr. 2017:13); second, active epistemic attention towards the service of those in power (ibid).

Following the literature on epistemic justice, inspired by Visvanathan's (1997:33) discussion on the need to avoid science to keep experimenting on the dispossessed and the demand for the lay public to be provided in non-technical language the implications of scientific endeavours (Visvanathan 2005; Danaher 2016) I propose the notion of *conscious understanding*. This refers to the awareness that local communities should have of the origin and possible effects of technological and scientific projects on them. Without this *conscious understanding*, the best-case scenario in terms of transparency and epistemic justice is a mere reproduction of tools in different settings. These limitations include understanding how science is done and having the technical capabilities to recreate it in their own space.

2.2 Contested Apocalypses

As it has just been discussed, some of the sociotechnical infrastructures and imaginaries discussed so far have related environmental justice issues. Environmental justice reveals the presence of politics, power and inequality in how marginalised populations face disproportionate environmental risks (Pellow and Nyseth Brehm 2013:232; Bullard 1994; Agyeman 2005). Environmental justice focuses on the structures that allow marginalised communities⁵ to have their hopes being displaced by the imaginaries of those in power (Harvey 2000). This is relevant for this research since it pushes us to dissect every metric of a QD by analysing, beyond numbers, all the implications of *improving* scores.

Nature as a place of hope and contestation is observed through global environmental practices. The climate emergency has been used to continue the endeavour of

⁵ It is important to acknowledge that a limitation of this research is its focus on communities as nations or blocks such as the Global South and the Global North. In this sense, nations are discussed as homogeneous entities rather than recognising the existence of marginalised communities in all nations. This approach is justified by the characteristics of the case studies.

"accumulation by dispossession" (Harvey 2005, 2004). An example of this is how the historical depletion and degradation of the environment have gone hand-in-hand with the capital intensive modes of agriculture and commodification of nature (Harvey 2004:75). These practices have been possible through the "suppression of alternative, indigenous, forms of production and consumption" (2004:74). In this sense, colonial powers have exploited and dispossessed others in the pursuit of achieving their imaginaries.

2.2.1 The Narratives of Quantification

Rankings and indicators play a crucial role in valuing biodiversity, ecosystems and other environmental elements. Wendy Espeland argues that rankings and indicators are "radical and useful forms of simplification" (2015:74). Interestingly, it is this simplification that makes them also easy to criticise. For instance, she shows how law schools with very different characteristics (e.g. vision, budget, size) can be compared through simplistic standardised metrics. At the same time, those standardisations often elicit *narratives* where rankings are embodied as a story by some person or organisation from their positionality (ibid:61). However, contestations by the measured subjects are often observed as reactionary events rather than valid criticisms of limited methodologies (2015:73). For example, Espeland shows how rankings are often framed as relevant stories by the media through US-based elite law schools, which spread through emails and tweets among students and faculty, compelling universities to mobilise multiple narratives, including administrative changes to counterbalance the results. While universities perceive rankings as limited in what they can measure, these devices have become so relevant among applicants and students that institutions are forced to communicate how they will keep improving in the rankings rather than clarifying the methodological limitations of the measurements (Espeland 2015).

While aiming to escape from the subjectivity of the social world, QDs' producers depend on establishing clear links and relations with broader problematics. Given that quantifications seek to provide representations of reality detached from human subjectivities, QDs must be situated within larger narratives where their metrics are seen as valuable. Following Kovacic (2018:1049), the processes of quantitative

storytelling imply the recognition that numbers are not representations of reality, but instead, they represent different narratives or understandings of reality. In other words, numbers "describe the perception of a particular story-teller". The main problem is that, as it was discussed above, tales often carry the vision of those in power. Hence, there is a need to recognise existing power relations between those who write the stories and their characters. This could be possible by examining the methodologies of QDs and the sociotechnical elements that allow their creation, circulation, and implementation.

Espeland (2015) invites us to unpack the methodologies of indicators and the narratives that develop in response to them. Indeed, the daily production of methodologies and narratives is at the core of this dissertation. Espeland's empirical case about US Law Schools shows that these tools provide more than just figures, rankings and tables. These devices create relationships among the measured elements (2015:59).

Both Kovacic and Espeland recognise an imbalance in the power of narratives that rankings use versus those of the measured subjects. Sauder and Espeland (2009) illustrate how elite universities, surely more influential than a local newspaper, react as dramatically as low-ranked institutions. This power imbalance seems to be rooted in the lack of capacity of those being measured to contest numbers seen as facts.

2.2.2 Ecosystem Services as storytelling

One of the *dispositifs* through which climate change is expected to be managed is the notion of Ecosystem Services (ES). I refer to ES as an expectation given the need to analyse who, and under which conditions, is designing these projects. ES operate under the assumption that the only way for humans to care about the environment is by valuating it in economic terms (Redford and Adams 2009). In this context, I follow Fisher and Tronto (1990) who define *caring* as:

"a species of activity that includes everything that we do to maintain, continue, and repair our 'world' so that we can live in it as well as possible. That world includes our

bodies, ourselves , and our environment, all of which we seek to interweave in a complex, life-sustaining web" (Fisher and Tronto 1990:40).

Fisher and Tronto recognise that their definition does not balance different cultures, genders or other contexts. Instead, they argue that pursuing that "world" will be done through existing power relations that often clash (see: Murphy and Parry 2021). In this respect, *ecosystem services* are a proposed way to care for the environment by highlighting its economic value. This includes understanding ecosystems as "capital goods like produced capital (roads, buildings, ports, machines), with the difference that nature cannot always be regenerated after its collapse (Dasgupta 2021:52). Finally, ecosystems are also defined based on their contributions to human well-being (Haines-Young and Potschin 2018). These definitions recognise ecosystems as "valuable capital assets" to which it is necessary to set prices on the "services" they provide (Kareiva et al. 2011:4). QDs may play an essential role in setting the *right* price for ecosystems by measuring environmental issues in financial and market terms.

Richard Grove (1995) discussed how European colonialism developed multiple globalizing discourses (Yearley 1996:ch 4) and imaginaries around environmental awareness to avoid losses on supply chains in the 18th century. While the idea of ES had not been explicitly developed back then, there was already an interest in valuating nature in economic terms to raise awareness against the destruction of the world's image as a biblical *Eden* found in the colonies (ibid). Therefore, the storytelling within ES requires the protection of ecosystems, given their relevance within the capitalist system. Both discourses of environmental protection need time to run at different speeds. While one account runs at the rate at which ecosystems remain 'as they were' (or are expected to recover eventually), the other account will run at the speed at which humans derive goods and services from those ecosystems. As a juxtaposed set of imaginaries, the countries around the Amazonian Forest, for example, have been asked to remain stagnant by not exploiting its resources. At the same time, the economic growth and consumption of goods in the West can continue.

Environmental governance technologies deepen marketized forms of socio-ecological relations (Dunlap and Sullivan 2019). Dunlap and Sullivan pledge to fight back the capitalist valuation endeavour rooted in ecosystem services. For these

authors, inspired by David Harvey's discussion on accumulation by dispossession, some of the most common ecosystem services agendas, rather than procuring the protection of environmental ecosystems, favour an increase of capital accumulation by certain groups. Discussing the notion of dispossession by accumulation requires us to analyse both elements of the equation. A way in which commodification of the environment, through ES, has enhanced dispossession of the environment is through *bioprospecting* (Reid et al. 1993). These are projects where not only the value of biodiversity is directly linked to its usefulness to capitalist exploitation, but also where knowledge from indigenous communities is expropriated to be commercialised (Shiva 2007). An increase in the use of metrics that disposes of the singularity from individuals would increase the process of accumulation-by-dispossession by rendering all biospheres into capital terms.

2.3 Environmental Security, Migration Flows, and a Cup of Coffee

How could people in Germany ensure that the more than 77,000 cups of coffee they drink during their lifetime ("Responding to a Global Challenge" N/D) could continue to be delivered if Brazil loses its arable land due to climate change? The Stockholm Environment Institute (SEI) launches this question as part of their Adaptation Without Borders project. This project (which has gone through different names across time, including the Transboundary Climate Impacts index) has been designed to show that European nations will *also* suffer the consequences of climate change. By focusing on how environmental degradation impacts nations that provide commodities (i.e. coffee, beef or soy), this QD adopts a discourse where the lack of access to our morning cup of coffee is equivalent to the loss of lives in the Global South. For the past couple of years, there has been an increase in the development of QDs aiming to measure the impacts of climate change in a globalised world.⁶

The question about Germany's coffee consumption was launched in a video that finishes by claiming two possible scenarios: one, Germany could easily find a

⁶ Examples of these include the Transboundary Climate Impacts Index, produced by the Stockholm Environment Institute; or the Global Commons Stewardship Index made by the UN Sustainable Development Solutions Network & the Yale Centre for Environmental Law and Policy.

newer supply chain country, or two, it could "help" Brazil. This last statement highlights existing inequalities and discourses where rich nations could easily disengage from the suffering of developing countries or show a willingness to intervene and "help". During the 2021 G7 Summit, the UK Government recognised the "tipping point the world is in relation to climate change"; in reaction, the government set as a priority:

We will protect the future of our planet by moving to net-zero and providing financial support for developing countries to do the same. By protecting 30% of our land and our ocean by 2030 we will look after our natural environment for future generations (UK Cabinet Office 2021).

The statement aims to portray the UK, and its peers within the G7, as the saviours of the world's future. Yet, the responsibility is towards achieving a desired future while ignoring the past. As I briefly mentioned at the beginning of this chapter, human ingenuity has been set (in the form of scientific development) as a driver of economic growth that can continue while dealing with the environmental crisis (Dasgupta 2021). The promised "support" aimed at having access to newer technologies often implies poorer nations increasing their financial debt towards the wealthiest countries. A report published by OXFAM (2020) found that poor nations often go into debt to protect themselves from carbon emissions produced by the Global North. Still, rich nations will boast the "help" they provide to developing countries. These discourses of "support" to tackle climate change should be seen as ways in which existing illegitimate financial obligations between nations endure. As discussed previously, these common claims also show the different ways in which communities relate their existence with that of others throughout *imaginaries* (Benedict Anderson 2006:6) and *expectations* (C. Taylor 2004:106).

Statements like the one made by the UK Government have allowed industrialised nations to pursue nationalistic imaginaries disguised in actions against climate change. While concerns are raised towards expected shared global futures, the interest is to ensure swift supply chains and control migration flows at the local level. Examples of the western position against climate change as a national security concern include the EU, the US and the UK. For instance, for Benzie et al. (2019), Europe is "increasingly" globalised; therefore, adaptations towards climate change

should include a recognition of "cross-border" issues. For these authors, Europe should adapt to possible volatility in supply chains or increasing migration flows. In the US, John Kerry's appointment as "climate Czar" signals the understanding of climate change for the Biden administration as an issue that requires military capacities (Shirazi and Johnson 2020). This includes Kerry's inclusion in the US's National Security Council.

Climate change has been framed as a migration policy issue within the Global North. Under this approach, an increase of climate-driven conflicts in the Global South will increase migration flows. Dietz, Shwom, and Whitley (2020) argue that there has been an underrepresentation of the literature focused on the normative theories of the sociology of climate change. In particular, the ethical aspects of climate change have been usually ignored, despite the rich literature on climate and environmental justice (see: Banzhaf, Ma, and Timmins 2019; Brulle and Pellow 2006; Mohai, Pellow, and Roberts 2009). Therefore, one of the dangers of framing climate change within a securitisation framework is that the response from developed nations will be focused on increasing border protection, stricter migratory policies or even defence spending rather than reducing their per capita greenhouse emissions (Barnett 2003). Even more, the dominating discourse used when dealing with climate change is only one where the Global North needs to be protected, and economic growth should continue its expansion.

2.3.1 Climate Change, Conflicts and Security

An important distinction for this dissertation is between environmental and climate security. Defining both will allow me to analyse how QDs reinforce visions where the Global North constantly needs to be protected from what could happen in the Global South. Following Detraz and Betsill (2009), while environmental security is concerned with the effects of climate change on human populations, climate security focuses on the impact on states' security as the result of conflict over resources. In this sense, managing available and future resources also becomes crucial. An example of future resources can be found in agricultural markets where future harvests are commercialised.

Scarcity over natural resources could become more common as the consequences of climate change, such as land degradation or hydrological stresses (droughts), increase (Watson, Zinyowera, and Moss 1995). Following Libiszewski (1992), when talking about *scarcity*, we could identify at least four types: *physical* (finitude of a given resource); *geopolitical* (availability of resources in particular locations); socioeconomic (unequal purchasing access to a resource); and *environmental* (a resource thought as plentiful becomes scarce). At this stage then, it is possible to argue that there is a direct link between scarcity and the propensity towards conflict (Homer-Dixon 1994). For Homer-Dixon, while conflict is not always a negative event (i.e. social movements against tyrannic governments), these could overwhelm fragile states' capacities and result in uncontrolled violence. At the same time, most conflicts triggered by environmental scarcities (e.g. droughts or land degradations) are unlikely to turn into a war between countries; instead, the instability is most likely to remain local or with contingent borders (Gleditsch 1998). However, one of the possible social effects could be an increase in migration flows from countries without the sociotechnical infrastructures to face climate change. These forced migrations could represent an example of environmental security where the national values and security of the receiving nation are threatened by external action (Levy 1995).

In 2007 the UK was the first country to raise how a dispute over resources, driven by climate change, could affect economic growth. During an annexe sent to the United Nations Security Council (UNSC), the UK Government (2007) stated that given the dependency on fossil fuels to prompt economic growth, the world would face a conundrum between pushing for growth and taking care of conflicts triggered by climate change. Back then, the UK government identified six threats related to climate change towards international peace and security: border disputes, migration, energy supplies, societal stress, humanitarian crises, resource shortages. Since then, the UK has approached climate change through DEFRA and the Ministry of Defence.

There is the risk that a discourse focused on environmental conflict could provide the perfect excuse for military interventions to occur in the Global South in the name of climate change (see: UNSC 2021). While multiple QDs with a bearing on environmental issues are being produced in the Global North, there is a risk that these

tools will be used not to protect humanity from climate change but to ensure the continuation of the imperialist/colonialist environmental (Grove 1995) endeavour where the supply chains of dominant states are kept safe.

Climate change could trigger conflicts in at least two ways: due to changes in the political economy given energy transitions or due to social changes driven by events or perceptions linked to climate change (Barnett and Adger 2007:640). The most affected communities will be those with a higher dependence on the agricultural sector, given the effects on land degradation. However, it is crucial to recognise that climate change does not undermine human security in isolation; instead, it should be seen "across space, over time, and at multiple scales (2007:642). This perspective highlights the role of colonialism, and it sees current land degradation not so much as the result of contemporary climate change effects but instead of the consequences of extractive activities and dispossession. These processes of environmental despoliation have been possible through economic and political systems that seek to force the continuation of the *status quo*. Hence, when evaluating the contemporary effects of climate change, we need to do so within historical contexts.

2.3.2 Environmental Sociology and the Quantification of Conflict

Environmental sociology has studied the relationship between social stability and environmental changes for the past couple of decades. More recently, an increase in data availability and computing power has allowed the development of quantitative approaches to study these links. Most quantitative studies have focused on the relationship between water scarcity and violent events (i.e. the collapse of societies, instability and civil conflict) at a different time and spatial scales⁷. For example, reconstructing hydroclimate data between the period of 1030 and 2008 (Buckley et al. 2010) shows how prolonged monsoons between the late 14th and early 15th centuries, together with socioeconomic and geopolitical stresses, provoked the fall of Angkor in current Cambodia. This study helps us to see that current computer power has allowed scientists to generate data from particular places from almost a millennia ago. Of

⁷ For a detailed chart of recent quantitative studies on the relationship between water scarcity and types of conflict see: (Hsiang, Burke, and Miguel 2013).

course, this is not surprising since we often hear climate scientists telling us about how hot the Earth was millions of years ago. What is interesting for us is the combination of climate data with social processes since an increase in technical capacities has allowed researchers to combine historical evidence of previous conflicts with environmental data to study the relationship between both events.

The relationship between changes in the environment and conflicts, displacements or even societal collapses is not exclusive from our time. Kuper and Kröpelin (2006) used data from archaeological excavations in the Eastern Sahara (current Syria, Sudan, Egypt, Libya and Chad) from over 12,000 years ago to demonstrate how the development and abandonment of settlements in the region were linked to environmental changes. Their study focuses on between 8500 and 1500 BCE, showing how increases in the rain that lasted thousands of years allowed communities to thrive in larger areas of the Sahara; however, after 1500 BCE, a lack of living conditions caused conflicts for food and land. The authors conclude by arguing that current conflicts in Sudan can be traced back to these ages, given that most of the inhabitants of these nations were pushed to this arid area where rainfall and water remained sufficient. More contemporary examples include Blakeslee and Fishman, who discuss the links between rainfall shocks and agricultural income in India from 1971-2000 (Blakeslee and Fishman 2013). Or, H.F. Lee et al. (2013) studied the correlation between violent conflicts and climate variability in Europe (1400-1995). Finding those colder periods generated food scarcity which triggered violent events across the continent. These examples demonstrate that the interest in the relationship between climate change and societies has expanded towards quantitative fields due to an increase in the technical capacities that allow the integration of global scales and very long periods.

Just as in the case of environmental degradation, across experts in conflict studies, there is a consensus that climate change should not be seen as a sole trigger for armed conflict, but it should be accounted for, together with other multiple social, political and economic factors (Mach et al. 2019). In quantitative terms, Mach et al. (2019:194) demonstrate that from all conflicts in the last century, climate variables have influenced them in only 3-20%. Instead, they argue that factors such as low socioeconomic development, weak states, inequality, and a recent history of conflicts

play a more prominent role. However, given that their estimations only consider recent climate change events and not historical data, these authors acknowledge that changes in the environment are a complex variable to include. In other words, given that the consequences of climate change are not previous experiences but current, it is difficult to measure their historical effect in triggering armed conflicts. In this sense, Hsiang, Burke, and Miguel (2013) agree with Mach et al. (2019) and conclude that environmental variabilities will increasingly become more relevant by the mid of this century.

Mach et al.'s. (2019) paper is of particular relevance because it was co-authored by multiple scholars with divergent positions about the relationship between climate variabilities and conflict. For example, among the authors are some who have had heated academic discussions on the relationship between an increase in global temperatures and civil wars (a type of armed conflict (UCDP 2019)) in Africa. The debate started after Burke et al. (2009) published a paper claiming that given the historical linkages between civil wars and changes in temperature in Africa, it was possible to forecast that by the year 2030, there would be at least 390,000 deaths (a 54% increase) as a consequence of droughts-driven armed conflicts in rural areas. This increase in fatalities was linked to the dependency rural areas in Sub-Saharan Africa have on agriculture and socio-economic conditions as the main factor for armed conflicts. That is to say that the loss of income due to droughts, in this case, increases the likelihood of armed conflicts. However, within the same journal, Buhaug (2010) replied that the claims made by Burke et al. (2010) were limited due to their methodological decisions, including the characteristics of the conflicts that had been selected. Instead, for Buhaug (2010), climate variability is a poor predictor for armed conflicts in the short term, arguing that "the causes of civil wars are political, not environmental" Buhaug (2010:16481). The last interaction in this dispute was a response from Burke et al. (2010) who found "little merit in Buhaug's criticism" (2010:E185), given that they never deemed to link conflict to a single factor (climate change). However, Burke et al. (2010) conclude by agreeing with Buhaug's claim that if more recent conflict data were used for their study, this would show the existence of a weak correlation between changes in the environment and armed conflicts.

The academic dispute between Burke et al. and Buhaug allows us to recognise that climate change should be considered with caution when explaining the origin of conflicts. Rather than being assumed as a trigger, it should be seen as one more element of a more extensive correlation of factors. This claim does not seek to undermine the increasing effects of climate change. The 2019 Armed Conflict Survey (International Institute for Strategic Studies 2019) highlighted that environmental changes had become an essential factor among conflicts that started in the past couple of decades. For example, within the survey, it was recognised that the Syrian Civil War (2011 - nowadays), the Central American forced displacement (2018) and the conflict in South Sudan (2018) occurred after prolonged droughts that caused disturbances in the agricultural sector. Agreeing with the conclusion of the debate between Buhaug (2010) and Burke et al. (2010), the survey refers to climate change as a "threat multiplier" (International Institute for Strategic Studies 2019:37), meaning that rather than understanding changes in the environment as causes of conflict, they will exacerbate social and political issues. For instance, while in Central America coffee production was decimated, the forced displacement towards Mexico and the US was simultaneously the result of widespread violence across Honduras and El Salvador. In Syria, the start of the Civil War should be seen as the result of a spiral of events where droughts forced migrations into urban areas which, as tension increased, triggered revolts against an exhausted political regime (International Institute for Strategic Studies 2019). Therefore, while climate-related disasters should be accounted for as having effects on social unrest, these are not triggers nor *causes* but a piece of a broader set of factors.

2.4 Conclusion

Moving from local contexts to globalised positions requires what Paul Edwards calls *global infrastructures* (Edwards 2010). This refers to "projects for permanent, unified, world-scale institutional-technological complexes that generate globalists information not merely by accident, as a by-product of other goals, but by design" (Edwards 2006:239; 2010:25). These sociotechnical systems depend on building scientific, social and political legitimacy to mobilise the knowledge they create. A

particularity between *global* and *sociotechnical infrastructures* is the scope at which both expect to operate. The former is developed to create *global* rather than more localised knowledge. An increase of the technical capacities has allowed researchers to move on from studying local interactions between climate and societal changes towards examining global scale dynamics over more extended periods.

In sum, while environmental conflict should not be linked solely to climate change, there has been an increase in militarisation and securitisation adaptation by most Western countries. In contrast, some developing nations have proven to be unprepared to face the consequences of a combination of climate change and colonial exploitation. Multiple QDs are starting to be produced to predict the indirect impacts of climate change in the Global North. These devices carry storytelling processes of "desired futures" (Leach, Scoones, and Stirling 2010:4). However, as I argued throughout the chapter, tales are often written by those in power. In the case of QDs, where stories tell us about the past and aim to design the future, it is crucial to understand who is building these futures.

3 Research Design and Methodology

This thesis examines how quantitative devices and the imaginaries embedded in them are influenced by the everyday actions and social processes of the actors participating in the production of such devices. It offers an analysis of how QDs result from everyday mundane activities usually thought of as standardised methodologies. It is both an analysis of mundanity and one that focuses on how researchers translate quantitative data into their visions of better worlds. Hence, it becomes a research on the devices, as well as on the imaginaries that are created through them. Using an interdisciplinary approach, I discuss the *micropolitics* within the organisations that produce QDs. Mainly, I am interested in exploring how those organisations and individuals creating QDs understand the imaginaries, expectations and even *worlds* they create. Finally, I analyse the production of QDs through the sociotechnical infrastructure in which they are embedded. In other words, through this research, I consider the social and technological elements that allow but also limit the production of these devices. The overall aim is to contribute to the debates around the increasing quantification of policymaking. To achieve this, I conducted ethnographic research in two particular case studies. First, the Violence Early Warning System, a QD constructed to forecast the probability of armed conflicts. The second case study is the Environmental Performance Index, a benchmarking tool that ranks the uptake of environmental policies at the national level. Both devices are constructed through different methodological approaches, although as I have already argued, the nature of QDs resides on their production depending on statistical methods and the aim to represent reality in particular ways.

This chapter presents and discusses the research design underpinning my empirical fieldwork along with the research methods selected. I have divided this chapter into four sections. Section one introduces the research aims and the research questions of the project. Section two provides an overview of the interests and inception of this dissertation. Section three discusses the research design of this PhD and includes the different research methods that were employed and appraises their suitability. Section four discusses the way in which data was collected during my

fieldwork and analysed later. It considers the challenges that arose during this research and reflects on how my own limitations impacted this research.

3.1 Research Aims & Questions

This research aims to analyse the processes through which university-based research centres go through in the creation of quantitative devices that represent the world. This aim will contribute ethnographic research around processes of quantification. After a detailed literature review within the fields of STS, environmental sociology and conflict studies, it is clear that while there has been a great deal of focus on the effects of quantification in policy formulation across sectors (e.g. environment, education, health), the everyday processes through which our physical world is transformed into quantitative forms have been left unattended.

As has been discussed so far, QDs have increasingly been developed and used in the context of climate change as an aid in policy formulation due to their perceived capacity to provide objective information. Yet, we understand little about their development and use in the context of climate and related social and ecological crises. Because of this increased use, and the possible influence on policymaking they could have, there is a need for QDs to be scrutinised across their processes of production and circulation. This research focuses almost exclusively on the production of QDs, although as I discuss later, processes of circulation were also analysed. Without expecting every individual of this world to become a programmer and expert in statistical methods, it is my belief that everyone who is or could be affected to any degree by a QD should have the right to fully understand how the device was produced. For this, as this research demonstrates, the provision of methodologies and technical books is not enough. There is a need to increase the production of metadata where researchers share everyday decisions, politics and social processes since these play a key role.

Empirical data, in quantitative or qualitative forms, has become an object of inquiry within STS. At the same time, as established earlier, the production of QDs depends on processing *quantitative* data through a myriad of statistical methods, including machine learning. Hence, this research contributes to the growing literature

that has started to be developed around the sociology of data in multiple areas including health (Stevens, Wehrens, and de Bont 2018; Starkbaum and Felt 2019), labour (Stephany 2021), humanities (Siles et al. 2020; Niederer and Taudin Chabot 2015), justice (L. Taylor et al. 2020) and governance (Redden 2018) aiming to analyse the increase in datafication.

Datafication refers to rendering into data a world that had not been quantified before. In terms of data, my aim is to study how data is understood, used, shared and circulated by those interested in producing QDs. It discusses data availability as a reflection of sociotechnical capacities and interests. In other words, I claim that it is important to understand why some issues have gone through processes of *datafication*, while others have not (see: Cukier and Mayer-Schoenberger 2013; Dourish and Gómez Cruz 2018; Micheli et al. 2020; Sadowski 2019).

The sociology of quantification, defined by Espeland and Stevens (2008) as a subfield of sociology that offers a critical discussion towards numbers, invites us to think not only about how numbers are generated but also about the consequences of quantifying everything and how numbers should be governed (Berman and Hirschman 2018; Desrosières 1998). Work on these issues includes Porter's (1995) *Trust in Numbers* or larger academic projects like METRO (2019) at the University of Edinburgh. This project, led by Sotiria Grek, aims to investigate how international organisations have increased their interdependencies as a result of *metrics* becoming a universal language. Grek (2020), METRO's Principal Investigator, demonstrates how while quantification is often offered as a democratic and consensual based approach towards decision making, in practice, there are power imbalances between those who control the production of metrics and those who consume them. An important distinction I feel the need to make at this point is between the sociology of data and the sociology of quantification. While the former is focused on studying how our world is increasingly transformed into data forms and the ethical consequences of this, the latter is driven by an interest in all forms of numbers. This research brings both subfields together in an effort to understand how the representations of the world created through quantification and datafication should be treated.

To address this overarching research aim, there are five sub-research questions:

- **What mundane activities are involved in the construction of quantitative devices and what role do they play in their construction?**

Individuals working on the production of QDs interact on a daily basis. These interactions can occur during meetings, lunchtimes, hallway conversations or in shared offices. These are the moments I will analyse as possible spaces where standardised procedures are subject to unorthodox, methodologically speaking, processes. The divergence from stated methodologies responds to pragmatic approaches by the researchers, who on occasions can obtain the same results whether they use their tacit knowledge or follow standardised procedures, as in the case of data management (Plantin 2018). Given the individual nature of how programming is done, mundanity does not always happen in shared spaces but within individual working spaces. While researchers work alone, they take decisions and re-interpret the world through data and statistics. This ethnographic research focuses on the mundane by incorporating individual and shared processes within their own "cultures" (Seaver 2017). This includes understanding how researchers enact data and algorithms in their own way.

- **How is quantitative data understood by those using it to produce quantitative tools?**

Aiming to contribute to the increasing literature on the philosophy of data (Leonelli 2016) and processes of datafication, this question seeks to understand how programmers engage with data. As I have established in my definition of QDs, data sits at the core of these devices. Before researchers can manage data through algorithms, processes of collection, cleaning, standardisation (Plantin 2018) are required. None of my case studies engages in data collection processes, but they are required to clean and standardise the data they use. These steps not only represent labour (Plantin 2021), but during each one, data is perceived through different temporalities (Edwards 2010:97-104). Finally, while those producing QDs have an interest in establishing these devices as the epitome of standardisation, each one of the multiple datasets required for their production has a different origin. This invites us

to understand the meaning that researchers give to single number metrics, given the heterogeneity of their sources.

- **Which factors allow researchers to define their quantitative devices as stabilised?**

One of the main focuses of this research is to analyse what it means for QD's producers to have a stabilised tool. Fujimura and Clarke (1992) have studied the production of science and the processes that allow its *stabilisation*. For them, the idea of stabilisation corresponds to commitment processes, which are reflected in decisions about how to use specific tools in particular contexts. In contrast, for Law (1986: 241) stabilisation refers to technology having independence from any particular context. We can see that these two ideas are contrary to each other. While Fujimura and Clarke defend the idea of stabilisation as contextual, Law would defend it as being context-free. The framework provided under the Social Shaping of Technology (SST) (Sørensen and Williams 2002) makes no mention of the context of use, instead, it is the settling of a dispute or negotiation that is seen as relevant. SST affords more flexibility to the notion of stabilisation, which is useful for this research considering the characteristics of algorithms and quantitative data. Algorithms are easily interchangeable to be used for environmental or conflict data in Uppsala or New Haven. In part, this happens because users care more about the results of these algorithms than by how the results are obtained. This makes SST an appropriate framework for the analysis of ViEWS and the EPI.

- **What are the [social, technical, political, ethical, professional] expectations of researchers when producing a quantitative device?**

This question seeks to understand the effect that immediate beyond-metrics interests and expectations from researchers have in the construction of QDs. This implies that not only the expectations developed through these devices will be analysed, but also the effect of personal and professional prospects on the devices. Schyfter and Calvert (2015) demonstrate how the need to secure funding and or fulfil imposed expectations

will frame the relationships and objectives of researchers. This could lead to researchers defining what is worth quantifying or managing when new metrics are included.

- **What role do expectations play as a narrative embedded in quantitative tools?**

Research centres looking to influence policymakers through QDs may need to accompany the scientific data with discourses of hope. Building on the sociology of expectations (Borup et al. 2006), this question aims to analyse a dominant narrative among QDs' producers that sees possible ethical consequences of their devices as acceptable given the expectations of improvement they carry. In other words, the benefits of following the advice provided through QDs overshadows any uncertainties or unintended consequences. As argued earlier, organisations often have more interest in improving scores than in solving the problem underlying the measured issue. QDs, as tools of governance (Fukuda-Parr and McNeill 2019), may have the capacity to influence policymakers by limiting the ways in which an issue can be tackled while expecting score improvements.

The relevance of these questions relies on the notion of micropolitics (Nast and Pile 1998; Irwin 2001) which positions everyday processes as central to the understanding of the production of knowledge. It is through everyday negotiations, politics and mundanity that researchers represent the world. The production of QDs depends on the development of algorithms able to deal with large amounts of data, *big data*, that no human could handle or operationalise. While these algorithms can be written through different coding languages and styles, there is a constant push towards standardisation. However, as I discuss in the empirical chapters, the push towards standardisation is pursued mostly by project managers than by the programmers themselves. Some would even refer to programming as unique and personal as writing poetry. Starting from these positions, I investigate the effects of individuality in programming in its replicability.

In sum, the overarching research aim, together with the research questions, contribute to the discussion about how the future proposed through QDs is unilateral

and does not acknowledge the myriad possibilities that might arise from a diversity of worldviews. I analyse how processes of quantification and datafication operate within particular sociotechnical infrastructures (Edwards 2010, 2003) and imaginaries (Jasanoff and Kim 2015), which limit how issues are approached. I also discuss epistemic injustices (Coady 2017; Fricker 2007; Kidd, Medina, and Pohlhaus Jr. 2017; Pohlhaus Jr. 2017) that emerge from power relations (Foucault 1982; Foucault and Gordon 1980) between those who can quantify and those who are expected to follow metrics. This ethnography expects to push for more *account-able* (Garfinkel 1984) QDs, where not only algorithmic systems (Neyland 2015) are accessible but where we can make sense of the everyday actions that allow the production and effect of these devices.

In particular, this ethnographic research followed the everyday life of researchers at two university-based research centres. Both centres have been creating environmental-related QDs, seeking to influence policymakers. These two case studies worked as entry points for the infrastructural inversion (Bowker 1994) this dissertation seeks to achieve. By working as a research assistant at both centres, I was able to interact with multiple elements of the sociotechnical systems (Edwards 2003) that allow the production of each device. The two case studies are:

The Violence Early Warning System

The Violence Early Warning System (ViEWS) is a forecasting tool aiming to predict the occurrence of conflict within the next thirty-six months. ViEWS is a project located at the Uppsala University Department of Peace and Conflict Research (DPCR). While this tool has secured funding until October 2021 through an ERC Consolidator Grant, its principal investigator has the goal to make it a longstanding project. This tool is published every month, which means it needs its team working exclusively on the production of the tool. ViEWS aims to predict conflict within a grid of 50 x 50 km in which the project has divided the world, implying that it disregards any political border. The implications of the grid and of not using nation-states as the measuring unit, as most quantitative tools do, will be explored in further chapters.

ViEWS is built through a machine learning process, which means it is done by a set of tailored-specific algorithms that deal with significant amounts of quantitative databases at the same time. While most of the members working in ViEWS agree that the project is curiosity-driven, they also claim an interest in eventually being able to influence global peacekeeping operations. It is this other interest that also creates most of the internal, non-spoken discussions: the ethics around being able to exert influence in other parts of the world.

The Environmental Performance Index

The Environmental Performance is a benchmarking tool that ranks the performance of countries' environmental policies. The index has been produced eleven times since 2000, making it one of the most longstanding environmental rankings. This longevity was in itself worth exploring, including which decisions, actors and factors have made this possible. An initial explanation is the EPI's team capacity to keep including new indicators every time a new edition is published; keeping it 'updated'. The most significant change, at least in general terms, occurred in 2006 when the Environmental Sustainability Index (ESI) became the Environmental Performance Index marking a change in the interest of the group from measuring sustainability issues to environmental performance.

The EPI has been published every two years. Until the 2018 edition it had always been presented during the World Economic Forum (WEF) annual meeting. However, in 2020 for the first time, it was not. The reasons why the EPI stopped being showcased at the WEF will be explored in subsequent sections. In the meantime, it can be said that perhaps the EPI stopped being part of the WEF agenda and interests. While WEF was never involved in its production, it has been included as an EPI partner. The production of the index mainly depends on the Yale Centre for Environmental Law and Policy and the Centre for International Earth Science Information Network (CIESIN) from Columbia University. Through these years other organisations like the European Commission Joint Research Centre (JRC); and the Yale Data-Driven Environmental Solutions Group (Yale Data-Driven) have participated in some editions.

While the constitution of the EPI has changed through the years, the index tends to be built around *issue categories* representing policy areas (e.g. air quality, ecosystem services, fisheries). The weighting of every indicator towards the final score is something decided unilaterally by the EPI team. This weighting of the different issue categories is something that has been changing over time. For instance, while in 2016 the Air Quality of a country constituted 33% of the Environmental Health policy objective, by 2018 this same issue category weight decreased to 26%. The rationale for these changes is something that will be explored more deeply in chapter seven as part of the participant observation analysis.

3.2 Coming up with a PhD research

The difference between a metric, an indicator, a ranking or an algorithm is one of the main debates around the sociology of quantification (Berman and Hirschman 2018:258). Is an algorithm a way of quantifying the world? Is a ranking a metric? The concept of Quantitative Devices, defined in the previous chapter, allows this research to move across different tools while respecting their particular characteristics. By tying them through what I consider their basic elements: the management of *data* through *statistical methods* in order to provide *quantitative results*, the scope of this research remains wide enough to be able to include an array of devices without cherry-picking those that fit my interests. Another aspect is the type of organisations in charge of producing these devices. I am particularly interested in QDs produced by university-based research centres. An explanation for this decision will be presented in the next section. While initially this research intended to focus on non-state actors, as the study progressed university research centres showed more openness than some NGOs. The following paragraphs provide an overview of how this research changed during the last five years. I hope to engage the reader in some of the methodological and epistemic decisions I went through as a researcher. As Murphy and Parry (2021) mention, sometimes it is helpful to tell the reader how an idea came to be as a process of contextualisation.

In 2015 the germ of a research idea emerged: perhaps the methodologies of rankings generate findings that do not tell us everything about what happens during

their creation. After I graduated with my bachelor's degree in Mexico in Political Science, I started working at my university on an ambitious project that had been launched one year before, a global ranking on impunity. Being not only a very violent country but also one with a lack of trust towards judicial institutions⁸, Mexico seemed the right country to do this ranking. While working as a research assistant in the development of this project, I witnessed how senior researchers were often concerned with securing the budget for next year's iteration or with the politics of mobilising international organisations such as the UN in recognising this device as a relevant global index. Back then, still in 2015, the difference between a ranking and an indicator was not clear to me - and it remains debatable within some fields - so both terms were used interchangeably. Also, the focus was on indicators without a specific interest in what they were measuring, merely as tools. Two years later, in 2017, by the end of my master studies in STS, I became more interested in how the environment is quantified. Therefore, I decided to keep my attention on indicators but to focus on those that were measuring environmental issues and analyse how they were produced. After several challenges (that I will reflect upon at the end of this chapter), and with the support of my supervisors, I was accepted by two research centres in order to learn how it is that they come to create tools capable of representing the world.

After a year of fieldwork, in 2019 I started to analyse the data that I had collected through ethnographic methods including, interviews, participant observation and document analysis. While analysing my data, my attendance at seminars, summer schools and discussions with my supervisors encouraged an iterative dynamic between theory, data collection and analysis. For instance, during a supervision meeting I was introduced to David Harvey, whose work was very influential for my approach towards political ecology. My attendance at the STEPS Centre Pathways to Sustainability (Sussex University) and Centre for the Understanding of Sustainable Prosperity Summer Schools in 2018 & 2019, respectively, allowed me to engage in epistemic discussions beyond STS.

In the following sections, this overview of how my research interests evolved will be further elaborated upon. First, I discuss the research methods that were used

⁸ For example, only 18% of crimes are reported to the police due to a belief that nothing will ever happen (Kuri, Castañeda, and Román 2017)

and justify their adequacy for this research. Afterwards, I explain the particularities of the case studies selected.

3.3 The right tools for the analysis of Quantitative Devices

For this research the 'right' methodological tools were those that allowed me to learn, and later analyse, how QDs are the result of a complex process of frustration (Riedlinger and Rea 2015) negotiations (Epstein 2021; Voß and Amelung 2016), contradictions (E. Martin 1998), and emotions (Lorimer 2008) from those making these devices. The methodological framework was defined to let me arrive at my fieldwork with enough understanding about the context I was aiming to immerse myself in, while at the same time being flexible enough so that it could be used in a different setting. While previous research on non-state actors producing QDs is limited, plenty of literature has been written on how to analyse the production of knowledge. Karin Knorr Cetina (2010) proposes that for the analysis of the production and consumption of financial indicators, one should immerse oneself in the production process. This includes paying attention to all the conditions (technical, political, bureaucratic) that facilitate the production of scientific knowledge; or as Clarke and Fujimura (1992) call it: *everything in the situation [italics in the original]*. For Harry Collins (1981:7) by interpreting the day-to-day work within a workplace, it is possible to describe how more extensive social and political structures affect the production of knowledge. Hence, as Hannerz (2003b) proposes, it is necessary to 'being there...and there... and there' when the knowledge is produced. Therefore, the choice of an ethnographic approach seemed the most suitable.

An ethnography is a set of methods whose objective is 'writing about people' (Ingold 2014:385). It aims to render a rich account of how people experience life; it refers to a holistic contextualisation (D. Miller 2017:28) where before writing, the researcher needs to construct and understand the conditions under which people's actions and words make full sense. Ethnography involves continuous learning from the researcher about the people from a specific community, but these subjects can also learn about themselves through the accounts of the researcher. As I discuss below, my experience as an ethnographer included a requirement to provide feedback

on the daily practices of one of my case studies. In this sense, the intention of an ethnography is to bring human notions of the self into account (Howell 2017). This final product becomes a case where, when placed along with similar studies, some generalities emerge (Ingold 2017:21). Therefore, an ethnography does not have to be taken as a single document on its own but as one that can enable us to comprehend broader contexts.

A discussion within anthropology ponders whether ethnographies should be considered as a data collection method given that we are trying to analyse *with* humans rather than *about* humans (Ingold 2017:24). The focus is on their emotions, decisions, actions, we should thus not transform humans into simple data. Taking these issues seriously, I adopted participant observation as a solution. This method of analysing a community transform the research into one with people and not about people. According to Clark (2011:XIX), "as well as being interested in what scientists actually do, we need to be interested in what scientists are interested in: our critical rituals must lead on to decisions, allegiances and, especially, to commitments." This is a key driver for the third wave of laboratory studies (Clark 2011:XIX; Gjefsen and Fisher 2014) which seeks for the ethnographer to engage critically with the knowledge being produced; we are not only interested in understanding how scientists work on an everyday basis or how their work articulates with social movements. Laboratory works should transform the ethnographer into a researcher committed to the work done, thereby moving from an observer into a critical participant of the laboratory. Valve and McNally (2012) show that by becoming "loyal" to the studied projects, ethnographers may end up having to abandon their "vision from nowhere", limiting the contributions that could be provided from less intervening studies.

3.3.1 *Participant observations*

For anthropologists, participant observations refer to long-term fieldworks of at least fifteen months (Shah 2017:51) where the researcher is immersed in the daily life of a group of people who are willing to share their everyday experiences. Only by sharing the same space with a community one can start to access and learn with them the meaning of actions and words that otherwise could have little significance. The goal

of the ethnographer is to give meaning to the knowledge that participants do not feel the need to show (R. Astuti 2017:11), possibly for being considered irrelevant – mundane. It is when the researcher is able to pay attention to different actions and details than those initially identified (after an extended period of time spent with the group) that the learning process of everyday life ends. In this process of continuous learning, the ethnographer understands the difference between *observing* and *objectifying*. To objectify would be to bound a research on predisposed assumptions, to gather data *of* a community. In contrast, to observe is to learn (Ingold 2017:23), the researcher needs to be prepared to modify their assumptions and theories (Shah 2017:47-48). To observe is also to give voice to the community the ethnographer is learning with. It can be said that there can be no ethnography without a process in which the researcher recognises not only their limitations and biases but also the voices of everyone. Because of this, I reiterate that the goal of this ethnography is to learn from *the inside* (Bloch 2017:23) of the community, rather than making assumptions from the *outside*.

By the end of participant observation, it is expected that the researcher will have an intimate relationship with those who, in the beginning, was a group of strangers (Shah 2017:51). In the case of my research, where the case studies are made of groups of researchers, learning from them often included erasing a line between fieldwork and personal life. In other words, the fieldwork continued at parties (see figure 1) or after-work drinks. This implies building trust, which, as a social value, is something that needs to be developed as part of a relationship, it should not be assumed as a given. Time is an issue for multiple reasons. First, given the set framework by funders and the university to complete a PhD programme within four years, it left me with one year to conduct my fieldwork. This meant that I had four months per case study to meet people, gain their trust and wishfully think to 'become one of them'. This timeframe was unrealistic, but I am happy to say that in some cases, I developed friendships, a sign of trust, with some of the researchers. A proof that we breached the relationship bonded to the office was my 'failed' participation at a pie-eating contest with my colleagues at a state fair (see figure 2). Failed since I barely ate a quarter of the pie.



Figure 1 Gasque⁹ to celebrate the conclusion of a PhD



Figure 2 A 'failed' attempt to eat a pie without hands

⁹ A *gasque* is a traditional Swedish party organised in student environments. The gasque I attended was to celebrate the PhD graduation of a student at the Uppsala Department of Peace and Conflict.

Participant observation is not an easy process; it is a long-term negotiation with power relations, where the researcher is weak (Bloch 2017:33). This is not to ignore the power ethnographers have in relation to the way their observations are told (Katz 2018). However, it is important to recognise that the individual characteristics of each researcher modify the power relations with their subjects. For example, Rodriguez (2019) shows the struggles she went through while trying to study members of the Latinx community. Klobß discusses the experiences of sexual harassment she suffered as a female researcher (2016). In my case, my position as a non-European and non-US citizen made my migratory status dependent on those I was trying to observe. Only through their "sponsorship", I was able to obtain student visas that allowed me to work with them. While I never felt that my sponsorship was at risk (on the contrary, I always felt full support from the research teams) my relation to these institutions was one of dependency. Not only that, as I discuss later, given the architecture of the research centres I worked at, I was able to "observe" as much as research leaders wanted me to observe.

In summary, participant observation is a process through which the researcher spends a defined amount of time learning with a community about their practices. During this process, challenges and opportunities were recurrent. In my particular case, my fieldwork was as full of challenges as of support and ingenuity to overcome them.

3.3.2 Interviews

As it has been established, the objective of my fieldwork was to gain access and learn how QDs are produced. As a research project *with* my collaborators, the accounts of how these devices are produced could not solely depend on my insights; but their voices were essential. Through the informal conversations of our daily interactions and formal interviews, I complemented and contrasted the initial interpretations and assumptions I had made. I also asked work colleagues about their practices and the meanings they attribute to them.

Interviews as a research method aim to reveal the way a person thinks and not only how it acts. They aim to arrive at the core of a person's emotions and rationales

(Hermanowicz 2002:481). When part of ethnographic research, interviews could lead to obtaining a deeper understanding of the issues being sought. This is due to: i) the interviewer first-hand knowledge about the organisation being researched; and, ii) an existing relationship between interviewer and interviewee where the latter could recognise the former as "one of them" rather than to an external individual. Alternatively, it could also trigger the contrary effect if people do not understand the aims of the research or think it is not in their benefit to *speak openly*. This makes the participant observation even more relevant since working with those you will eventually interview, might increase the chances of the people to show themselves.

When conducting multiple interviews and placing them together, it might be possible to reconstruct stories (H.J. Rubin and Rubin 2012). The interviewer aims to find how these stories can be understood from multiple perspectives. As a way to learn from my interviewees, I borrowed from previous researches, in particular from Clarke and Fujimura (1992) who propose key questions that should be explored when analysing the production of knowledge; these questions are:

- Who is doing it and how is the work organised?
- What is construed as necessary to do the work?
- Who cares about the work? (This should be understood as who intends to care for the work)
- Sources of sponsorship and support both locally and elsewhere
- What are the intended products? And, for which consumers or users?
- What happens to products after they are sent out the door into user workplaces?

These questions were a starting point to develop an interview schedule (Appendix II) that worked as a guide for semi-structured interviews. With semi-structured interviews I was able to follow a similar pattern across the interviewees so that a comparison could eventually be made. Additionally, a semi-structured interview has the flexibility and versatility to adapt the questions to each organisation member's individuality.

During the production of this research design, I noticed the lack of literature that could guide me on how to conduct interviews with this particular group: elite academic

researchers. While the literature on how to interview elites is broad (Smith 2006; Woods 1998) and particular terms such as business and political (see the collection of essays edited by: Hertz and Imber 1995) is available, I was unable to find previous accounts on possible specificities of interviewees belonging to academic environments. Woods (1998:2105) argues that the elite should be understood within a context where society works as a fluid network and those belonging to the elite are part of "clusters of individuals bonded by social, political, or professional ties". Woods also recognises that elites are context-specific, hence, it is not a matter of a held position (i.e. professorship) but will depend on a set of factors including the institution they belong to and the roles they play within them. For Hertz and Imber (1995:1), these groups have usually been understudied due to the difficulties of breaking the barriers that prevent having access to them. Also, there is a tendency by social scientists to try to empower disenfranchised groups, by *giving* them voice through the research carried out. However, in this case, the question is whether those at elite institutions are the ones with the resources to build QDs. I will follow Bruce and (2006) definition of elites as people that dominate an organisation without an apparent explanation, although they argue that unlike *ruling classes elites'* position, they do not depend on their economic position. In this sense, I refer to *elite academics* as those individuals dominating research centres, university departments or academic institutions. Haynes et al. (2011) have referred to similar types of researchers as "highly influential." While elite and highly influential share commonalities, Haynes et al. do not share methodological information in their study.

While most of my 25 interviewees do not fit under my categorisation of those that constitute an *elite*, at least five do. Among these individuals are researchers with previous experience in advising international organisations including UN agencies, the European Commission and federal US agencies. It could be argued that advising and influencing are not correlated, but it does increase the opportunities to have a saying in the design of a policy. Apart from these five individuals, among my interviewees there were research assistants, academic and administrative staff, and former collaborators of those groups. The importance of knowing how to interview elite academics is grounded on the different experiences each position carries within a team.

As part of the multiple interviews that I conducted, two of them were not included in the analysis. The first one was discarded by me since it did not add relevant or useful data. The second one was a case where the interviewee requested to be removed from the research. Months after having conducted this interview, I received an email from the interviewee telling me that they did not feel comfortable with the information provided. Therefore, I was requested not to use the data from the interview for my research.

3.3.3 Document analysis

As stated above, through the right research tools, I aimed to understand *everything in the situation* that allows the production and circulation of QDs. To achieve this, it was important to contextualise the everyday work at the research centres by understanding who the researchers were, their previous work, as well as previous versions of the QDs. *Document analysis* allowed me to complement my observations and interviews by filling the gaps of information (Marshall and Rossman 2016, 164-166) and comparing claims done by the researchers and their work.

I categorised documents as personal, organisational and public, each one providing particular types of information but also presenting its challenges of accessibility and privacy. Personal documents, such as CVs, allowed me to understand the professional and personal backgrounds of those who were part of the research. Recorded personal statements (e.g. interviews or conferences) offered access to participants' historical positions on specific issues and the implications of their proposals and speeches for QDs. In the case of organisational documents, budgets, memos, summaries of meetings and drafts of internal works allowed a broader understanding of the day-to-day operation of the research centres.

3.3.4 Multi-sited ethnography

As it was already mentioned, this research analyses two quantitative devices as case studies, each one focusing on different environmental-related issues: 1) the Violence Early Warning System (ViEWS) and 2) the Environmental Performance Index (EPI).

The identification of suitable case studies was based on their incorporation of environmental issues for the quantification of wider social problematics. Before moving on, it is important to reiterate that I acknowledge the indivisibility between human societies and nature (Macnaghten and Urry 1998). While, as I show later, this distinction is not always shared among those producing QDs, the environment is usually presented as a way to measure human-related issues. On the one hand, the Environmental Performance Index (EPI) has been measuring and ranking national environmental policies since 1999. On the other hand, the Violence Early Warning System is a forecasting tool produced since 2018. It uses machine learning and aims to forecast the statistical probability of different types of conflict in Africa and drought-driven conflicts and migration in Southeast Asia.

The decision of choosing ViEWS and the EPI as empirical case studies is based on the scholarly gap found in the intersection of the sociology of quantification, STS and environmental sociology in terms of the study of QDs. While the focus has been set on analysing the effects of metrics both in policy and on organisations (Grek 2020; Bogdandy and Goldmann 2012; Merry, Davis, and Kingsbury 2015) little attention has been directed to the individuals making those metrics. Finally, this thesis aims to contribute to the ethnographical scholarship on the study of quantification. Ethnographic studies that allow comprehending the usage and construction of numbers and algorithms have been signalled as a challenging but needed methodological and anthropological endeavour (Guyer et al. 2010). Given the challenges studying the culture, linguistics, philosophy and infrastructures needed for the construction of QDs, very few ethnographic works have been conducted. This includes a workshop organised by Jane Guyer in 2010, which developed into the publication of a special issue in *Anthropological Theory* under the title 'Number as Inventive Frontier: Equivalence, Accounting, Calculation' (Guyer et al. 2010). Guyer et al. argue that while numbers have been studied for millennia – in the case of mathematics – little work has been done to try to understand *from within* the culture, practices, assumptions and vernacular processes of manipulating words, things and life through numbers (Guyer et al. 2010:39). Day, Lury and Wakeford (2014) coordinated a special issue called 'Number Ecologies: Numbers and Numbering Practices' that sought to "understand our relationships with numbers and numbering

practices" by questioning "how to live *with* or *in* rather than *by* numbers" (2014:123). In other words, Day, Lury and Wakeford argue that while the study of how numbers impact social practices, the processes of how numbering occurs often remains invisible or simply becomes 'data' (2014:124).

The priority of this research is given to the individuals, followed by the tool they design; the organisations allow to situate the devices within specific imaginaries. In this sense, as a research grounded within the Sociology of Scientific Knowledge, I am interested in where these researchers work and the supposedly irrelevant processes, as a way to draw detailed empirical investigations (Irwin 2001:73). Continuing with the effort of using ethnographic work to make sense of numbering practices started by Guyer et al. (2010), Lippert and Verran (2018) moved into gathering articles that interrogate the relations that exist between numbers, analytics and analysts. These collections allow me to situate this dissertation as part of contemporary discussions around the processes of quantification and datafication.

A multi-sited ethnography (Garfinkel 1984; Hannerz 2003a; Hine 2007) allows one to increase the claims derived from the analysis by including different contexts in which these quantitative tools are produced and operated. For example, the EPI is a device with over 20 years in the making, privately funded and constructed under US imaginaries. Contrary to this, ViEWS has limited public funding (European Research Council) ending in October 2022. It is not only a matter of longevity or funding; the differences at the hosting organisations also provide extra layers of analysis, including statistical techniques and epistemic cultures (Knorr Cetina 1999). A critique against the notion of *multi-sited* ethnographies argues that we should recognise that relationships among communities go beyond physical spaces (Shah 2017:52). Hence, I approached the use of two case studies as a combination of QDs produced by similar-but-different organisations with a shared objective: to influence policymakers. Similarly, both case studies are produced by universities in the Global North, which locates them within a specific area of influence in global politics.

Following Gerring's (2004) discussion on what constitutes a good case study, three characteristics were crucial: focus, type and longevity. Given my personal interests in environmental issues, an important feature was their bearing on these matters. Second, the type of organisation had to be a non-state actor (NSA). At this

stage I made no distinction between an international NGO, a think tank or a UN Agency. In this sense, having their funding or governing bodies independent from states (unlike the OECD or the UN, for instance) was the baseline criteria. The decision to analyse QDs produced by NSAs is a crucial moment, it denotes my preference towards the sociotechnical infrastructure's framework over that of sociotechnical imaginaries; both discussed earlier. This was not a cherry-picking process but one that recognises the state as an important element in defining the imaginaries of communities while also identifying the role that other actors play. In this sense, universities (private and public) occupy a particular position given their relationship with the state where: they are administratively independent; have a degree of dependency on public funding; and, very important for this research, are totally dependent on the demographic data that they use.

The third desired characteristic of my case studies was diversity. Luckily, I achieved my plan to study a longstanding QDs and one of recent creation. Knorr Cetina argues that, in the case of financial indicators, these should be understood as products that become "depleted, discounted outdated or dysfunctional" (2010:175). In other words, each iteration of a ranking or forecast should be seen as independent from the previous and the future ones. Therefore, when analysing metrics that are periodically published, one should not fall into the trap of assuming that no matter the edition, a metric can be analysed in the same way. Even though the same organisation might be in charge over several years, each edition should be analysed as an individual object that belongs to a series of productions with shared elements. The different lifespans of those two tools may, in fact, be decisive when considering the stabilisation of QDs.

Gaining access to the case studies is the combination of the researcher's ability to convince and the communities' willingness to participate. An apparent "perfect case study" means nothing without the eagerness of the people to provide access. This disposition can depend on factors such as working schedule, space availability, or the researcher's ability to explain their research. In my particular case, while negotiating access to some NGOs, I was faced with the sudden cancellation of projects or a sensed resistance towards my research proposal. At the same time, university-led research centres showed much more openness to the idea of allowing someone to

conduct research about their work. These negotiations, rejections and approvals show that the appropriateness of a case study for specific research depends on its characteristics, a matching timing and an interest from those being studied.

As can be seen, both case studies pertain to recognised organisations in the Global North, managed by highly educated people, an elite in the sense I proposed earlier. Both organisations are constructing tools where the line between environmental and sustainable development issues is not entirely clear. I had to learn as a *mantra* that the process of conducting a participant observation implies a continuous process of learning from those that I was learning *with*. However, as Ingold (2017:24) mentions, this *mantra* about learning was accompanied by the reminder that one does not need to take everything from the people happily; if there are uncomfortable moments or abhorrent episodes, there needs to be sincerity and ask the people about the rationale of those acts.

In sum, the decision of choosing two case studies was based on my interest to identify different processes during the construction of a QDs. ViEWS would allow me to focus primarily on a device of recent creation, while the EPI on a device with longstanding longevity. This approach of using two units (Gerring 2004) allowed me to provide an exhaustive analysis of the production of QDs. While evident for some, it is clear to me that the decision of which research centres to include was unilateral and, by times, pragmatic.

3.4 Elements of Data Collection and Analysis

All research participants signed a consent form and kept an information sheet (see Appendix III) about the research. The data collection process could be divided as follow:

- Between September 2018 and January 2019: participant observation was conducted at the Uppsala University Department of Peace and Conflict Research (DPCR). During this same period, thirteen interviews took place. In a second round during July 2019, four more interviews occurred as a process of clarification. All interviewees were researchers working at DPCR.

- Between February and June 2019: participant observation took place at the Yale Centre for Environmental Law and Policy (YCELP). During the participant observation at YCELP, seven interviews were carried out. The interviewees were current and former EPI contributors.
- Documents such as emails, internal memos, datasets and budgets were collected throughout my PhD studies.

For six months, between the 1st Year Board Review and the start of the fieldwork, I attended the Stockholm Environment Institute Science Forum in Stockholm, Sweden. During this one-day event, the institute introduced most of the QDs they were working on at the moment. This allowed me to have conversations and explore QDs. During this period, there was also an exchange of emails and informal conversations with people working at centres and academics whose interests lay on STS, environmental sociology, sociology of quantification and environmental politics. These conversations helped me to keep framing the research design considering possible case studies and alternative options.

3.4.1 Data Coding

The multiple categories of data that I collected were analysed using NVivo. Interviews were manually transcribed, which helped me develop a more intimate relationship with the data. By using a thematic analysis process (Braun and Clarke 2006), themes were generated around the codes. In total, more than fifty codes were divided into seven themes (see Appendix IV). The process of coding was a combination of letting the data 'speak by itself' but within epistemic frameworks originating in STS and Environmental Sociology. Therefore, the labels defined for each code represent STS or ES notions and concepts, while their content was filled by what interviewees and documents expressed. Internal documents, memos, pictures and field notes were also coded and categorised with the same labels.

The final number of codes is the result of a continuous process of merging and splitting narratives. Also, they represent the interests that I kept developing while

analysing the data. It is worth mentioning that the theme *Miscellaneous* encompasses coded data not specific to an existing code but still recurrent.

3.4.2 Dealing with confidentiality in small groups

We live in an era in which most of us can be easily found through our online social media profiles, this makes anonymity almost impossible (Walford 2018). Both ViEWS and the EPI are produced by relatively small groups whose individual responsibilities (i.e. to only have one programmer) could make them easily identifiable even if people were given a code or pseudonym, which they were. Because of these characteristics, the ViEWS gatekeeper was concerned with how anonymity would be secured. As part of the negotiations it was agreed that as much as possible, direct quotes would not be used. Instead, when at least half of the team agreed on something the claim would be attached to the team and not to the people who had made. Given the similar characteristics between both teams, I extended this approach with the EPI. When a direct quote is needed, aliases have been created for every individual in both teams. The relation between the real name and the alias was not even shared with the corresponding person to avoid the possibility of knowing *who is who* by discarding the rest.

The precautions towards protecting confidentiality were taken before starting my participant observation. Previous to my arrival to Uppsala and New Haven, through my *gatekeepers*, I tried to address any concern the researchers at both centres could have. In the case of ViEWS, when I was ready to conduct one of my first interviews at the researcher's office, I was asked to go to a coffee since the participant expressed their lack of comfort in talking about their colleagues' work. At that moment, this surprised me since I was not aiming to "uncover the truth" in a journalistic sense, but to learn with a community. Beyond my weight concerns¹⁰, I had no problem in holding most of my interviews at this bakery. This discomfort to speak about the internal work at DPCR contrasted a common discourse, within the department, of being very open

¹⁰ On one occasion I met with four interviewees within the same day. This meant eight cups of coffee and four pastries.

among themselves to discuss and debate about their work. A technical issue of meeting in this bakery was the surrounding noise which made some transcriptions difficult.

In the case of the EPI, confidentiality was sought even more by some individuals. While not generalised, at least four individuals requested to be extremely careful in how I was dealing with their comments. This included being told: "you can hear what I have to say, but you and I never met", "make sure my name does not appear anywhere." These requests were particularly present when asking about the EPI's founder, Daniel Esty. My main assumption is the existence of power relations between an established Professor and individuals looking to start a career in the same field.

Both cases show that the actions around confidentiality responded to existing concerns in the communities. While the extra caution was requested by the gatekeepers at the beginning of my fieldwork, early-career researchers were the ones being more explicit about these concerns during the research. These calls for me to protect the identity of individuals implied me being part of the politics of the research centres (Bryman 2008:130-132); in fact, an objective of an ethnography. However, I had to be careful not to be pushed to take sides within internal disputes. In particular, as an ethnographer, I had the responsibility to be careful with the data since it could risk the professional careers of young researchers. These anxieties were taken seriously, so on occasions, this research might fail in providing a detailed description of who is the person stating a quote.

3.4.3 Limitations

There were issues of accessibility that happened before and during the fieldwork. The first, as dealt with below, was the opinion some of the individuals had towards me. Some perceived my research as trying to "find out" the secrets of the communities. This perception created issues of accessing some of the daily practices, meetings, even after-work drinks, all of which represent the mundane and intimate performances in which I was aiming to participate. I was struggling to achieve what Astuti (2017) considered the aim of an ethnography: to give significance to the mundanity.

Expressions that made me realise this included: "I know what you are doing here, you can hear what I say but do not quote me" or "I hope you find out what they do in there". This last one came from a colleague working at the same research centre on a different project. Just as in the case of the interviewee that withdrew from the study, these perceptions reflect a rightful position not to take part in a study and also the researcher's ability to explain the aims of its research. Together with understanding the career concerns some individuals had, which I discussed in the previous subsection, during informal conversations I re-introduced the aims of my research, highlighting that I was pursuing a PhD not writing an article for a newspaper.

In the particular case of the EPI, the topic that caused most the apprehension was the relationship between Daniel Esty and former EPI author Angel Hsu. Before arriving in New Haven, I knew that Hsu had not been worked at YCELP since 2016. However, after a couple of informal conversations with former EPI members, it was brought to my attention that the relationship between both had not ended amicably. Given my interest in the politics of the index, it was while I was trying to understand the reasons for this tension that I received the requests not to quote. The reason for the sour end of the association seemed to be rooted in Hsu's perception that Esty had not worked enough on the production of the index, and therefore, he should not appear as co-author anymore. To provide more context, Hsu's role as author coincided with Esty's job as Connecticut's Environment Commissioner, during which he requested a licence as professor at Yale and YCELP director, and the responsibilities around. Hsu's departure. It was clear that there were two sides to this story. Some would argue that it was Esty's capacity to secure financial support that made the EPI viable. So, even if his involvement had been reduced to the minimum –he was attending briefing meetings– he was the "owner" of the index and Hsu's was trying to "steal it". Those defending Hsu's position, argued that she had revolutionised the way the index was produced, by moving from excel worksheets to big data algorithms. Not only that, but she had also organised interdisciplinary seminars to improve the index. In the end, it seems like the existence of power relations between both favoured Esty. My interest in trying to understand the dispute between both members was also preventing me from observing the entire production of the EPI since I was focusing on a single event.

Hence, after understanding the circumstances of the quarrel, I decided to "go back" and centre my attention on other aspects of the production of the index.

The second limitation was having to learn the language of the community. By *language*, I am referring to the rules and commitments of the epistemic community (Knorr Cetina 2010) or even a social world (Clarke and Star 2007) being studied. In my case studies, there was also a need to learn a new skill: statistical programming. While already trained in basic levels of statistics, when I arrived in Uppsala I had to learn how to programme on my own. Learning how to programme was the only way I could become part of the ViEWS workflow. On what I thought¹¹ would have been my first fieldwork day at ViEWS, the principal investigator asked me if I knew how to programme. Since I had zero experience, I was suggested to learn the basic elements of programming while my access to the department was granted. Without the right programming skills, I could not be given any tasks; and I would not be part of the daily conversations of the project. For the EPI, while my work was not focused on programming, having learned necessary skills allowed me to be part of conversations about the overall workflow of the project. As it will be discussed in the empirical chapters, it can be challenging to do participant observation of a community whose work is mostly carried out on personal computers. Generally speaking, what can be "observed" are individuals looking at their monitors (see figure 3). That is why being an active element of the working dynamics is key; it gives one access to the 'how' people do things but, most importantly, it offers the opportunity to discuss with them the rationale behind taking individual decisions.

¹¹ Having full access to DPCR was another limitation that I faced. On the 1st of September, I arrived at the department expecting to start my fieldwork. However, I was told by the administrative staff that there was still paperwork to be done before I was allowed to start my fieldwork. I was even asked to not attend the department at all. This represented a timing and a mental setback that made me feel highly unwelcomed. While the paperwork was solved, I was recommended to work from the law's department library where, since I had no student ID, I had to be sneaking to avoid being "caught" as a non-student. (un)Fortunately, my access was granted in October. During my first day and the rest of my fieldwork with ViEWS, I always felt welcomed by the team.

[illegible]

Figure 3 Geeks in the Wild (Geek and Poke, 2010)

The reflexive ethnographer understands that what is written are not 'facts' nor 'truths' but interpretations which construction is the result of their own biases (Finlay 2002: 532). Then, a question arises: how can these interpretations be closer to what everyone involved in the participant observation 'originally' meant? The answer lies in the researcher continuously coming back to the people so that knowledge and understandings can be co-created rather than just being one-sided. This implies processes of co-production; I intentionally eluded this word to avoid confusion with Jasanoff's notion of co-production (2004). I refer to co-production as the creation of knowledge through continuous dialogues among stakeholders (Bremer and Meisch 2017). These dialogues are part of the analytical processes in the empirical chapters.

By committing to reflexivity, an ethnography will not only have a stronger empirical and evidence base but also can start learning processes (Boud, Keogh, and Walker 1985). Reflexivity is not a process done by the researcher for its own benefit. It should start discussions where those in the observation benefit. In the case of ViEWS, this expectation was explicitly requested. As part of the research bargain (*Bryman 2008:131*), I was asked to provide, by the end of my participant observation, some insights on the labour dynamics among the team. I discuss this experience in chapter five.

Finally, as it has been established, this data collected for this research is the result of eleven months of participant observation, where I had the opportunity to work with two groups of researchers who showed openness to learn from them. The accounts and sources used throughout this research include internal documents and interviews that, without the proper care, could risk the anonymity agreement I reached with them. Therefore, no authors will be attributed. In the case of the interviews, each interviewee was assigned an alias. As a homage to my roots, all aliases represent characters from Gabriel Garcia Marquez' *100 Years of Solitude*. The names and positions within their organisations can be reviewed in Appendix I. A balance between confidentiality and providing context to the reading around the interviewees was reached by dividing all of them into two general groups. *Senior member* refers to individuals that have worked on the EPI in multiple editions or that hold directive positions. The second group, *junior members*, includes research assistants, PhD students and individuals with no directive positions.

4 Indexes and the creation of in-vitro environments

"[I]t is kind of ironic that I've become now an indicators expert because I was sceptical at the beginning. I still have a lot of scepticism to be honest" (Pietro 2019).

In January 2020, the World Economic Forum (WEF) and PricewaterhouseCoopers (PwC) published a report titled "Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy" (WEF and PwC 2020). One of the main claims of this report was that more than half of the global GDP depends on nature and its services. The report positions the environment as something that we need to manage because it is good for businesses. Whether we agree or not with an ecosystems services strategy, it seems that the business approach towards the environment is shared with the highest level including the United Nations Environment Programme (UNEP). The UNEP uses the dependency towards nature, in economic terms, to raise awareness about both poor people and high-tech research depending on the direct use of nature (fishing, forestry, farming or drugs). Under this logic, the protection of the environment is justified by the economic dependency towards the services it provides, rather than its intrinsic value. According to the Environmental Performance Index (EPI), the case study of this chapter, the best way to protect the environment is through quantitative metrics that allow us to optimise gains from investments in environmental protection (Wendling et al. 2018b).

In this chapter I analyse the everyday micropolitics (Nast and Pile 1998; Irwin 2001) under which the EPI is constructed. I also focus on the imaginaries (Ben Anderson 2010) that emerge from its metrics, and just as important, what these metrics tell us about the sociotechnical imaginaries (Jasanoff and Kim 2015) and system (Edwards 2010) that make this QD possible. As already discussed, this empirical analysis is the result of five months of participant observation at the Yale Centre for Environmental Law and Policy (YCELP). Specifically, my analysis will focus on the 2020 EPI, the index construction that I witnessed. I will also include data from previous editions to conduct a comparative analysis of the changes this device has gone through its history. In terms of the conditions that shape the EPI, I demonstrate

that its construction is motivated by the expectation of a data-driven (Esty and Rushing 2007) world it is also constrained by the lack of processes of datafication (Dourish and Gómez Cruz 2018; Redden 2018; Sadowski 2019; Micheli et al. 2020). In other words, the measuring ambitions of those creating the EPI are compromised by data shortages. Following Espeland (2015) I will unpack the methodologies and the narratives of a QD. In this chapter, I unpack the EPI through five sections; in each one I analyse a story that could help us to understand the imaginaries proposed through this device. This introduction, **section one**, provides an explanation of the EPI to offer a familiarisation with the EPI.

On **Section two** I unfold the first story, the worldview under which the EPI is created. The index has the objective of becoming an influential QD across two particular sectors, businesspeople and policymakers. Therefore, it requires to appeal to the needs of two sectors; both described to me during informal conversations by YCELP members as "very busy people." Simplicity is at the heart of the EPI, visible when complex environmental issues are boiled down to a single number, but also through the discourse employed to describe the measurements. The EPI has its origins in the WEF Competitiveness Report, which was used by Daniel Esty – a Yale faculty staff member – to propose to a group of WEF-sponsored individuals the production of the Environmental Sustainability Index (ESI) in 1999 (Esty and Emerson 2018). The ESI was a composite index that measured the potentiality of a country's economy to become sustainable. This index remained under production until 2006, when it was decided by its producers that the concept of sustainability was too broad to provide useful insights (Esty and Emerson 2018). The lack of a straightforward definition of what sustainability meant, implied in the eyes of YCELP, that they were unable to provide metrics to a specific national agency or ministry in charge of a singular agenda. At the same time, not all decisions about what the index measures, depend on its producers. As we will see, researchers depend not only on data being available but also at the right scale; in this case, national.

While part of its name, the *Environmental* Performance Index is focused on a wider agenda: a data-driven world. I start **section three** moving one step back from the notion of datafication (Sadowski 2019; Micheli et al. 2020). The second story I unfold explores what those at YCELP understand by data. Through interviews and

informal conversations, it was revealing to realise the multiple understandings that exist about data, and their effects on the construction of the index. In **section four** I start by focusing on the notion of *simplicity*, understood as an approach to explain an issue with as few elements as possible. This third story unfolds the multiple indicators used for the EPI to demonstrate how the device is built with simplicity at the core. This is reflected in the lack of integration of all the metrics used. In other words, rather than understanding environmental issues from an ecological perspective where all environmental issues interrelate, each issue is treated as an independent silo. As I demonstrate, simplicity goes beyond theoretical and empirical elements, it is rooted on the performativity (Goffman 1973) of those creating the device. This includes the way in which senior researchers push to standardise the work of programmers as a way to reduce the interaction between humans and data. Programming constitutes the technical aspect through which databases are transformed from 'raw' data into elements that can fit into the needs of the EPI. Therefore, I also focus on the influence programmers have (see: Plantin 2018, 2021) in deciding how issues are measured.

Across the chapter, I discuss the multiple limitations that exist while building the EPI. In **section five** I pay particular attention to the process of data alignment. This invites us to reflect on how the metrics that combine datasets originating in different organisations and in different moments represent collages of the environment at different moments, rather than the environmental conditions of a location. In this sense, I talk about the device representing *in vitro* environments to refer how researchers are capable of manipulating (Knorr Cetina 1995:145) in time, size and space the elements they work with.

4.1 A Detailed Description of the Environmental Performance Index

The EPI is a composite index that measures and ranks the performance of national environmental policies. These policies are evaluated through indicators across issue categories covering environmental health and ecosystem vitality (Wendling et al. 2018a). This index has been produced every two years since 2001 by YCELP and the Centre for International Earth Science Information (CIESIN) at Columbia University. Between 2001 and 2006 the index was called Environmental Sustainability Index (ESI)

to then become the EPI. During this time other organisations have cooperated in various ways with the EPI; WEF being the most prominent in terms of launching platform and remaining until now as 'partner'. Until 2018, the EPI was launched during the WEF Annual Meeting in Davos. The 2020 edition (see figure 4) included 32 indicators across 11 issue categories, which were aggregated and weighted to present a single score for each country; a ranking is presented, showing the "leaders and laggards" (Wendling et al. 2018a).

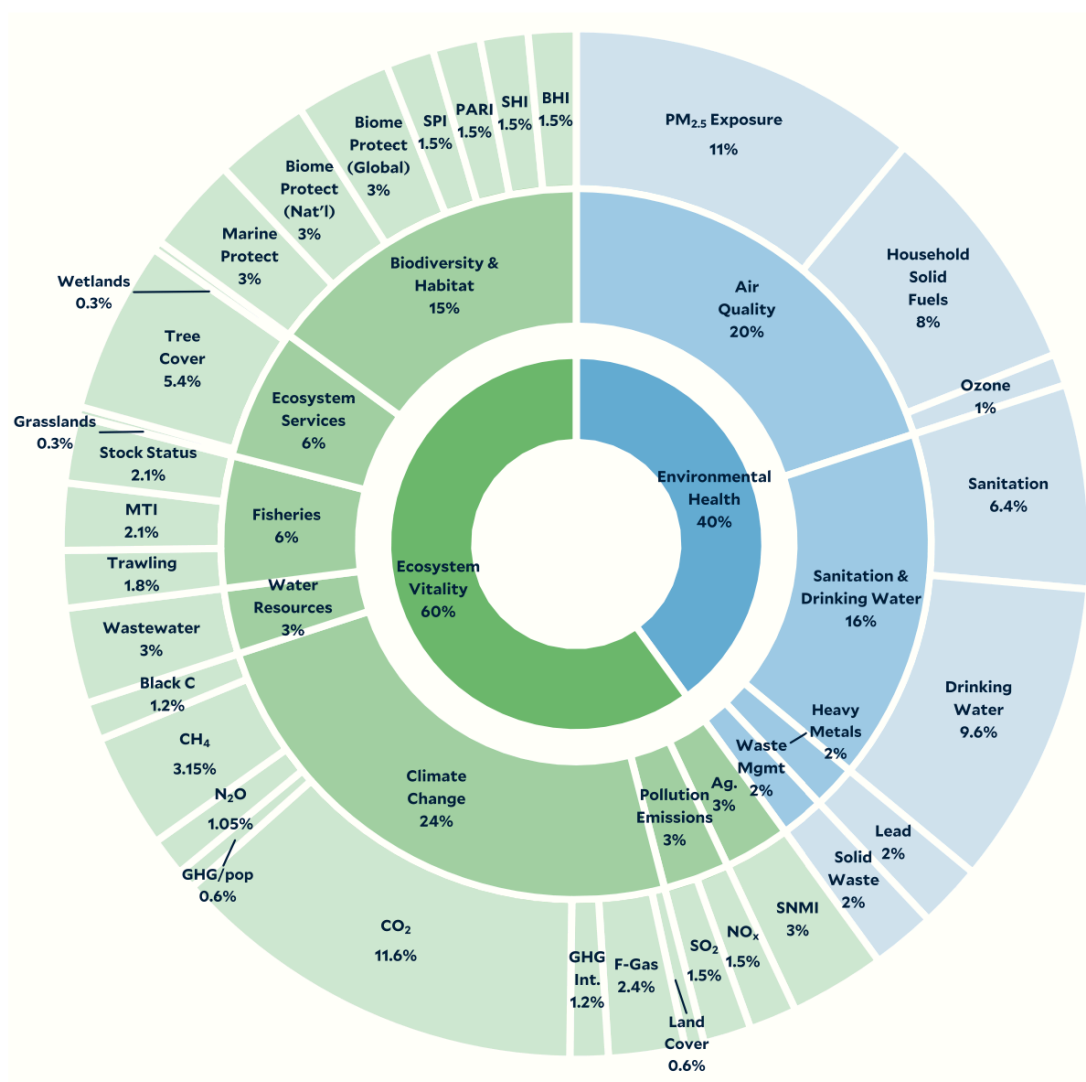


Figure 4 2020 EPI Framework.

The two dimensions, environmental health and ecosystem vitality, represent what the researchers building the EPI consider an existing tension for sustainable development. According to YCELP, environmental health increases with economic growth and prosperity, while ecosystem vitality comes under strain from industrialisation and urbanisation. Hence, good governance will be achieved through a balance of both dimensions.



Figure 5 Portugal's country profile and scorecard for the 2018 EPI

The report (figure 5) includes a profile and a scorecard with the scores each issue category and the final score. The sheet also includes a peer comparison to observe how countries scored compared to countries with socioeconomic similarities. The ranking of countries considers socioeconomic and regional differences among

countries. Hence, the ranking is offered both globally but also within regions (Figure 6).

RANK	COUNTRY	SCORE	REG	RANK	COUNTRY	SCORE	REG	RANK	COUNTRY	SCORE	REG
1	Denmark	82.5	1	61	Uruguay	49.1	9	120	Samoa	37.3	12
2	Luxembourg	82.3	2	62	Albania	49.0	16	122	Qatar	37.1	15
3	Switzerland	81.5	3	63	Antigua and Barbuda	48.5	10	123	Zimbabwe	37.0	11
4	United Kingdom	81.3	4	64	Cuba	48.4	11	124	Central African Republic	36.9	12
5	France	80.0	5		St. Vincent and Grenadines	48.4	11	125	Dem. Rep. Congo	36.4	13
6	Austria	79.6	6	66	Jamaica	48.2	13	126	Guyana	35.9	30
7	Finland	78.9	7	67	Iran	48.0	6	127	Maldives	35.6	3
8	Sweden	78.7	8	68	Malaysia	47.9	6		Uganda	35.6	14
9	Norway	77.7	9	69	Trinidad and Tobago	47.5	14	129	Timor-Leste	35.3	14
10	Germany	77.2	10	70	Panama	47.3	15	130	Laos	34.8	15
11	Netherlands	75.3	11	71	Tunisia	46.7	7		Sudan	34.8	16
12	Japan	75.1	1	72	Azerbaijan	46.5	5	132	Kenya	34.7	15
13	Australia	74.9	12	73	Paraguay	46.4	16		Zambia	34.7	15
14	Spain	74.3	13	74	Dominican Republic	46.3	17	134	Ethiopia	34.4	17
15	Belgium	73.3	14		Montenegro	46.3	17		Fiji	34.4	16
16	Ireland	72.8	15	76	Gabon	45.8	2	136	Mozambique	33.9	18
17	Iceland	72.3	16	77	Barbados	45.6	18	137	Eswatini	33.8	19
18	Slovenia	72.0	1	78	Bosnia and Herzegovina	45.4	18		Rwanda	33.8	19
19	New Zealand	71.3	17		Lebanon	45.4	8	139	Cambodia	33.6	17
20	Canada	71.0	18		Thailand	45.4	7		Cameroon	33.6	21
	Czech Republic	71.0	2	81	Suriname	45.2	19	141	Viet Nam	33.4	18
	Italy	71.0	18	82	Mauritius	45.1	3	142	Pakistan	33.1	4
23	Malta	70.7	20		Tonga	45.1	8	143	Micronesia	33.0	19
24	United States of America	69.3	21	84	Algeria	44.8	9	144	Cabo Verde	32.8	22
25	Greece	69.1	3	85	Kazakhstan	44.7	6	145	Nepal	32.7	5
26	Slovakia	68.3	4	86	Dominica	44.6	20	146	Papua New Guinea	32.4	20
27	Portugal	67.0	22	87	Moldova	44.4	7	147	Mongolia	32.2	21
28	South Korea	66.5	2	88	Bolivia	44.3	21	148	Comoros	32.1	23
29	Israel	65.8	1		Uzbekistan	44.3	8	149	Guatemala	31.8	31
30	Estonia	65.3	5	90	Peru	44.0	22	150	Tanzania	31.1	24
31	Cyprus	64.8	6		Saudi Arabia	44.0	10	151	Nigeria	31.0	25
32	Romania	64.7	7	92	Turkmenistan	43.9	9	152	Marshall Islands	30.8	22
33	Hungary	63.7	8	93	Bahamas	43.5	23		Niger	30.8	26
34	Croatia	63.1	9	94	Egypt	43.3	11		Republic of Congo	30.8	26
35	Lithuania	62.9	10	95	El Salvador	43.1	24	155	Senegal	30.7	28
36	Latvia	61.6	11		Grenada	43.1	24	156	Eritrea	30.4	29
37	Poland	60.9	12		Saint Lucia	43.1	24	157	Benin	30.0	30
38	Seychelles	58.2	1		South Africa	43.1	4	158	Angola	29.7	31
39	Singapore	58.1	3	99	Turkey	42.6	19	159	Togo	29.5	32
40	Taiwan	57.2	4	100	Morocco	42.3	12	160	Mali	29.4	33
41	Bulgaria	57.0	13	101	Belize	41.9	27	161	Guinea-Bissau	29.1	34
42	United Arab Emirates	55.6	2	102	Georgia	41.3	10	162	Bangladesh	29.0	6
43	North Macedonia	55.4	14	103	Botswana	40.4	5	163	Vanuatu	28.9	23
44	Chile	55.3	1	104	Namibia	40.2	6	164	Djibouti	28.1	35
45	Serbia	55.2	15	105	Kyrgyzstan	39.8	11	165	Lesotho	28.0	36
46	Brunei Darussalam	54.8	5	106	Iraq	39.5	13	166	Gambia	27.9	37
47	Kuwait	53.6	3	107	Bhutan	39.3	1	167	Mauritania	27.7	38
48	Jordan	53.4	4	108	Nicaragua	39.2	28	168	Ghana	27.6	39
49	Belarus	53.0	1	109	Sri Lanka	39.0	2		India	27.6	7
50	Colombia	52.9	2	110	Oman	38.5	14	170	Burundi	27.0	40
51	Mexico	52.6	3	111	Philippines	38.4	9		Haiti	27.0	32
52	Costa Rica	52.5	4	112	Burkina Faso	38.3	7	172	Chad	26.7	41
53	Armenia	52.3	2		Malawi	38.3	7		Solomon Islands	26.7	24
54	Argentina	52.2	5	114	Tajikistan	38.2	12	174	Madagascar	26.5	42
55	Brazil	51.2	6	115	Equatorial Guinea	38.1	9	175	Guinea	26.4	43
56	Bahrain	51.0	5	116	Honduras	37.8	29	176	Côte d'Ivoire	25.8	44
	Ecuador	51.0	7		Indonesia	37.8	10	177	Sierra Leone	25.7	45
58	Russia	50.5	3	118	Kiribati	37.7	11	178	Afghanistan	25.5	8
59	Venezuela	50.3	8	119	São Tomé and Príncipe	37.6	10	179	Myanmar	25.1	25
60	Ukraine	49.5	4	120	China	37.3	12	180	Liberia	22.6	46

Asia-Pacific

Eastern Europe

Former Soviet States

Global West

Greater Middle East

Latin America & Caribbean

Southern Asia

Sub-Saharan Africa

Figure 6 2020 EPI Rankings. Countries are arranged based on their global score; the coloured scores are their regional position.

In some cases, an indicator does not apply to a country due to their "natural resource endowment, geography and physical characteristics" (Wendling et al. 2018a)

(i.e. landlocked countries have no fisheries). When this happens, the weight given to that indicator will be nullified, and the weight of the rest of the indicators increase. The two indicators where this happens are fisheries in 44 countries, and forests in 30. The understanding is that countries should not be "penalised" for their natural characteristics and given a score of zero.

On almost all occasions, the EPI does not create the datasets needed for the production of the index. These are mostly downloaded from open-source databases produced by the World Bank, the UN system, and NGOs.

In sum, the EPI measures through multiple indicators how close or far countries are from a 0 – 100 score. The score reflects the weighting of indicators chosen by the researchers producing the index. The scores aim to represent the success of policies that allow a balance between environmental protection and economic growth. The expected audience of this tool are policy and decision makers, although it also hopes to generate a public conversation in each country. I am sure that this summary of the EPI has raised multiple questions. Therefore, this chapter focuses focus on unfolding the multiple sociotechnical layers that constitute the production of this index.

4.2 Story One: Staying Relevant

During my time at YCELP, I was told on multiple occasions, that the EPI was expected to influence "elite policymakers." This refers to Prime Ministers, Presidents, Ministers and Secretaries of the measured countries. This expectation is grounded on the origins of the index, having been conceived at the WEF, an international organisation focused on bringing public and private leaders together, to shape global and regional industry agendas (WEF N/D). The close links to the WEF have shaped the EPI from the place it is launched, to the way scores are presented – simple scorecards that allow 'busy' people to receive the intended message efficiently. This section discusses how the design of the EPI, focused too much on appealing to its target audience, has raised critiques from within the team.

Daniel Esty is YCELP's Director and Professor at the Yale Law School and the Yale School of the Environment (YSE). Outside of academia, he has served as Connecticut Commissioner of the Department of Energy and Environmental

Protection, making him someone with a career both as an academic but also within policymaking. His "revolving door movements" (Baker 2010) have been simultaneous since he remained as Professor while serving as Commissioner, although during those years he stepped back from the EPI; he has also partnered with corporations including Coca Cola, Unilever and Ikea as advisor (Esty 2020). While he tends to be absent from the day-to-day work of the index, there is no doubt that the continuation of the index depends on the interest he puts to the project. Therefore, while most statistical, programming and data selection is beyond his fully understanding, he remains an authoritative voice within the project by choosing where to launch the index and alliances with other stakeholders. A general view of him, shared by interviewees that requested not to be recorded, is that he is not an academic but a politician. It was also thought that the EPI is used by Esty as his "calling card", allowing him to remain active within political circles. During an interview, Pietro, a senior member of the EPI, was clear about this perception:

Yeah, and I wonder to what degree Dan see us as his calling card. These are things...I don't spend a lot of time worrying about, one way or the other, if you talk about longevity, I'm like "why does Dan Esty want to see this keep going?" That's a sociological question (Pietro 2019)

Pietro went even more into the specifics when I asked him about the EPI as a political tool to remain relevant in Washington (referring to the elite political circles in the US).

Yeah, because Dan travels in these circles and is kind of how to be seen still. He's a smart guy; I'm sure he could come out with other things. Again, he has the whole Green Growth, and all these other things he has come up with, books he has written. I've never doubted his knowledge in terms of, I think he's pretty smart and understands. However, he's a political animal, let's face it. His wife was in congress, and he likes to travel in those circles [Laughs] (Pietro 2019)

In a survey study Haynes et al. (2011) demonstrate how policy-influential researchers usually engage in a wide array of strategies to advance their agendas through research dissemination and promotion. These strategies include the development of personal relationships with policymakers to speak the language of the media and academic publishing. According to this study, these researchers regularly refer to themselves as classic researchers since that "ideal type is epitomised by

impartiality, detachment and rigorous scientific methodology" (2011:1049). However, 82.9% of these researchers also argued that publishing was not the main way for them to influence policy. Instead, they valued media appearances, briefings, interviews and direct conversations with policymakers as more important. This describes Esty's approach towards setting his agenda. For instance, through the WEF Esty has actively engaged with global businesspeople and policymakers.

While Esty's strategies can be clear, this does not necessarily imply they always work smoothly. Since 2001, the index had been launched during the WEF Annual Meeting event in January. However, for some senior members of the team, it was clear for a long time that the index was no longer part of the WEF agenda. Examples of the lack of engagement from the WEF attendees are the low attendance at the launching events in 2016 and 2012. For instance, figure 7 shows that, at least in the front rows, only a journalist attended the 2016 EPI. The circumstances were not that different in the 2012 edition, figure 8 shows that there are only two visible journalists (although from the recording it is possible to identify that there were at least two other attendees in the room).



Figure 7 Screenshot of the 2016 EPI presentation at the WEF Annual Meeting. Source (WEF 2016).



Figure 8 Screenshot of the 2012 EPI presentation at the WEF Annual Meeting. Source: (WEF 2012).

Despite the notion that the EPI was part of the event's agenda, Esty kept the alliance between YCELP and WEF, maintaining WEF as a collaborator of the index. While Esty's image of being interested in remaining active around political circles was shared among senior members of the EPI, it was also clear that the index was not reaching that audience. Based on internal documents, YCELP has hired public relations companies including UK-based *Onalytica*, to arrange interviews with media outlets (including The New York Times and The Economist) during the launching day as well as to identify industry influencers (see Figure 9). Even with the hiring of these companies, it seems like the EPI has struggled to circulate among its target audience.

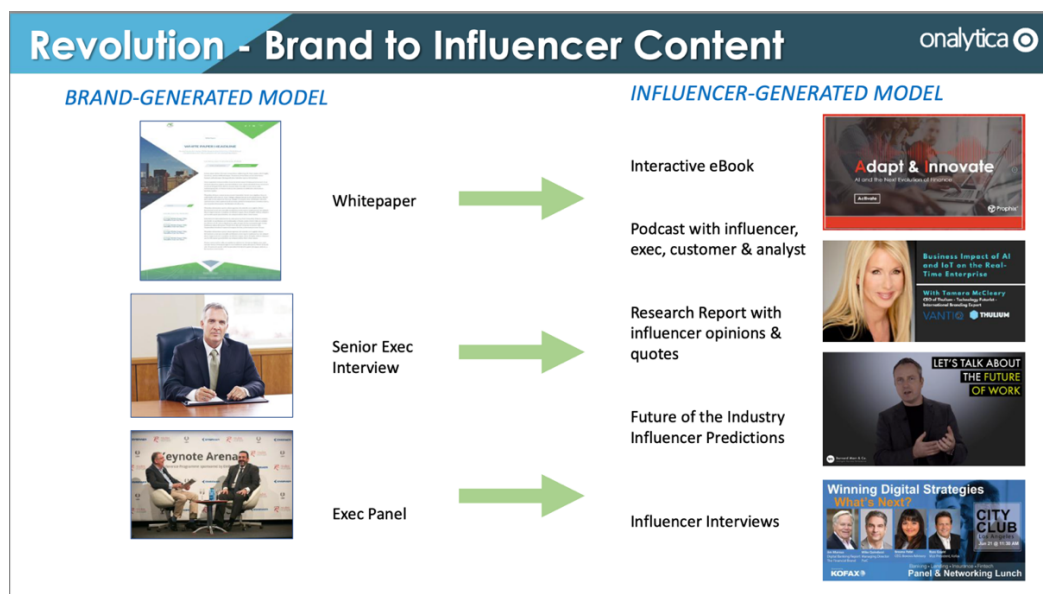


Figure 9 Analytica services offered to boost the EPI influence

During my time at YCELP, and as part of my weekly tasks working as a RA, I was requested to look for alternative venues for the 2020 EPI launch event. It seemed that the relationship between with one of the institutions where the index had been conceived, was over. No conditions were given to me, so I focused on looking for two types of venues: tailored events that could be co-hosted by local think tanks in various countries, and macro events like the Annual UNFCCC Conference of the Parties (COP). While contacting local think tanks multiple people told me "use your @yale.edu when sending an email and everyone will reply". This confidence towards Yale as a brand that should be exploited made me question what degree of the authority attributed to the EPI was supported by the quality of the index and what degree was linked to the prestige of the hosting institution. For instance, in Haynes et al. (2011:1051) survey, 68.5% of influential researchers argued that their institutional affiliation enhanced the influence of their research even providing a degree of authority. While having an informal conversation with a former EPI researcher, and current principal investigator of another QD, that requested not to be directly quoted they told me: "because we are not an ivy-league, most of the times we need to work twice the amount to be heard". The claim by this researcher represents an example of *distributive epistemic injustice* (Fricker 2013), where claims made by particular institutions (Yale in this case) are granted, *a priori*, more authority than others.

After a week, I presented a list of suggestions of alternative venues with the idea of working with think tanks being discarded immediately. The rationale behind this was that YCELP would prefer to avoid being considered politically aligned with other institutions. Most of the mega-events that I proposed were hosted by an UN-system organisation like FAO, UNEP or UNDP. Unfortunately for me, these events were also discarded since most of them would occur in the second half of the year, which would cause the index to move its launching date too far. However, a senior member suggested looking at the Abu Dhabi Sustainable Week (ADSW). Proposing the ADSW as the venue was not left to chance; Fiona Paul Schwab, who is an advisor to the Crown Prince of Abu Dhabi is also a YCELP board member. However, some EPI advisors discouraged the idea since the ADSW was a macro-event with more than 30,000 attendees and hundreds of events occurring simultaneously. This could cause the EPI event to become 'just one more', rather than attracting attendees.

During the same meeting, a senior member of the EPI suggested a second option, the congress of the International Union for Conservation of Nature (IUCN). This is also a macro-event, but it was seen as a good option. While the EPI applied through the call for panels for one of the 300 available slots, the application was unsuccessful.¹² However, some weeks later, I was told that the EPI would be presented during the IUCN event in June 2020. This was an interesting development since it testifies, once again, the institutional support and relations behind the EPI. During an interview, Nicanor, a senior member, talked about the importance of Yale for the EPI:¹³

'Yeah, being at Yale provides us a lot of resources, provides us with access to very smart research assistants, access to faculty like Jay

¹² It is important to highlight that I was partially involved in this process since it occurred at the end of my fieldwork. While I was still at YCELP when the idea was brought into the discussion, I had left when the application was sent. I was able to reconstruct this through emails in which I was still being included.

¹³ The EPI, like any other QD, raises the question of how much its production costs. Based on internal documentation, the production of the 2020 EPI will have had an approximate cost of USD \$235,000. In the case of the 2020 EPI, the total cost was of USD \$306,940 with funders providing USD \$225 599 and YCELP -arguably coming from Yale – having to cover the rest USD \$81,000. There are no profits in producing this QD, which is relevant since it is not perceived as an academic tool. During an interview, Rodrigo, a senior member within the EPI, showed himself comfortable with the current financial circumstances "Funding is always an issue; we wish we had more money to pursue the agenda. With more money we could do more, we probably could achieve greater, bigger and faster, progress on some of these data gaps. But we feel good about what we've been able to do with the money we have" (Rodrigo 2019).

who has institutional knowledge and practical skills that help us in how to teach, it also helps us gain credibility with external partnerships we are trying to build relationships with; a work from Yale does open doors' Nicanor (2019).

Unfortunately, due to the Covid-19 pandemic, the event was postponed to January 2021. Still, the EPI was launched online in June 2020 in a YCELP-organised event. The circumstance that led to the team to decide to launch the index outside of any major event can be linked to an already six-month delay in the regular publishing strategy.

4.2.1 Scientific gurus

WEF, ADSW and IUCN have one aspect in common; they are not scientific but stakeholders' events. They are focused on gathering policymakers, businesspeople, and civil society. This is key since the argument for the entire production of the EPI is that quantitative devices represent a scientific approach towards the decision-making process. However, its construction has remained shielded from scientific scrutiny. During an interview, Pietro was clear about this,

[The EPI] is meant to be a policy tool, that's Dan's thing. I think, if we have wanted to be purely academic, we would have gotten that peer-reviewed article out. Dan has published a few things, I'm not saying there's nothing out there, I don't think there's a foundational article that says "this is our basic approach" that's what I'm saying from an academic perspective. So, if we wanted to have academic chops, that's what we would have done, I guess we just never found the time to do it...seems a little bit [laughs] after twenty years [laughs] (Pietro 2019).

These internal discussions about the nature of the EPI were common. For most members, the tool is perceived as statistically strong as to provide trends about environmental policy. However, with limited potential due to the lack of peer-reviewed processes. Hence, while the EPI is presented to the exterior as a scientific tool, internally is recognised as lacking scientific authority. This absence of the EPI from

academic or scientific discussions could lead them becoming the gurus¹⁴ they intend to eradicate through metrics. Yet, as it was argued before, influential researchers aim to mobilise their agendas through different strategies even at the cost of not being perceived academic enough. For example, the EPI is built to serve as a device capable of being used by environmental scientists, policymakers and businesspeople. However, Pietro was very critical towards the EPI's lack of scientific rigour and scrutiny:

"I would say, one of our shortcomings is the lack of peer-reviewed articles, five years ago we should have had at least, five, maybe longer, a benchmark peer-reviewed article in like Proceedings of the Natural Academy of Science or something in a high impact journal that says, this is what we did, this is the methodology, and these are some of the findings, and that becomes scientific credibility that groups desire" (Pietro 2019)

Pietro is clear by stating that, for him, the EPI lacks a degree of scientific authority. However, this is also part of how the index wants to be seen, as a simple and easy-to-read tool. The researchers in charge of the index have had to strike a balance between being perceived as scientific and an easy-to-read report. However, reaching that balance has not only been hard to achieve, but it involves leaving important issues aside.

4.2.2 Simplicity

The notion of simplicity runs throughout the making and delivery of the EPI. In particular, it is sought in three ways: avoiding scientific jargon on the report; measuring issues only at the national level; and perhaps the most obvious one, boiling down

¹⁴ Esty and Emerson (2018), a longstanding EPI contributor, wrote a book chapter titled "From crises and gurus to science and metrics." Here, both authors argue that the land and conservation efforts of the 20th century were rarely rooted on evidence that could avoid an overpromising and under-deliverance. Instead, these efforts failed in achieving a balance between economic costs and environmental benefits. In other words, obtaining the expected economic returns from investments in environmental protection. While they do not define *gurus* it is easy to conclude, that when decisions are not based on *science and metrics* crises driven by gurus is what it is left. Hence, inspired by the WEF competitiveness ranking, a team of "global leaders for tomorrow" summoned by businesswoman Kim Samuel, commissioned Esty to develop a similar scorecard to the WEF competitiveness ranking, to push politicians and corporate leaders to act on environmental protection based on data.

complex issues to a single number. The idea of delivering 'easy-to-read' reports is based on the understanding that the target audiences of the ranking are busy people with no time to read full scientific articles or technical documents. During an interview, Nicanor told me how this approach towards simplicity is at the core of the EPI:

"This goes back to the philosophy behind the EPI is that policymakers, and indeed most of the public, have limited attention span – and that's not derogatory, is just a fact of how things work.

So, if you're trying to communicate with people, you can look at other domains like GDP, is a very handy number to let the people know the state of the economy. Is not everything, is not perfect, a lot of measurement error there, but over the years you can kind of point to that as being a good barometer. So, if you want to talk about how the environment is doing, you are looking into boil this down to one number, one rank; and that's meant to be the start of the conversation rather than the end. (Nicanor 2019)."

Nicanor understands that the simplification of issues will not provide results with which decisions can be taken. The aim then is to start conversations and not to provide final statements around an issue. However, simplicity has created limitations to the EPI; three, in particular: first, the necessity to frame the structure of the index to existing policy administration. Second, deciding to measure issues only at national level; and finally, a dependency towards third-party organisations. All of these problems signal that rather than understanding the environment as a complex system, it was framed to fit other existing structures.

In the pursuit of simplicity, the EPI has been framed to measure what existing infrastructures perceive as relevant. During an interview, Nicanor highlighted how the "simple approach" has meant that the EPI lacks a full perspective towards the environment:

We can help to stir up things towards constructive domains in which action is feasible by different stakeholders. You think more holistically about the environment, everything is interconnected, it's hard to try to separate these things if you look too closely' which is great, because you can have these great discussions with people about the need to be more interdisciplinary and have integrated approaches towards environmental challenges. When you are looking at whatever kind pressures countries are under, it might be several ministries that need to be involved or several scales of competency; you might have local, regional, and national governments' units working together. But it's hard to communicate

that within the index, as a matter of methodological construction, is really about the narrative around it (Nicanor 2019).

Nicanor brings the notion of the narrative created by the EPI, which needs to understand the environment as a single-ministerial issue and not as transversal one. He argued that, unlike the EPI, I was understanding environmental issues from an ecological perspective where all the measured issues affect each other (see: Chapin, Matson, and Vitousek 2011). Rodrigo (another member of the team) underlined the ministerial approach when referring to the rationale behind the shift from SEI to EPI.

In fact, in the early framing, we had a wide sustainability structure, and we narrowed it over time to really the environmental sustainability elements because the feedback from those who were interested in the work we were doing, was that the original sustainability frame was too broad, and it meant that no one official in any government has responsibility across all those issues. It makes more sense to focus on things that would be within the mandate of an environmental ministry (Rodrigo 2019).

It seems that while aiming to influence how countries approach environmental issues, the index was framed by the dominant structures of public policy. The EPI had to be adapted to only measure what a single ministry would cover. This represents the first limitation that the approach towards simplicity has set upon the construction of the index. Whatever has to be measured through the index, will have to be the competencies of a ministry, limiting the understanding of the environment. While for Rodrigo, the EPI seems to be an immutable mobile (Law 1984), a tool capable of being applied anywhere, in practice, the EPI should be understood within their sociotechnical imaginaries and infrastructure. These include the imaginary of a data-driven world and the sociotechnical infrastructure that allows the quantification of everything. Still, the index ignores the social perspective in its design (Jasanoff 2015:2) in order to fit within existing systems like ministries being designed from a neoliberal perspective of scarcity (see: Harvey 2007). In other words, the EPI producers willingly ignore the interactions across environmental issues, so that the index can maintain a compliance with dominant ministerial and bureaucratic designs. Hence, the nature of the index can be seen in its lack of recognition of the environment as a transversal issue where multiple stakeholders of the society have participated. This understanding goes

against the definition of ecosystems ecology, where forests, oceans, farms, human and non-human populations, to mention a few elements, are seen as integrated and affecting to each other (Chapin, Matson, and Vitousek 2011).

4.2.3 Simplicity at the National Scale

Another issue that the team faces for measuring environmental issues at the national scale, is to ignore the existence of different degrees of governance. In other words, the EPI assumes that all environmental issues are tackled through national policies which ignores the role of local governments. For instance, the UK is a country comprised of four nations, and a national government, each one with different degrees of authority over their policies. In the case of agriculture and the environment, each of the four nations has full authority. Hence, it is each nation and not the UK government who holds responsibility and who should remain accountable. However, the EPI presents a score for the UK and not one per nation. While the UK may seem like an exceptional case due to its plurinational constitution, this is replicated in Bolivia. Also, similar governance issues happen in countries with federal arrangements such as Germany, Mexico or Canada. In Mexico water policy is managed at the basin level (Secretaria de Medio Ambiente y Recursos Naturales 2020). A ranking that evaluates water management at the national level will ignore the role of municipalities, states and the private sector. This represents a major problem for the EPI since it shows that the glimpse the index could provide about the performance of national policies will be irrelevant given that issues are tackled at a completely different level.

4.2.4 An issue of dependency

As I have demonstrated, the EPI will be able to measure only as much as others allow them through the provision of datasets.¹⁵ This dependency towards other organisations, represents a shift on how we conceive the creation of QDs. Rather than

¹⁵ From the more than 40 databases that are used for the EPI, according to internal documents I had access to, only in two cases, the EPI pays to other organisations for their data. These are produced by Around Us and Map of Life.

creating new knowledge, those making these devices manage what others have previously *datafied* (Dourish and Gómez Cruz 2018). While the lack of quantitative databases is one of the main obstacles, it also seems to be one of the drivers not only for the production of QDs and statistics – the field to which the QDs belong. During an interview, Remedios, a RA, told me:

Statistics, as a field, is the field of predictions, is the field of taking what we know and using it to help guess what we don't know. There is no statistical model that is going to produce an absolute truth; otherwise, there is no reason behind it. Is not necessarily a guess, as much as an educated guess. It's taking what we know and doing our best to say what we think this means. Is not research, it's modelling. If there was an absolute truth, we wouldn't need to model. If all of this information meant something specific, it wouldn't be worth us going through the entire process of interpreting it. Because there is no absolute truth; the work that we do is to try to capture the essence of the truth or the essence of what it means without declaring a single value, a single point that everything bends towards (Remedios 2019)

Remedios's claim helps us to better understand the notion of *in vitro environments*. For her, statistical modelling will gather all the available information and, within a controlled environment, tries to make sense of the world through their own sociotechnical processes. Remedios shows a process of reflexivity in acknowledging that what she delivers is not "the truth" but the way she understands the world through data and statistics. However, as we have seen, these interpretations are the result of what Remedios interprets, as well as of the frames that influence it on multiple sides. While aiming for simplicity, the team has had to renounce to an authoritative scientific voice and also to limit their measurements to what others consider relevant. Statistics exist because we do not know the truth. If we knew the truth, then there will be no need for us to model something. As Remedios puts it, this is not the only way in which things could be told; hence, it is important to analyse under which circumstances this particular interpretation is being constructed.

These self-imposed but also external limitations are part of the storytelling this chapter aims to unfold. While this section focused on explaining why the index measures what it does, the relationship between the EPI and datasets opens other

questions. Also, while briefly mentioned, the notion of economic growth central to the EPI will be explained further. These two elements are part of the unfolding processes of how QDs are actually produced.

This gap between the scales at which the EPI measures issues and that at which they are tackled, exemplifies how QDs create *environments in vitro*. In the upcoming section I analyse how time is paused through datasets where researchers are capable of controlling the scale and time at which environmental issues are evaluated, ignoring social and governance elements. As described by Knorr Cetina (1995:145), scientists can often manipulate the size and space of the elements they work with. The idea of simplicity at the core of the EPI was supposed to provide accessible metrics. However, it has also delivered weak metrics where the environment is treated as a set of silos that can be merged without considering the social and ecological aspects.

4.3 Creating *in vitro* Environments

The decision of what to measure does not depend entirely on what the EPI perceives as relevant. Continuing with the understanding of the EPI as a device integrated in a wider sociotechnical infrastructure and given that the production of QDs depends on data, the team requires the work of other organisations. In particular, the index will be capable of integrating into indicators only those environmental issues that data providers have deemed as valuable enough as to *datafied*. However, unlike the shared belief that we live in a data society, where there is data about everything, QDs will depend on having it at the right scale for their measurements.

During the production of the 2020 EPI, the team sought to include one more indicator in the agriculture issue category. Until then, the only indicator within the agriculture category measured the performance of agricultural production (Wendling et al. 2018a) through the sustainable use of nitrogen-rich fertilisers, which are an important component for crops production. However, if overused, nitrogen-rich fertilisers could lead to land degradation, groundwater contamination and a decrease in biodiversity (FAO 2019, 2-3). An advisor suggested adding an indicator of land certification among countries. The aim was to observe the proportion of certified

sustainable agriculture in each country. However, as it has just been mentioned, measuring an issue is not only a matter of deciding what seems relevant but of realising if the indicator can be measured at all. Nicanor is clear:

Absolutely! This is especially true in agriculture, and you can find very good analysis in single countries or single regions but not global assessments, which is frustrating because these are things that are important. If the global community really gathered around funding, research and data collection reporting verifications, we would have a much better idea of how the world is changing for good (Nicanor 2019).

To explore the possibility of the sustainable agriculture indicator, RAs had to look into the organisations that provide certification of sustainable agriculture. Among these are the Rainforest Alliance (whose frog label we tend to see when buying our bananas), or the International Social and Environmental Accreditation and Labelling Alliance (ISEAL). However, while searching for these databases, we soon realised that land certification occurs at the most local level, parcels! In other words, what it is certified are the practices that occur at privately owned parcels and not countries. Not only that, but certification organisations also are not global, either, and each one has its own metrics to provide their labels (Pye 2019). These practices of self-defining what counts as "sustainable" makes global comparisons very difficult to achieve. It was clear that this indicator could not be included within the EPI.

The lack of environmental data is one of the main struggles the EPI has faced since the first edition in 2002. During an interview, Rodrigo highlighted these issues:

... this has been a longstanding issue. I think what we found was that the world was, at the time this project was launched in the late 1990s, not very well-equipped when it came to environmental metrics. There was not enough, in a way, environmental information. So, what we have been calling for, and if you go back and look, you will see that occurs in every iteration of the EPI, is that there's a call for more data and better data. I think the world has come around to that. We now have a much greater data foundation for decision making. The world has evolved to the point of having sustainable development goals, a very broad appreciation for the importance of quantitative metrics that underpin policymaking of all kinds, but including and not limited to, environmental protection (Rodrigo 2019).

Hence, even if researchers would like to measure an issue category through multiple indicators, it can only be done through national data. However, for Rodrigo, there has indeed been an increase in the production of national data. The number of indicators measured through the EPI reflects this. Just from 2018 to 2020, there was an increase from 24 to 32 indicators. If we consider that the 2018 EPI was produced in 2017, three databases were updated on that year while seven were updated one year before. The longest "time gap" between the creation of a dataset and their use for the EPI is of seven years. This exemplifies the capacity that researchers have to manipulate and control time to create what I defined earlier as *in vitro environments*. In this particular case, by ignoring the time at which the integration of ecological ecosystems occurs, databases from multiple years are combined together as if no real-time effects between environmental elements occurred. The indicators with the seven year's time gap were the ones related to the Air Pollution issue category: Black Carbon Emissions (BCI); Sulphur Oxide Intensity (SDI); and Nitrogen Oxide Intensity (NXI). All of these indicators use as reference the Emissions Database for Global Atmospheric Research (EDGAR) produced¹⁶ by the EU Joint Research.

EDGAR was updated in 2019 and now includes data for up to 2015, meaning that the 2020 EPI data will have a delay of 5 years. As Alfonso pointed out, this delay should be considered as a normal issue considering the amount of effort that building these databases take. When I asked Pietro if the production of data had become faster than when the EPI started, he told me:

It's all domain-specific, the mass of effort like Edgar to produce SO₂ emissions and things, and then suddenly for reasons that I don't understand, I don't know why, but suddenly they go silent, they don't do things anymore. And then new stuff arises like satellite-derived air pollution, which is a very exciting development. The group at the [X] I'm in touch with regularly I know better what's going, but you know they are always looking for new funds and their work is dependent on continuing receiving funds from external sources. There's a lot of factors that can play into whether a dataset has longevity or not and is something we looked at whether there's a

¹⁶ Two important clarifications are needed here. First, the latest EDGAR update was delivered in 2021, this already accounts for the effects of the COVID pandemic over CO₂ emissions. Second, while EDGAR is independently produced, it is done with data provided by the International Energy Agency (IEA) which obtains its data from national ministries (Crippa et al. 2021). Therefore, the work by the EU Joint Research Centre, does depends on countries providing data.

commitment to the individual dataset overtime or modelling after this or that (Pietro 2019)

Air pollution is a single-issue category; however, extraordinary circumstances such as the COVID pandemic, which had an effect on CO2 emissions, could be replicated to the rest of the EPI indicators. Also, the effect in air pollution might affect other indicators as well. This frustration towards the lack of data was common, Alfonso, who is a senior member, expressed this:

There are a lot of things where I think we point to a desire to be able to improve but, if we are not the ones collecting the data but relying on a research team someplace else to do those updates, is beyond our control (Alfonso 2019)

The 2020 EPI is made with data on food loss from 2013; SO₂ emissions from 2014; marine protected areas from 2018; and tree cover loss from 2017, to mention a few. The efficient advice the EPI intends to provide will be minimal since it will not correspond to how countries are implementing policies given that they measure multiple issue categories (environmental issues) that never existed together. As Alfonso told me, this is another external limitation the EPI faces, and one of the main reasons why the index is produced every two years:

"In some cases, they are exactly the same, there are no data updates, which isn't very interesting and that's too bad, but in other cases, it's the same data source, but there might be an extra year or two of data that we have now"(Alfonso 2019)

What Alfonso said shows the frustration from the researchers when there are no updates, and the results will have to be the same. It is important to remember that the EPI has been launched every two years. Hence, if multiple datasets are not updated on time, the same data will be used to produce a "new" ranking. Alfonso also told me why datasets are not updated as fast as it might be desired.

"I think people don't appreciate how slow these metrics are to change. You are talking about macro-level information at the level of

countries, and things like child-birth mortality, which we used for a long-time, just don't change that much. Is not as if you all of the sudden are going to do something and change your rate of child mortality in a striking way in a two-year time period. That might be true for one or two countries that just at some time made a commitment to improving sanitation in a vast majority of households in that country. I can imagine some strikingly important innovation that might have changed child-mortality, that's incredibly rare, probably it doesn't exist, I'm saying is a hypothetical, maybe it happened. And most of these things are like that, you are not really going to change, again, air pollution much, in any country in a short period of time" (Alfonso 2019)

The delays on the updates of the data are not only a matter of organisations not updating an issue but is part of the nature of the issues. However, a problem may arise when employed data goes beyond the time in which changes could be expected to occur. Figure 10 shows the delay between the time the 2018 EPI was constructed and the last update of the datasets.

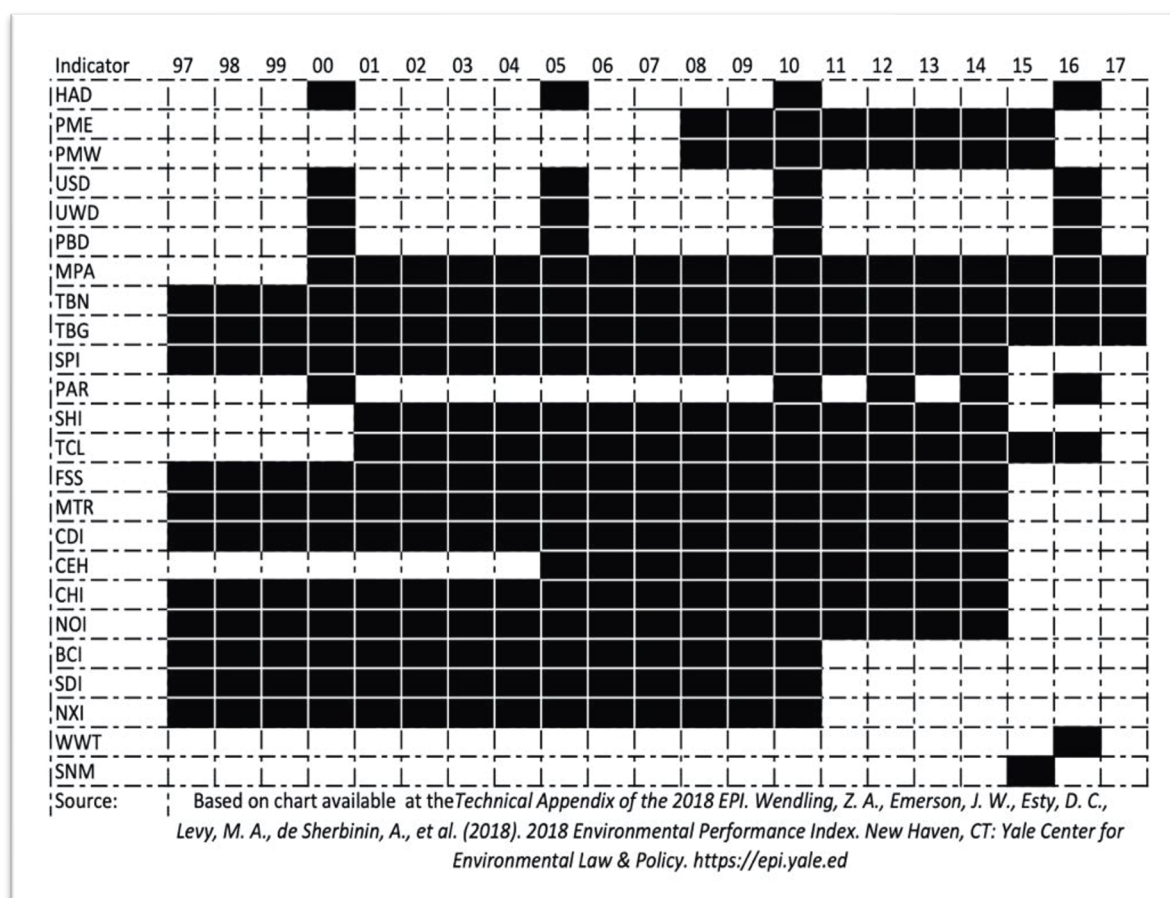


Figure 10 Years in which each database used for the EPI 2018 was created.

If we consider that the 2018 EPI was produced in 2017, we can see that three databases were updated on that year while ten were updated one year before. The longest delay is with three databases that were last updated in 2010, i.e. seven years before the index was built. These indicators are the ones related to the Air Pollution issue category: Black Carbon Emissions (BCI); Sulphur Oxide Intensity (SDI); and Nitrogen Oxide Intensity (NXI). All of these indicators use as reference a database produced by the EU Joint Research Centre called EDGAR (Emissions Database for Global Atmospheric Research).

EDGAR was updated in 2019 and now includes data for up to 2015, meaning that the 2020 EPI data will have a delay of 5 years. As Alfonso pointed out, this delay should be considered a regular issue considering the amount of effort building these databases take. However, an issue will arise during extraordinary circumstances. The COVID-19 emergency has shown (see footnote 11) that the delay issue will cause QDs not to reflect the current status of the measured issues. If EDGAR keeps its updating trend, the next update will be in 2026. When I asked Pietro if the production of data had become faster than when the EPI started, he told me:

It's all domain-specific, the mass of effort like Edgar to produce SO₂ emissions and things, and then suddenly for reasons that I don't understand, I don't know why, but suddenly they go silent, they don't do things anymore. And then new stuff arises like satellite-derived air pollution, which is a very exciting development. The group at the [X] I'm in touch with regularly I know better what's going, but you know they are always looking for new funds and their work is dependent on continuing receiving funds from external sources. There's a lot of factors that can play into whether a dataset has longevity or not and is something we looked at whether there's a commitment to the individual dataset overtime or modelling after this or that (Pietro 2019)

Air pollution is a single-issue category; however, these extraordinary circumstances could be replicated to the rest. Also, the effect on air pollution might affect other indicators as well.

While this research is not focused on measuring the impact, these tools might have an actual impact on policies. It is important to highlight that not because these tools are developing scores that reflect a representation of an environment that never

existed, their impact on people is lesser. These tools are being used, as part of other instruments, to make decisions; that is why we need to understand the story they want to tell us.

4.4 A story about growth, data [and the environment]

One of the outcomes of the 2018 EPI was to confirm "that success with regard to sustainable development requires both economic progress that generates the resources to invest in environmental infrastructure and careful management of industrialisation and urbanisation that can lead to pollution that threatens both public health and ecosystems" (EPI 2018).

While the EPI certainly aims to measure the performance of environmental policies, other factors drive the production of this indicator. Perhaps the main driver is to co-produce (Jasanoff 2004) our understanding of environmental policy. This means establishing the framework through which environmental policies are designed. For this to happen, their worldview will have to be disseminated and adopted by institutions and governments. However, as we have seen, the EPI also has to adapt to an existing sociotechnical infrastructure of quantification. So far, I have shown an interaction among sociotechnical systems where data providers, ministries, and YCELP interact. Therefore, rather than being solely designed by YCELP there is a co-production process led by other sociotechnical systems within the infrastructure. In this section I unfold the two dominant imaginaries in which the EPI is framed: a data driven world and one where economic growth is ensured.

4.4.1 A story about data

The core interest of the teams producing QDs is *data*, not the measured issued. While conducting my fieldwork, I came to learn how the environment was the channel through which this group of researchers could push for a data-driven world. Hence, the EPI is not [only] about the environment, but mainly about producing a device that shows the advantages of data-driven policy over qualitatively informed. I got this perception from the published reports, and while working with the team. However, as

an outsider with no degree on statistics, mathematics or computer science I often felt that my ignorance around statistics was not allowing me to fully comprehend what they were referring to when talking about *data*. Hence, as a way to learn about and access the meaning attributed to data during the interviews, I asked them directly: *what are data?* The answers point towards a notion of data that has a representation beyond a numerical figure; they are stories that only when gathered together can be unfolded.

A shared belief among those working on the EPI was that data represents the smallest unit of analysis, represented even as a maize kernel, under which information can be catalogued.¹⁷ Datasets are a collection of data, which together will make a database. However, while data is understood as the minimal element, it is also an element that already encapsulates wider notions. For instance, in Pietro's opinion:

"Data reflects observations of some phenomena at a point in time and space" (Pietro 2019)

In a further question, I asked him about what would make environmental data different from other types of data, to what he replied:

Typically, it is just harder to get a whole of it, maybe it is harder to produce. [...], one student scripted this ephemeral stream water quality from state-level monitoring sites in Delaware and Pennsylvania for two other sets. It took him a long time to do that, it was just this tiny area, and it was basically water bodies that are not even permanent, they are streams that dry up sometimes of the year. I was surprised that the states were even monitoring this; I was actually impressed that there was this level of effort. But to collect, compile and aggregate data like that is a massive level of effort takes a lot of time and effort (Pietro 2019)

His second reply helps to start a discussion around how problematic it might be to collect environmental data. When both responses are compared, we can see how, while there is an interest to "freeze" data into a single instant to create their *in vitro environments*, in practice, a dataset might reflect the environment across several moments and space. Therefore, when used as part of a composite index, a dataset

¹⁷ It is important to recognise that a corn cob is not homogenous, but it is formed by a multi-colour set of kernels; hence, data should not be understood as homogenous even if within the same database.

will not represent an environmental circumstance in a given moment, as a photograph, but as collage. Alfonso described accurately the perception I had during my fieldwork; for them, data is almost entirely quantitative:

Well, I would say that data, fundamentally, are almost entirely numeric, sometimes text but even that could be coded as numeric at the lowest possible level that on their own without a context have no value, and I think that in order for data to have some value they need to have a context, a real-world context, you need some measurement in many cases, knowledge of the data collection process, in some cases knowledge of sampling designs or maybe experimental design in some areas. But without really understanding where numbers come from and what they mean, you have no chance of making sense about the problem that you care about (Alfonso 2019).

While Alfonso also mentioned the importance of contextualising data, it is not clear how much of this contextualisation is transferred into the EPI report. It is true that databases are available for anyone with interest to verify them, however, databases tend to ignore a degree of metadata (Edwards et al. 2011) in which contextualisation is provided; making it difficult to know from where exactly each number comes from. Hence, without offering the user a detailed meta-analysis of the used datasets, the user will lack an understanding on the process of *datafication* (Dourish and Gómez Cruz 2018; Micheli et al. 2020). This could limit what I referred earlier as *conscious understanding*, to refer to the capacity that users should have to understand the origins of QDs. researchers such as Alfonso and Pietro claim that it is important to contextualise where data comes from, but it seems that it is only relevant for the producers, not for the users of QDs.

When I asked Gerineldo, a technical member of the EPI, about his definition for data, he told me:

To me, I want to stick with my maths background; I want to say, a collection of objects, it's an array, it's a set. To me, though, when I'm given a dataset, I often really just think of it as a box that is labelled and spatially in my head it has two dimensions. I rarely think of it three-dimensionally or one-dimension, I try not to look at the numbers in the processing stage, I just try to say what are the numbers there, whether they are missing or exist, or whether is 0, which is sometimes important (Gerineldo 2019).

Gerineldo shows a degree of disengagement towards what datasets contain. For him, the work is technical; he needs to detach himself from any representation beyond numbers. His goal is to clean a dataset from possible errors that it can contain, not to look for errors of environmental representations. Since Gerineldo seemed to refer to dataset rather than just data, I made a follow-up question trying to understand more about his understanding of data.

If I was asked to make the dataset in a collection of small discrete items like that, I guess the statistical answer is that it is a data point. [...] To me, a data point is just a number. I cannot say that that number was generated in a very objective and honest way based on who provided the number, but for the sake of cleaning and processing, to me, I try to treat it like a number that just exists within the dataset. That's my goal (Gerineldo 2019)

For Gerineldo, just as for Alfonso, data has only numerical characteristics. This quote shows again his aim to stay detached from the features of the data. He goes one step further when he claims that he cannot judge the quality of the datasets, but his work will aim to represent the collection and not the environment. In this sense, programmers are fully aware of the context behind their data but their objective is to deliver numbers detached from any particular story (Stone 2020). Gerineldo also argues that data is the minimal unit of understanding, which still, without context is useless. As expressed earlier, I refer to the process of datafication as the rendering into data of a given issue (Cukier and Mayer-Schoenberger 2013; Dourish and Gómez Cruz 2018; Micheli et al. 2020; Sadowski 2019). For Gerineldo, datafication will require programmers to abstract any particularities from their data and contain it within their datasets. The expected usefulness of QDs was explained to me by Nicanor:

The metaphor I would use is, data is light, so we are groping our way in a dark world and data is illumination. It gives us some kind of reflex to see how the world comes back into our eyes, is not always perfectly accurate, but it's better than groping in the dark. Lots of data mean you have a lot of light; you can have a very good sense of what's going on. Some parts of wherever we are looking are obscure, we only have a candle, sometimes we have a very fresh light, so data helps us navigate and find our way around to

understand what is actually going on around so that we can make appropriate decisions (Nicanor 2019).

Nicanor's words encapsulate the multiple responses to *what are data?* His reply highlights not only the trust in data as a way to make the best decisions but also as individual units. The more data there are, the easier it should be to make good decisions. Through the claims made by my interviewees, it is possible to see that they are not focused on delivering individual solutions to how countries can design better policies. Instead, they aim to build a robust methodology capable. Hence, the stress is not on how policy can work as a driver for a better environment, but on how quantitative data can help policymakers to make 'better' decisions. The EPI claims that 'the world has entered a new era of data-driven environmental policymaking' (Wendling et al. 2018b). However, for Rodrigo, this goes beyond the environment:

I had seen the value of this in other contexts, where the math-based social sciences of the 20th century, things like economics, were spilling out into other parts of the social sciences, therefore increasingly becoming more data-oriented. I thought it was time for the environment to become similarly more grounded in facts and figures (Rodrigo 2019).

Rodrigo argues that environmental policy should follow the trend that other fields have taken and move towards an economic approach. Hence, rather than seeing an economics approach as part of a neoliberalisation of public policy (Harvey 2007), for him, it offers the possibility to take unbiased decisions.

In sum, researchers share an understanding about what constitutes data that goes beyond the numeric unit. Even those to whom data are purely numeric are aware that they belong to a wider element of analysis that includes time and space. This nuance matters as from now onwards the idea that researchers have a given understanding towards data which is almost never questioned when looking into a computer, they are looking to build a trustable tool based on the right context.

4.4.2 A story about a "better capitalism"

As we have just seen, the researchers producing the EPI are focused on creating a tool that provides accurate descriptions of the environment, without the perceived bias of unnecessary contextualisation. However, the justification of why data should substitute the advice of experts (described earlier as *gurus*) has not been discussed. For Nicanor:

"The push for data is a push to make policymaking more rational and scientific, and to focus limited resources where they are gonna have the greatest impact on human wellbeing (Nicanor, 2019)"

One of the underlying elements in the "logic of environmental metrics" according to the EPI report is "... maximising the return on governmental investments" (Wendling et al. 2018a). This business-oriented language allows me to analyse the EPI as a tool whose origins and current measurements are oriented towards a competitiveness model rather than the protection of the Pachamama, Akna or Gaia.

I have analysed how the EPI was influenced by its links to the WEF. In the words of its founder, Klaus Schwab, WEF aims to build a "stakeholder capitalism" (2019) which embraces economic growth as a necessity for the protection of the environment; "a better kind capitalism" (2019)¹⁸. This vision of a world where the economic growth and environmental protection¹⁹ are possible represents a keystone of the argument this entire chapter is aiming to build; quantitative storytelling will assume numbers not as a description, but as a perception of reality created by those who designing QDs (Kovacic 2018). In the case of the EPI, and as I described in the previous section, it will build a world through data based on how YCELP understands the world. In Pietro's words:

I tend to see the EPI, partly because it came out of the World Economic Forum and this group, Global Leaders for Tomorrow to have a heavy sort of western business sort of slang. I think Dan [Esty] also brings that to his work. There's nothing wrong with that, but I think it is better to be explicit and say "we have a basic western kind of mindset, that a) these metrics are objective, and they are

¹⁸ Similar approaches to this includes that by fashion designer Brunello Cuccinelli notion of humanistic capitalism (Cucinelli 2012) and the creation by multiple global CEOs of the Council for Inclusive Capitalism (N/D).

¹⁹ For a critique to the idea of decoupling (the idea that economic growth can be decoupled from environmental degradation) see Jackson (2016).

scientific, and they are rigorous. b) that you can make decisions and bank on those decisions, and blah, blah, blah. I think there's actually a lot more ambiguity in the space than sometimes the EPI lets on (Pietro 2019)

Pietro is explicit when highlighting that the YCELP should acknowledge that the EPI is a tool built under determined values. The language used throughout the several documents that make the EPI, signals some of these values without being explicit. Its authors define the EPI as a benchmarking tool, which is a way businesses and companies use to reduce costs by comparing their practices with others. This market approach can be seen in the EPI with proposals on decoupling greenhouse gas emissions from economic activity or understanding sustainable development challenges as something that can be dealt with by managing costs.

Another example of the EPI market approach is the use of a balanced scorecard. Robert Kaplan and David Norton proposed the scorecard approach in the Harvard Business Review in the early 90s as a way for executives to "minimise information overload by limiting the number of measures used" since according to this approach "companies rarely suffer from having too few measures" (Kaplan et al. 1992). When this scorecard approach translates into policy, it hints on to a neoliberal approach of 'simple governments' with few regulations and measurements. During an interview, Rodrigo explained how the scorecard became part of the index:

So there was a subset of the hundred [members of the GLT], maybe 20, who were having a discussion about what to do on the environment, so I proposed the idea of trying to do a scorecard and the model was the competitiveness scorecard that the WEF had been doing for some years before that (Rodrigo 2019).

The WEF competitiveness index, from which the EPI got inspiration, evaluates how market-friendly policies are in each country. The perceived friendliness is evaluated mostly through surveys to CEOs working in each country. Hence, these types of scorecards should be understood as devices that reward visions from those who already benefit from market-oriented policies. In this regard, during an interview, Pietro stresses how some countries feel that their economic condition should be part of the index. In particular, he describes an episode with a former Chilean Environment Minister about the EPI, he was told:

There are industries in Chile that contribute a lot to air pollution, and these other countries don't have as much of that. So, he basically said, "they are getting a pass because they just don't have much of that industry". It's a valid point, but you know, we do denominate carbon dioxide emissions by GDP, might it make sense to say, it's almost the same thing, should we give countries a denominate by the industrial sector, something like that, GDP; sort of giving countries a pass because they're producing most of the world's goods? (Pietro 2019)

Pietro talks about how some countries should be allowed to pollute more due to their contribution to the world economy. In this particular case, Chile is the main copper producer in the world which is an industry that generates all kinds of heavy metal pollutants. In the meantime, Chile was ranked 84th in the 2018 EPI out of 180 countries. This becomes even more complex when the geology of the country is considered. The country has more than 3,000 volcanoes, from which 90 are considered active. Every volcanic eruption release most of the particles that are measured by the EPI in terms of air pollution. This might be one of the reasons why Chile is ranked 176th within the EPI when only the Air Pollution index is considered and 175th within the SO₂ emissions (see: Osipov et al. 2020).

The epigraph at the top of this chapter, a quote by an EPI member, shows the reserves that some people working on the construction of these devices have towards their own work. The limitations mentioned by Pietro are not only in terms of data availability (as we will see in the following sections), but also about how certain issues are ignored. In the case of Chile, a combination of dependency towards an industry that generates a basic raw material for the world economy, plus natural characteristics of the country caused a complaint of unfairness. However, these calls for a holistic measurement of environmental issues have been ignored by the EPI team in benefit of providing simple metrics.

4.5 The everyday problems of quantification

When thinking about the quantification of the environment, it is important to clarify that this is not done by 'just' (for example) counting the number of trees that were lost in a forest from one year to the other. While deforestation constitutes one of the many issue categories included in the EPI, transforming entire forests into a dataset is a much more complex process that can include methods such as satellite observation, surveying and citizen science. As with this thesis, the data collection process is not the final step. On most occasions, the available data required for the production of QDs is incompatible with the project. Edwards (2010:84) refers to this as *data frictions*. An example mentioned earlier is the scale at which databases are compiled (e.g. global, national or local). The decisions, analysed below, taken towards these very common problems, are usually perceived as processes that can be ignored without affecting the understanding of the tool.

During the production of the index, Research Assistants (RAs) are the ones in charge of most of the labour which is managed by a Principal Investigator (PI). Senior researchers work as advisors to the PI and guide the inclusion of the metrics and also serve as contacts with other organisations. While senior researchers are the ones proposing what should be measured, RAs are the ones finding and suiting the data. RAs are Yale students and could be divided into two groups: programmers and qualitative researchers. Qualitative researchers are Yale Forestry & Environment Sciences master students with two main jobs²⁰: find datasets among data providers (e.g. international organisations, NGOs and think tanks), and looking for existing research around the issue categories. Programmers are undergraduate students majoring in computer science, mathematics and statistics. Their work is at the centre of the entire EPI since they are the ones managing all the data and making it suitable for the EPI production pipeline.

Continuing with the argument of QDs required to be unfolded into multiple stories, the next section analyses two processes although thought –by the EPI team – as too mundane to care about, reflect important aspects of the device. First, the characteristics of the countries that are incorporated into the ranking. Second, what

²⁰ I will analyse the role of qualitative researchers in a forthcoming section.

constitutes "good data" (Gabrys, Pritchard, and Barratt 2016) for the production of the EPI.

4.5.1 I am datafied; therefore, I exist... do I?

The EPI focuses solely on measuring the performance of environmental policy at national level. To fulfil the aim of "optimising the gains from investments in environmental protection" (Wendling et al. 2018b), the index will have to measure each issue at the same scale at which it is governed.²¹ In other words, if water quality policy of a country depends on local authorities, gathering national metrics may become a problem. At another level but equally problematic, when measuring former colonies, devolved nations or territories under dispute, the decision to consider them sovereign is a unilateral one and internal to the EPI. As I show in the upcoming paragraphs, for the EPI team, data availability constitutes a more important element of sovereignty than constitutional arrangements or self-perceptions (by local communities).

During the production of the 2020 EPI, through an email exchange among senior members, the following issue was suggested as a "strategic question":

"Recently, I began to think about whether we are doing this properly. Our current approach is to consider anything with an ISO²² code as a 'country' and figure out at the end of the process who makes the cut. This ignores that many geographical units with an ISO code are not properly countries – at least, they do not have the autonomy to make their own policies regarding the environment. In these cases, it seems like the thing we want to do is take the data for a dependent territory and aggregate those value to the administering country. For example, French Guiana is a department of France, and the environmental performance in that department should be reflected in France's overall score since – as far as we can tell – policy is being set in Paris" (N/A 2019a).

21 Here I am focusing exclusively on the role of multiple levels of government, although I do not ignore the existence of other stakeholders as highlighted by S. Parry and Murphy (2013). This decision is based on the fact that the EPI does not consider the role of other stakeholders.

22 ISO refers to the International Standard Organisation. In the case of countries, they are given a three-digit code and a three-letter code.

The author claims that having an ISO code should not be sufficient to consider a country as sovereign. For they, there are countries that hold an ISO code but not the capacity to design or implement their own environmental policy. This highlights the politics of standardisation as only member countries of the UN are assigned an ISO code (ISO N/D). In this sense, Taiwan, Scotland or Kosovo -to mention a few- do not have a code. During my fieldwork at YCELP, I worked as an RA with weekly tasks; after the email just mentioned, I was asked to review the list of candidate-countries to be added to the most recent edition. The threshold to choose whether a territory could be included was based on seven considerations that were proposed by a senior a member; these were:

- Would most people want to see it listed in the EPI?
- Where is the most logical place to look up environmental information about the place?
- Would the people who live there want to see it listed?
- Do most of the people in the sovereign territory consider it an integral part of their identity?
- What is the degree of political autonomy in the territory?
- Do people in the sovereign territory consider environmental improvements there to constitute improvements in national environmental conditions?
- When the sovereign [territory] reports its national statistics, does it include the territory's information as a fully integral part of the national picture, or does it segregate it apart from the rest of the country?

Considering that some of these more than 20 countries (Palestine, Hong Kong, Bermuda and Puerto Rico amongst them) recognise themselves sovereign territories while being subjected to other countries, I was aware that these contemplations should not be left unattended. However, since the list had to be completed in less than a week, the research and decisions were made by two RAs [me one of them] and a senior member; with none of us with particular knowledge of these territories. Some of the questions could only be answered by nationals or experts about the territories, but given the time pressure, there was no time to conduct surveys or contact

specialists. Our solution rested in a combination of online information and "intuitions". When possible, we tried to read the constitution of those territories in an attempts to find out how they would define themselves or how the sovereign nation would define them.

Another approach was to *guess* the content of documents if they were written in a language with a common root to our native tongues. An example of this was Spanish, my native language, and Papiamentu, which is one of the official languages in Curacao. While an easy solution would have been to use online translating services like *Google translate*, Papiamentu is not available. In some cases, we tried to call the governments of the candidate countries to ask about their opinion regarding the seven threshold questions. However, no-one answered the calls.

code ISO	Country	Super/ Admin	Proposal	1) Desire	2) Info	3) Self	4) Identity	5) Autonomous	6) Subsidiarity	7) Nat'l database	Conclusion
36 AUS	Australia	AUS AUS	aggregate	no	super	no	no	no	yes	super	aggregate
162 CKR	Christmas Island	AUS AUS	aggregate	no	super	no	no	no	yes	super	aggregate
166 CCK	Cocos (Keeling) Islands	AUS AUS	aggregate	no	super	no	no	no	yes	super	aggregate
334 HMD	Heard Island and McDonald Islands	AUS AUS	aggregate	no	super	no	no	no	yes	super	aggregate
574 NFK	Norfolk Island	AUS AUS	aggregate	no	super	no	no	no	yes	super	aggregate
156 CHN	China	CHN CHN									
344 HKG	Hong Kong	CHN HKG		yes	Hong Kong	yes	yes	partial	no	no	retain
446 MAC	Macao	CHN MAC		yes	Macao	yes	yes	partial	no	no	retain
208 DNK	Denmark	DNK DNK									
234 FRO	Faroe Islands	DNK FRO		yes	Faroe Islands	yes	yes	yes	yes	no	retain
304 GRL	Greenland	DNK GRL		yes	Greenland	yes	yes	yes	maybe	no	retain
246 FIN	Finland	FIN FIN									
248 ALA	Åland Islands	FIN FIN	aggregate	no	Åland Islands	yes	yes	yes	maybe	partial	aggregate
250 FRA	France	FRA FRA									
258 PYF	French Polynesia	FRA PYF		maybe	super	yes	yes	yes	no	super	retain
652 BLM	Saint Barthélemy	FRA BLM	add	maybe	super	yes	yes	yes	no	super	retain
663 MAF	Saint Martin (French part)	FRA FRA	aggregate	maybe	super	yes	yes	no	no	super	aggregate
666 SPM	Saint Pierre and Miquelon	FRA FRA	aggregate	maybe	super	yes	yes	no	no	super	aggregate
876 WLF	Wallis and Futuna	FRA WLF		partial	super	yes	yes	partial	no	super	partial
254 GUF	French Guiana	FRA FRA	aggregate	no	super	no	yes	no	yes	super	aggregate
312 GLP	Guadeloupe	FRA FRA	aggregate	no	super	no	yes	no	yes	super	aggregate
474 MTQ	Martinique	FRA FRA	aggregate	no	super	no	yes	no	yes	super	aggregate
175 MYT	Mayotte	FRA FRA	aggregate	no	super	no	yes	no	yes	super	aggregate
638 REU	Réunion	FRA FRA	aggregate	no	super	no	yes	no	yes	super	aggregate
540 NCL	New Caledonia	FRA FRA		no	super	yes	yes	ambiguous	no	super	retain
260 ATF	French Southern Territories	FRA FRA	aggregate	no	super	NA	NA	uninhabited	no	super	aggregate
376 ISR	Israel	ISR ISR									
275 PSE	Palestine, State of	ISR PSE		yes	PA	yes	yes	ambiguous	maybe	no	retain
504 MAR	Morocco	MAR MAR									
732 ESH	Western Sahara	MAR ESH		no	unknown	yes	unknown	ambiguous	maybe	unknown	retain
528 NLD	Netherlands	NLD NLD									
533 ABW	Aruba	NLD ABW		yes	Aruba	yes	yes	partial	no	no	retain
531 CUW	Curacao	NLD CUW		yes	Curacao	yes	yes	partial	no	no	retain
534 SXM	Sint Maarten (Dutch part)	NLD SXM		yes	Sint Maarten	yes	yes	partial	no	no	retain
530 ANT	Netherlands Antilles	NLD -	disaggregate	no	NA	NA	NA	NA	NA	NA	disaggregate
535 BES	Bonaire, Sint Eustatius, and Saba	NLD BES	aggregate	no	super	no	yes	no	yes	super	aggregate
554 NZL	New Zealand	NZL NZL									
772 TKL	Tokelau	NZL NZL	aggregate	maybe	partial	maybe	yes	partial	yes	partial	aggregate
578 NOR	Norway	NOR NOR									
74 BVT	Bouvet Island	NOR NOR	aggregate	no	super	no	no	no	yes	super	aggregate
744 SJM	Svalbard and Jan Mayen	NOR NOR	aggregate	no	super	no	no	no	yes	super	aggregate
826 GBR	United Kingdom	GBR GBR									
831 GGY	Guernsey	GBR GGY	add	yes	N/A	yes	yes	partial	no	GHG only	retain
833 IMN	Isle of Man	GBR IMN		yes	N/A	yes	yes	partial	no	GHG only	retain
832 JEY	Jersey	GBR JEY	add	yes	N/A	yes	yes	partial	no	GHG only	retain
660 AIA	Anguilla	GBR AIA	aggregate	maybe	N/A	yes	yes	partial	no	GHG only	retain
60 BMU	Bermuda	GBR BMU		yes	Bermuda	yes	yes	partial	no	GHG only	retain
86 IOT	British Indian Ocean Territory	GBR IOT	aggregate	no	N/A	NA	NA	uninhabited	no	GHG only	aggregate
136 CYM	Cayman Islands	GBR CYM		yes	N/A	yes	yes	partial	no	GHG only	retain
238 FLK	Falkland Islands	GBR FLK		yes	N/A	yes	yes	partial	no	GHG only	retain
292 GIB	Gibraltar	GBR GBR	aggregate	no	N/A	no	no	no	no	GHG only	aggregate
500 MSR	Montserrat	GBR MSR	aggregate	maybe	N/A	maybe	maybe	no	no	GHG only	aggregate
612 PCN	Pitcairn	GBR PCN	aggregate	no	N/A	no	no	no	no	GHG only	aggregate
654 SHN	Saint Helena, Ascension, and Tristan da Cunha	GBR SHN	aggregate	no	N/A	maybe	maybe	no	no	GHG only	aggregate
239 SGS	South Georgia and the South Sandwich Islands	GBR SGS	aggregate	no	N/A	maybe	maybe	no	no	GHG only	aggregate
796 TCA	Turks and Caicos Islands	GBR TCA		maybe	N/A	yes	yes	partial	no	GHG only	retain
92 VGB	Virgin Islands (British)	GBR VGB		maybe	N/A	maybe	yes	partial	no	GHG only	retain
840 USA	United States of America	USA USA									
580 MNP	Northern Mariana Islands	USA USA	aggregate	no	super	no	yes	no	yes	super	aggregate
630 PRI	Puerto Rico	USA USA	aggregate	maybe	super	yes	yes	no	yes	super	aggregate
16 ASM	American Samoa	USA USA	aggregate	no	super	yes	yes	no	yes	super	aggregate
316 GUM	Guam	USA USA	aggregate	maybe	super	yes	yes	no	yes	super	aggregate
581 UMI	United States Minor Outlying Islands	USA USA	aggregate	no	super	NA	NA	uninhabited	yes	super	aggregate
850 VIR	Virgin Islands (U.S.)	USA USA	aggregate	maybe	super	yes	yes	no	yes	super	aggregate
1) Would most people want to see it listed in the EPI											
2) Where is the most logical place to look up environmental information about the place?											
3) Would the people who live there want to see it listed?											
4) Do most of the people in the sovereign territory consider it an integral part of their identity?											
5) What's the degree of political autonomy in the territory?											

Figure 11 List of candidate sovereign territories and their sovereign countries.

Figure 11 shows the candidate countries, and the sovereign territories they are considered to be part of. The last column, with the heading "conclusion", was the final decision for each territory. *Retain* means that a nation should be considered as having enough sovereignty as to be considered an independent nation. *Aggregate* means that the territory should be recognised as a constituent part of a sovereign nation; hence, any available data would be merged. While this process only lasted a couple of days, it was extremely extenuating since I felt the responsibility of choosing whether a country should be considered independent enough or not. Even if the decisions were taken among the three of us, and later ratified by the senior researchers, I was reinforcing some epistemic injustices where I was denying the right to make sense of their own existence to certain communities. At the same time, I was aware that certain decisions could become controversial towards the EPI like deciding to recognise Palestine as an independent nation. It is important to contextualise that I was conducting this task while there had been an increase over the tensions between Israel and Palestine ("Trump and the Palestinians: A timeline" 2019). Hence, as someone who reads the news all the time, I was influenced by the Palestinian desire for international recognition. In this sense, unlike what other team members claimed, I was not able to detach my data cleaning and production process from my personal biases.

The existence of data to measure the 32 indicators in which the EPI is divided, was the last condition territories should pass. As part of the discussion through internal emails, it was argued that while many territories could be considered as sovereign enough to be included, their lack of data would make it impossible to score them. An extract from an internal email suggested that things would not change a lot anyway since it would not be possible to measure the newly designated sovereign nations:

"The final EPI products will have raw data for ~220 countries, though the final list for which we have an EPI score will likely be close to 180. For the few dozen territories we will aggregate, we will report no data; anyone who inquires about them will be directed to the datasets provided by our data partners. No one who is being dropped from the list of countries was previously in the EPI, and for most of them, we have only a handful of datasets" (N/A 2019b).

Hence, they would be merged with their sovereign nation even though they should be considered as independent in terms of environmental policymaking. This is key since it shows that countries are not necessarily included based on their sovereignty but on whether they can provide enough data. In many cases, this incapacity will be due to a limitation on their infrastructure capacity. An example of this was the Palestine. Despite the conclusion that the Palestine should be considered a sovereign country, since "it passed" the seven question-threshold, it was merged with Israel. The rationale for this decision was the lack of data produced either internally or by third-party organisations. Also, the fact that the Palestinian National Authority has an Environmental Ministry, and a Bureau of Statistics was disregarded; since in practice, Israel can block any policy.

When the knowledge built about a community does not benefit the studied but only third-party institutions, we can talk about an issue of epistemic injustice (Pohlhaus Jr. 2017). In the case of environmental quantification, it is clear that there has been an increase in the production of data, but it is not always evident whom this quantification benefits. An example of this was the merging of Aruba with The Netherlands. While Aruba is a constituent member of the Kingdom of the Netherlands, it recognises itself as independent and with authority over its environmental policies. However, when ranked, Aruba will not be represented as independent, but as part of the Netherlands. Hence, two distant realities, a country in the Caribbean is presented as the same as one in Northern Europe. Regardless of whether the merge could provide 'a better score' to Aruba or the Netherlands, there is an active process to deny a community the opportunity to make sense of themselves in an autonomous way.

4.5.2 Good data and databases

The production of the EPI takes one year on average; during this time, the team in charge will manage available data and their objectives for the index. While I demonstrated that the EPI team works under self-imposed and external limitations, the process of selecting datasets implies multiple decisions. This is another example

of a series of decisions that are part of the day-to-day mundanity of the team but that in practice, define the worldview of the EPI.

During the production of the index, Research Assistants (RAs) are the ones in charge of most of the labour which is managed by a Principal Investigator (PI). Senior researchers work as advisors to the PI and guide the inclusion of the metrics and also serve as contacts with other organisations. While senior researchers are the ones proposing what should be measured, RAs are the ones finding and suiting the data. RAs are Yale students and could be divided into two groups: programmers and qualitative researchers. Qualitative researchers are Yale Forestry & Environment Sciences master students with two main jobs²³: find datasets among data providers (e.g. international organisations, NGOs and think tanks), and looking for existing research around the issue categories. Programmers are undergraduate students majoring in computer science, mathematics and statistics. Their work is at the centre of the entire EPI since they are the ones managing all the data and making it suitable for the EPI production pipeline.

An issue of distributive epistemic injustice (Fricker 2013:1318) is the main cause of underrepresentation of several nations. Data has become a key aspect that allows countries to become observable or not. It is clear that countries dealing with issues like civil wars or extreme poverty will either not have a functioning state (with a working statistics office) or will prefer to tackle more imperative issues. For instance, the Haitian Census depends on more than 80% on external funding, including the World Bank, the Canadian Government and the Inter-American Development Bank (IHSI 2020). In other cases, the EPI will simply not trust governments to provide 'good data' which represents an issue of *testimonial injustice* (2013:1319). In this sense, Pietro clarifies some of the issues that might exist with particular countries:

If there's a major crisis that occurs, I think we stopped producing EPIs for Syria, I think it does make sense; North Korea we never really trusted the data. So, there're these countries where we realised that you can't simply report the data from five years ago and

²³ I will analyse the role of qualitative researchers in a forthcoming section.

assume that things continued in the same way. There are a few of those where we simply decided not to report anymore (Pietro 2019).

Pietro states what data critical studies in general have demonstrated: that the trust in data is contextual and political (L. Taylor et al. 2020; Seaver 2017). Given that the EPI will decide unilaterally what counts as "good data", this is decided when a dataset is assumed as "mature" enough. Alonso mentioned:

When the decision is made to download a certain database and pull it in the pipeline that's fine, then the team takes that then we process it, then we help review the data; contribute to the conversation that needs to happen among the team on whether to actually include that, if we think is a value or if we think is too early that the quality hasn't been established and maybe it has to wait an additional two years before we can consider pulling it in (Alfonso 2019).

Alfonso argues that databases are not independent or isolated from the researchers making them. Just as Yale's prestige has served the EPI, the institutions behind datasets will make them more or less trusted. The use of a dataset goes also depends on its longevity. The team wants to avoid datasets that are part of a one-time project and will not be updated since it would affect future editions of the EPI since the score would remain the same. Therefore, the idea of "good data" depends on who made it, and also on the prospective uses. Gerineldo, an RA, pointed out, how what could be seen as the best data will not always be selected:

One of the things we explored for our analysis was identifying the best data source or data partner for providing non-CO₂ Global Gas Emissions. And we found out that the EPI provided dataset wasn't that good compared to the dataset provided by ESA [European Space Agency]. Why wasn't good? [deleted to protect identity] thing, I don't know why, but that's something that won't come out with the EPI. Those very microscopic [decisions] that are made of what is the best environmental data? And I think those things are important for policymakers; it should be known—more than just a number from 0 to 100 (Gerineldo 2019).

Gerineldo was referring to a moment when the team had to decide between an ESA dataset versus one that had already been used. While for him, the ESA one was better, the choice fell over the one that had been used previously. But this team member, feels that the EPI is failing in its duty to communicate the rationale behind choosing one dataset over another. The EPI will usually publicly claim that "the best available data is used", however, it is possible to observe that what counts as "best" is disputed.

While data is seen by those producing and using it as an element disenfranchised of any political or social influence, I have demonstrated that several sociotechnical considerations (i.e. dataset longevity, prestige of the publishing institution, collection techniques) are key. It is perhaps this recognition that is reflected in the movement (this will be analysed more in detail in the next chapter) driving remote sensing as a way of increasing databases' neutrality and transparency.

I think a general trend is the abundance of remote sensing, is opening a lot of doors or a lot of opportunities to things that are meant to be visually inspected; or somewhere around the electromagnetic spectrum (Nicanor 2019).

For Alfonso, remote sensing would provide more objective measurements:

I think there are some things that are complete[ly] dispassionate and objective and say something based on satellite analysis that could be done by a single research institute, that hopefully has no agenda or ties to a given country, and yet they are maybe democratically measuring some aspect of performance across all countries (Alfonso 2019)

The pursuit of more objective data can become an oxymoron. Currently, the EPI defends the use of the index as one that provides scientific information (unlike a guru), but it is also being recognised that this data might not be as objective as expected. In EPI terms, objectivity refers to the capacity of providing disenfranchised metrics, where data speaks by itself. However, throughout this chapter, this claims have been dismantled by some team members. One step further to achieve this expected objectivity is to produce the tools in the most standardised possible way.

4.5.3 Standardisation

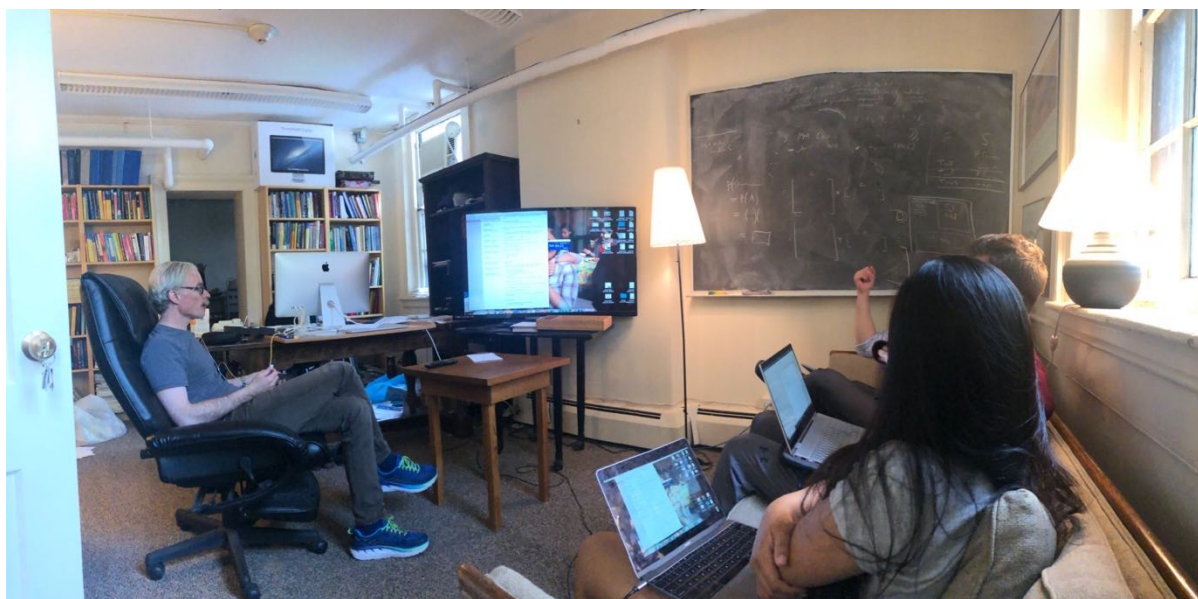


Figure 12 Group of statistic coders being supervised by the EPI Head of Statistics

Figure 12 shows a picture of one of the meetings we were having twice per week during the Summer of 2019. During these meetings, RAs would report on the progress of their work to Jay Emerson, the EPI Head of Statistics. These meetings encapsulate the aim of EPI senior members to keep the production of the index as standardised as possible, usually finding that RAs will do things differently. Quantitative RAs are Yale undergraduate students who take a statistics and data science course with Jay. It is expected that having been taught by Jay, they will code in the way he wants, in an effort to start standardisation since the recruitment to avoid one of the main worries: human errors.

During the five months that I worked at the EPI, a usual conversation was about standardisation while programming. After learning how to code during my fieldwork in Sweden, I realised that coding and programming were activities that can be perceived as standardised. However, quite soon I realised that the way I was doing things was –not only wrong most of the time– but, also, even when I was doing them right, I was doing them differently from how others would do them. These differences were also visible between experienced programmers. When I saw that standardisation was one of the EPI goals, I became even more interested.

When I asked about how standardised programming is, Gerineldo described the tension between standardisation and individuality in a very detailed way:

I want to say they would be exactly the same functionally. What I mean by that is the general functions that are called in the script are going to be the same, there's going to be some point when a CSV is loaded; there's going to be some point where the things are renamed, there's going to be some point where the countries are renamed; there's going to be some point where we merge it with the master-file; there's going to be some point where we fill-in missing values, without modelling, just filling in with codes and then writing up a CSV, an output. I would say that part would be the same. What would be different is the style, and styles are very broad, we are talking about how programmers write their code. Those are things like the comments that are done, indentation, spacing. How they index data in R, some people like to index them numerically and then see what those numbers are. Some people like to index them with strings because that is usually more readable in the code. The lead statistician Jay Emerson that's what he likes to see, he doesn't like seeing numeric indexing in R, that's a stylistic thing. When it comes to micromanagement tasks like that, the most discrepancy we will see between two programmers is going to be stylistic; I think, functionally it will be almost identical every time (Gerineldo 2019).

For Gerineldo, while all the results should be the same, the way programmers arrive at them will be different. This claim demonstrates that without Jay's micromanagement, programmers could have more space to conduct their work in multiple ways. Therefore, coding seems to represent a constant struggle between a control from principal investigators to keep all processes as standardised as possible among multiple programmers and the capacity of coding in individual styles. More interestingly, Gerineldo told me how there are processes in standardisation that, just as when datasets are being chosen, are not shared by the producers:

I want to say there's a lot of the researcher that goes behind it into sustaining what is the best environmental data that we have, what the issues with that environmental data? And I think those are things that just don't get reported on the methodology or are in the methodology and but are not really noticed outside of the research group (Gerineldo 2019).

Gerineldo brings back the everyday decisions and micropolitics that are not shared outside of the research centres. For him, all the cleaning and managing duties that programmers conduct is part of the mundane processes. Hence, their work is invisibilised or limited to an acknowledgement as RAs that completed a standardised job, rather than a specialised labour where decisions are made. To understand the

process of standardisation, it will be necessary to divide it in the two main purposes the EPI researchers think of as key: to reduce human errors and allow replicability.

Human errors

There is a trust in statistical programming as a process that can avoid human interaction with the datasets. That was the main reason why the EPI changed from being built in Excel to be done through a coding language like R. Also, automating things make things cheaper.

[Y]ou want to be able to take something like that and with a minimal amount of human effort reproduce the result, and it's important to have a minimal amount of human effort not just because there's a budget but because human beings make mistakes. Human beings can also make mistakes writing code, but that's why you have a code that evolves through time, and that is checked by lots of different people, lots of different sets of eyes that really reduce the chance of a bug in the code (Alfonso 2019)

While this section is focused on the idea of standardisation, it is interesting how the idea of resource scarcity, it is also present in how the index is produced. Alfonso is clear when he points out that coding can help to reduce costs due to human errors. Interestingly, for him humans are both the danger and the insurance of coding. While humans are seen as the weakest element of a QDs, they are also defended as the ones capable of detecting possible errors. This reinforces my previous argument where the labour of programmers is seen to be framed as executors of predetermined tasks; in this case, to supervise that algorithms and codes are well written. However, humans are the ones who create the codes that will process the datasets:

In the context of the EPI, the way we approach the workflow is very safe from bias, mainly that we never change numbers, we never look at a country and say, oh that is strange, maybe we should go back and look at that. We try to really treat the databases as raw, what we talked earlier, and not change it. That way, if there was any bias produced in this data, it hopefully wasn't by us, and it was at

whatever the acquisition generation process was in the data partner's work (Gerineldo 2019).

Gerineldo's claims defend the work of the EPI programmers as one where they 'simply' move datasets into the coding pipelines they have developed. Hence, they do not make mistakes or miscalculations since they are not the ones creating or collecting the data. The possibility of mistakes or biased is perceived as external to the EPI. As Nicanor told me,

I think Jay has also said, "there are multiple ways in which you can accomplish a task within your computer code." You want to select the one that is the most robust and the least likely to result in human error (Nicanor 2019).

Nicanor reinforces Gerineldo's idea that humans appear as the weakest element of the production of QDs; humans are the responsible ones if any mistake occurs, not the codes, not the algorithms, not the databases. However, he ignores that Gerineldo also sees humans as the only possible element within EPI sociotechnical system (i.e. codes, datasets and fellow humans) operate as they should be capable of supervise the adequate (objectively) operation of the pipeline. Continuing with the defence of algorithmic autonomy, for researchers like Remedios, programming is the most ethical way of doing things:

Frankly, I think it is more ethical to allow the machine to do it. I mentioned it a little bit, but the human error. The reason that we do so much of this, the reason that we write a code for false safe, and we automate error numeric and algebra break. Manipulations if I were to do that, 237 times, one for each recognised nation that we are dealing with, I'm bound to make some clerical error, somewhere there. And that clerical error will continue through because it won't be double-checked because no-one is going to do all the logarithmic transformations that I did. That's data corruption due to extraneous human errors. The reason why we automate processes that we could do by hand is that the computer, as long as is instructed correctly, will never to a clerical error, will never have that human element with it; so that's a more ethical way to go about the project (Remedios 2019)

This trust in the codes as an automatized way of doing things is part of the notion of data as an element that deserves to be more trusted than humans. As a synonym of efficiency, the decision of dealing with datasets with the least human interaction

possible, is also how the EPI expects policymakers to design policy: based on *efficient quantitative information*. However, as the old saying goes when talking about law making, "laws, like sausages, cease to inspire respect in proportion as we know how they are made." While in this case we might not "lose" respect for QD, it is true that the more we know about their making, the messier and more contradicting it gets. Still, just as in sausage making, QDs technical documents are unlikely to report how they are done.

Replicability

Trust in quantitative data is based on the assurance that since numbers are raw, they can be easily verified and results replicated. The next chapter will discuss in detail why the idea of replicability is not achievable due to infrastructure issues and tacit knowledge carried by researchers. In the case of the EPI, standardisation is required for internal and external reasons. While internally, it could help to reduce costs in the long run; externally, as Rodrigo puts it, there is a need to be transparent by sharing all the codes.

"I think the analytic rigour and the transparency, the willingness to put all the data online so people could come in and review it and cross-check it has given credibility and integrity; that means that's very well-regarded and used by a lot of people" (Rodrigo 2019).

Rodrigo's claim around "the willingness to put all the data online" represents an example of the discrepancies between what it is done and what it claimed. For him, the EPI is a well-regarded device since all data is publicly available. However, as demonstrated earlier, team members like Pietro have argued that the construction of the index lacks a scientific rigour including peer-review processes. Therefore, the "willingness" of the EPI to be scrutinised, seems to be limited to the conditions the team sets and not by traditional academic processes.

Internally, the EPI requires standardisation to reduce costs in the long run. Alfonso described to me the need to avoid writing the codes from scratch in every iteration,

"The goal now is to really have a set of tools that we could use for each iteration of the EPI with minor changes in a way that is far more efficient. So instead of writing every code on my own, I'm really managing a team of student/research assistants that have the quantitative skills to basically take some of the things that I built before and slowly refine them into little widgets that can be used through the process and recycle each year" (Alfonso 2019)

Alfonso is explicit about the multiple advantages that pushing towards a standardisation of programming could bring. First, he sees the possibility of ensuring the longevity of the EPI as new programmers would have to move from entirely writing new codes into "tweaking" existing coding lines as refinement. Second:

I have preferences for certain approaches because I think in the long run is more transparent and reduces costs and confusion, so I certainly have opinions as to a coding style (Alfonso 2019)

For him, the less manipulation across the years, the codes could be more easily scrutinised as their writing will be less messy. And finally, there are also cost benefits as less programming time is needed to edit codes than to write.

In practice, however, every time a new PI arrives, there are changes in the most technical aspects. Hence, under current conditions, ensuring what I have previously called a *conscious understanding* by EPI outsiders seems to be an aspiration more than something that can be fully reached. While guaranteeing that programming is as standardised as possible so that new RAs just refined existing codes and add updated datasets is a good first step, ensuring a conscious understanding goes beyond the RAs recruitment process. Documenting processes is an essential element for future iterations of the EPI:

Needs to be very clearly documented, very modular. The idea is that if there were a data update that happens next September, is a data source we've used, is a variable we like, but there's a new year of data available we are able to take that file, drop it into place, confirm that the format is the same we've used before, pull it in, confirm that probably is not a radical change; if something has radically changed then someone needs to do some work, but almost with the push of a button you initiate the entire pipeline being rerun, just pulling in that new data update, most of it doesn't change, most of it just runs successfully, there are some checks along the way if something is

really problematic it will crash the script and then we look at it very carefully (Alfonso 2019)

According to Alfonso, a good documentation allows a swift changes whether they had been planned or not. Still, just as Gerineldo did earlier, Alfonso also signals the existence of human "checks" capable of detecting the proper functioning of the codes. Also, there is a nuanced recognition of how much the EPI methodology could resist, dramatic changes. So far it has been argued that new RAs could come and go, and the EPI pipeline could keep working, however, it is not clear if the same applies for senior researchers. Hence, even if the "button" could be pressed, if the person who knows which button that is disappears, the rest may not know how the tool operates. I will come back to this in the upcoming chapter, but for now it is important to acknowledge that documentation is essential for the longevity of QDs. For this to happen, the level of documentation needs to be as microscopic as possible. Nicanor claims that hiring him was based on his capacity to look into the minutia of things:

Part of the reason I was hired is that I am good with what is called data hygiene, making sure that we are much more careful about documentation, especially at the granular level of knowing how we receive datasets and being explicit about the formulae that we used to calculate it. The technical appendix went from a few dozen pages to 75 pages, that's one area (Nicanor 2019).

According to several members that have worked on the EPI, before 2017 there was a serious problem of documentation. Perhaps this is one of the reasons why apart from the PI the statistics team also changed. As Nicanor points out, according to his expectations, the EPI was not as detailed as it should have been. During an informal conversation, I was told that there was evidence that people had been able to produce the EPI based on Excel rather than programming software such as R. The replication of the device in a more basic software (Excel) meant that the team has shared enough data so that someone external to YCELP can replicate the EPI. However, the question of where this replication was not a copy and paste process, but one where the external individuals consciously understood all the decisions, is not clear. The possibility of replication, understood as copy and paste, is not an indulgence QDs provide but the

bare minimum. Still, for this to be possible, for the 2018 EPI there was a new objective for the senior EPI team; to establish documentation at the core of the EPI:

I came into the project, met Jay, he has been involved in the project for a long time, and what Jay says is: "I've done these different ways, from scratch, different ways". And he's in a moment, especially after 2018, where he has accumulated knowledge of where all the pitfalls are, are leading to his guidance of what is a really robust codebase and method for doing things. All of his rules, constraints, preferences are based on his hard-won experience and mistakes. I am much more agnostic; I didn't come here with any preconceptions about how the data programming should be. The only thing I would really press people on, is documentation: documentation of where data came from, documentation of problems, comments on the code explaining what's going on. And that, I think Jay is on the same page with me in all of that. That is not really a programming issue, that's more a documentation/work-flow issue. A good code should explain what's going in every step so anyone could come into the code, look at it and figure out what is going on (Nicanor 2019)

This claim made by Nicanor situates Jay as the main decision-maker within the EPI, even perhaps on top of Esty. It is not strange to, again, see the index as going beyond the environment. In this case, the goal seems for it to be a tool that shows the power of data. The environment, again, is not the only agenda. It also shows how the neoliberal imaginary of small governments is translated into the production of the index. The push towards limiting the individual coding style of programmers to ensure a reduction in the costs of the EPI, can be translated as the notion of efficiency understood as doing more with less. In other words, forcing programmers to do their work in a very limited way, YCELP could hire less programmers in the future, ensure longevity and seen as transparent (even if there is no conscious understanding of how the device was done).

4.6 Conclusions: Creating multi-layered imaginary worlds

While the environment represents multiple elements interacting in various ways, its quantification has transformed it into multiple silos with no interaction. Each

environmental issue is measured through a database that does not consider the rest of the issues. Even more, each dataset does not only measure a different issue, but it is built in a different time and space than the rest. Hence, the final score provided by a QD should not be thought of as reflecting the status of a country in a given year. Rather, it should be understood, under the framework of *sociotechnical imaginaries*, as a *multi-layered imaginary environment* that has never existed in our physical world.

It is essential to define what I mean for the notion of a *multi-layered imaginary environment*. The first part, *multi-layered*, reflects on how the issues analysed through multiple datasets does not mirror its status at any given moment, but the superposition of multiple instants (datasets) of the measured issue. Even though these datasets will be merged to produce a single score, it is beyond the team's control to decide when and how the data is collected. Hence, when aggregated together to build an indicator, an issue category or a final score, these measurements represent the status of different issues measured at different moments.²⁴ The notion of an *imaginary world* reflects a world built through QDs framed by data limitations and sociotechnical infrastructures. As I have shown, these worlds are created with metrics that carry expectations and discourses. Hence, a *multi-layered-imaginary world* represents how QDs will provide measurements created with datasets from multiple-years and embedded within imaginaries. This does not mean that the measurements, or the countries, never existed nor that these will not have consequences.

As argued earlier, and I hope to have offered the reader enough empirical discussions, the EPI provides *environments in vitro* since they are the result of having been built under controlled conditions. This includes treating the environment as a set of silos. Now, I must add controlling time through datasets. When both limitations are combined, these *environments in vitro* emerge as representations of the world where each datafied issue has never interacted with the rest of the environmental elements.

24. This was an informal conversation I had during my fieldwork, and interestingly as part of the executive report of the 2020 EPI, the following was included: "The metrics on which the 2020 rankings are based come from a variety of sources and represent the most recent published data, often from 2017 or 2018. Thus the analysis does not reflect recent developments, including the dramatic drop in air pollution in 2020 in the wake of the Covid-19 pandemic or the greenhouse gas emissions from the extensive Amazonian fires in 2019" (Wendling et al. 2020).

To say this in plain English, the score the EPI provides is the result of multiple environmental issues being measured in isolation rather than as an ecosystem.

The case of multiple datasets produced at different moments could be understood as an issue of delay. While for me, this was interesting from an STS perspective, it was not a new issue for the EPI team.

I don't think that we've ever said we are measuring performance as it exists right now in 2020, because the most recent data update might be a new variable that just comes online now in 2020 and we only have it once in 2020. Other variables will have their last update probably in 2019 or 2018 or in some cases may be going back to the early 2010s. But if it's the best available information, then that's your current measure of performance (Alfonso 2019)

These imaginary environments represent the quintessential manifestation of the two storytelling processes this chapter has discussed so far. First, I analysed how the construction of the EPI is based on providing a simplified measurement of the environment in silos rather than through an integrated ecological perspective. The second story investigated how data are understood by researchers as the minimum unit of analysis which requires to be contextualised. Through a score obtained by bringing together multiple years, policymaking could be based on environments crafted (Latour 2017) without the recognition of the environment as a global force. Instead, they are the result of a process of encapsulation of environmental issues both in *time* (datasets from multiple times) and *space* (environment in silos). Linberry et al. (2020) show how the massive 2019 bushfires in Australia had environmental consequences as far as 4,000 miles away from the source of the fires (as far as Chile). Still, by encapsulating the environment within national borders, an increase of air pollutants, will be seen as a poor environmental policy implementation by Chile rather than an exogenous factor.

Through this chapter I discussed the challenges, frustrations and interests merged during the construction of the EPI. Through an analysis of the *micropolitics* within the EPI it is possible to say that the metrics provided by these devices are required to be explored within the sociotechnical infrastructures and imaginaries in which they are framed. In this sense, the construction of the EPI may be closer to the

gurus the EPI team aimed to displace than to a device able to provide human-free advice.

I started by discussing how the scientific authority built discursively around the EPI has been challenged internally by claiming that the device serves more a function of presentation card than a scholar contribution. However, it was shown how the profile of Daniel Esty fits within that of influential academics who are willing to sacrifice traditional academic pathways to boost their influence among policymakers. With this it is possible to claim then, that indeed Esty is not trying to contribute to the scientific community but to move the discourse of environmental protection based on his own understanding. Part of these understandings, which could be referred as "worldviews", are seen on the multiple interests that are pursued while quantifying the environment. By showing how the inspiration for the construction of EPI was a business scorecard, it was possible to establish that the measurements done through the index go beyond environmental protection. For the neoliberal approach towards policymaking to succeed, datafication is imperative as only through data an efficient and decontextualised advice can be provided while being surrounded by rigorous processes.

I showed how the construction of this QD is framed through the sociotechnical infrastructures in which it operates. The process of quantification is dependent on what, and how, others have *datafied*. In the upcoming chapter I will continue this discussion, but for now it is clear that the EPI is constrained by what others deem valuable enough as to spend resources collecting data about. This is not the only framing to which the construction of the EPI is subjected. The EPI has been designed with the aim of solving a policy question; how can a single ministry tackle an issue? In this sense, S. Parry and Murphy (2013:536) argue that research driven by policy questions, rather than academic inquiry, "transforms the design and scope of the research itself". This is clearly seen in the decision to favour the creation of what I called *in vitro environments* rather than understanding the environment through its interrelated complexities.

In sum, through this chapter I aimed to unfold the multiple stories that occur during the production of a QD to shed some light into how mundane processes reveal the worldview intended to be constructed and the frameworks in which the index is

built. It is important to conclude by reiterating that the EPI does not seem to co-produce knowledge (in Jasanoff terms) but that it is, instead, part of a sociotechnical infrastructure of quantification. There were at least three examples of this: **first**, the dependency that exists towards the data required to be at the right scale. For the researchers at New Haven to include a sustainable land management in Kenya, they require not only the farmer to be willing to participate in the certification but the entire country. **Second**, who is counted as a trustworthy data producer? As we saw, it is not enough to be the official data source in your country, you are required to be seen as a reliable source. And **third**, which countries are seen as sovereign enough. In the case of the EPI, the list of countries is sourced from the International Standards Association and the UN. In this sense, this is the infrastructure to which they belong; if the researchers were to opt to move into the FIFA infrastructure, then perhaps the Vatican, Scotland and Palestine would be considered as independent countries.

5 Quantitative Devices and the Future's Politics

"A tool is a tool. It's nothing more than a prediction based on a number of assumptions and those assumptions may not be obvious to the user, so there is a lot of uncertainty going on in the parameterisation of the tools, and obviously, there will be a lot of uncertainty in the projections" (Alvaro, interview, 2018).

5.1 Introduction

On the 11th of June 2018, the UN Security Council (UNSC) discussed the threat that climate change poses to global peace and security for the fourth time in its history. The meeting was presided by the Minister for Foreign Affairs and deputy-Prime Minister of Sweden Margot Wallström. Apart from the UNSC members, three speakers were invited to share their testimony of how climate change has aggravated forced displacement, rise in terrorism and multiple types of conflict. Wallström summarised the three interventions as situations where migrants and refugees are increasingly being displaced due to droughts and floods in their home countries (UNSC 2018:18). For her, beyond recognising the existence of this problem, it is important to invest in the development of early warning systems that predict climate-driven conflicts. Therefore, she announced the creation of the Stockholm Knowledge Hub for Climate Security²⁵. An initiative focused on providing *evidence-based* analyses to UN members. By doing this, the Swedish government would continue an endeavour that started in the 1960s when the country vowed to use climate knowledge as a geopolitical tool.

Continuing with the focus on the role of everyday life in the production of Quantitative Devices, this chapter will discuss the Violence Early Warning System (ViEWS), a forecasting device produced at the Uppsala Department of Peace and Conflict Research (DPCR). I pay particular attention to ViEWS' forecasts of drought-related forced displacements. As I will show, this is a device that is part of a national sociotechnical imaginary (Jasanoff 2015) and that co-produces global environmental

²⁵ Given the lack of an official acronym, I will refer from now on to the Stockholm Knowledge Hub on Climate Security, simply as "the Hub."

knowledge. An analysis of the everyday aspects associated with the production of ViEWS will allow us to understand the discrepancies between the uncertainty acknowledged by its producers (Jasanoff 2015) and a national goal to provide tools to "protect the future" (Swedish Institute N/A). The phrasing of "the future" in singular signals the impossibility of multiple cosmologies (Vasconcelos 1967). The achievement of "a future" will require others not to occur, or at least to modify their trajectory so that they merge into the dominant imaginaries (Benedict Anderson 2006). In this sense, the discussion will also focus on a division between the Global North and the Global South where the environment has been framed as either an issue of national security or human security. As will be discussed, the production of forecasts represents an exercise of power in which particular futures are expected to prevail over others. Therefore, it is crucial to question the way QDs design specific futures.

Forecasting tools are present in daily life for most of us, from weather to traffic, we want to prevent unwanted outcomes, to reduce the uncertainty of the future, to feel in control. In some parts of the world, farmers with access to economic and technological infrastructures use weather forecasting to predict seasonality and prevent themselves from unwelcomed futures (Youds et al. 2021). The construction of forecasts highlights existing inequalities in access to risk assessments and affords power to those with the means to create them. Even more, as it was reviewed earlier, future expectations direct our present by defining the actions required to arrive at it. Those with the means to impose "how things should be done" will do it (see: Belay and Mugambe 2021).

The chapter has been divided into four sections aimed at discussing the role of QDs in the development of national imaginaries. The first section starts with a description of ViEWS. Then I move into a historical account of my case study. Rather than focusing solely on ViEWS, I locate it within a wider national interest in using environmental policy as a geopolitical tool. I show how the rise of environmental thinking in Sweden results from an interest in protecting natural landmarks, as much as ensuring the continuation of a lifestyle based on the equilibrium between society and capitalism. Proposing that this vision towards the role of humans in the environment could be understood as a cosmology, I move on to analyse how some people in the Global South imagine the future concerning climate change. By looking

into the discourses of the three individuals invited to the UNSC, I open the discussion on how the imagined consequences of climate change imply either the destruction of the homeland or the disruption of supply chains.

The second section will move into the everyday performances of those producing ViEWS. In Goffman (1973) terms, the daily production of ViEWS can be seen as a constant clash between the desire to create an influential tool and the risks of producing unintended consequences. In this sense, the everyday actions of the actors evidence a concern towards how they should present themselves to the world.

The third section will continue the discussion of the previous chapter around an interest in standardising programming language. By using my programming-language learning curve as a prompt, I analyse how while ViEWS is presented as being produced by following a stepwise formula governed by statistical theory, in practice, it is done through everyday pragmatic interpretations. While these daily practices were also analysed as part of the production of the EPI, in the case of ViEWS, together with its producers, I examine the ethical implications of offering a device as replicable when this might not be the case.

The fourth section incorporates a series of conclusions from this chapter. My main conclusion is that given the current impossibility for ViEWS to be replicated outside of Uppsala, QDs could promote dependency from the Global South to the West since the former will require these forecasts to be done by someone else. Hence, I close the circle opened at the beginning of this chapter by showing how these tools do not only predict possible futures (Leach, Scoones, and Stirling 2010; Scoones and Stirling 2020): they aim to create their sociotechnical imaginaries by pursuing a desired future (Jasanoff 2015:3-5) through science.

5.2 What is ViEWS?

ViEWS is a forecasting tool aiming to provide publicly available²⁶ early warning systems for three forms of political violence: armed conflicts²⁷ involving states and rebel groups, armed conflicts between non-state actors, and violence against civilians. The tool forecasts events within the following 36 months. Jose Arcadio, a senior researcher, described this timeframe:

That's partly arbitrary. If you want to do anything with a conflict that is emerging, the decision-making procedure in the UN, for instance, is quite slow. In order to have good preparation, you'll need six months/1 year at minimum to be able to do anything. [...] What we were thinking when we started up the project, without having done any modelling, was that beyond 36 months would be very hard to know (Jose Arcadio 2019).

The second dimension we need to understand is the space in which ViEWS currently operates. The forecasts are limited to the African continent, although the team expects to increase them worldwide. The rationale behind choosing Africa seems to be based on a pragmatic approach of being an easy case study given the quantity of data available for the continent and the number of active conflicts. It is important to highlight that the project is funded through an ERC grant running between 2017 and 2022. Hence, the initial objective was to prove they could actually forecast conflicts. Given the small size of the ViEWS' team, they had to choose a continent with enough data

26 According to ViEWS' researchers this is not the only conflict forecasting tool; they claimed that most intelligence agencies, from developed countries, have one. However, these tend to be secret projects rather than open access.

27 The main project produced at DPCR is the Uppsala Conflict Data Programme (UCDP). Created in the 1970s, UCDP collects and reports data about conflicts worldwide. Under this database, a conflict has been defined as violent events with at least 25 battle-related deaths per calendar-year (UCDP N/D-a). According to their characteristics, conflicts have been defined in three different ways: armed: where there is a contested incompatibility around government or territory or both between two parties, of which at least one is the government of a state; interstate: an incompatibility between at least two governments; and, intrastate: conflict between a government and a non-governmental party. These definitions are the ones ViEWS uses for the forecasting and the three types of conflict that are forecasted.

UCDP's dataset is updated on a monthly basis under the "candidate events" label and a definitive revised version on a yearly edition. Before 2017 UCDP used to publish the datasets only every year, however, ViEWS requires data updated every month; hence, the ViEWS' team supported UCDP financially to accelerate their production. The "candidate" label implies that events reported by the media or NGOs as "conflicts" are automatically included but not its authenticity or characteristics are not verified but until the end of the year.

availability and conflicts. Catalan, a junior researcher, commented on their decision about choosing Africa:

Mainly, the practical reason is that we don't have enough people to cover all the world monthly. I suppose Africa is a region that is doable to code by a couple of people every month, and there is decent data quality. [...] There's no political reason for us to focus on Africa, it's mainly practical, of course, ultimately will lead to global forecasts, that's the idea (Catalan 2018).

While Catalan argues that there was no political reason behind choosing Africa as a pilot, it is important to observe how dangers are defined as being external to the West, as mentioned earlier. ViEWS provides forecasts at two different scales: a country scale and a much more granular one based on a small grid. The Country-Monthly level (CM) is the probability of conflict for an entire nation. Figure 13 shows the CM forecasts for the three types of conflict for August 2020. The red colour implies a higher probability of conflict, while the purple is a null one.

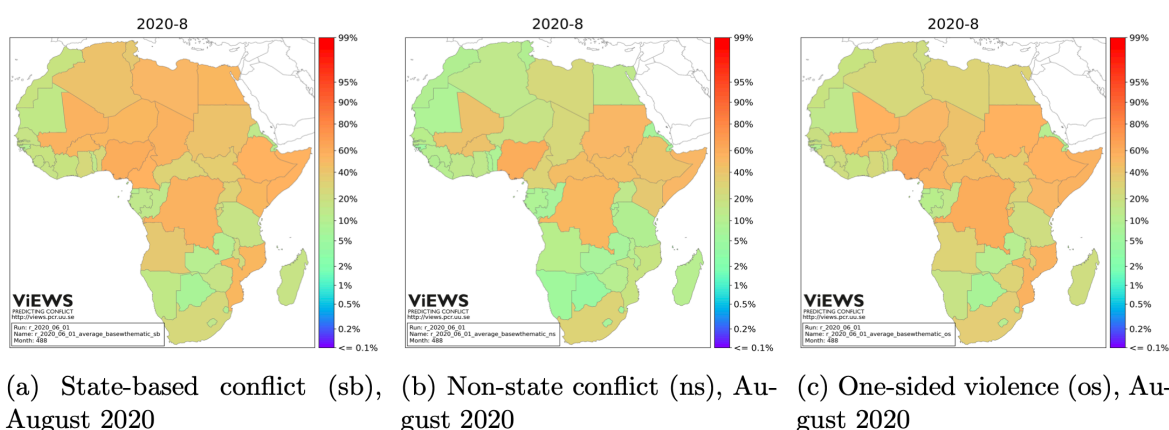


Figure 13 ViEWS Country Monthly Forecasts August 2020

The second scale at which forecasts are produced is at the geographical level. Thus, ViEWS uses a quadratic grid with cells measuring 0.5 x 0.5 decimal degrees²⁸ and developed by the Peace Research Institute Oslo (PRIO). While the size of these cells

²⁸ This is approximately 55 x 55 km (3025 km²). For comparison purposes, Edinburgh measures 264 km²; Lagos, which is the biggest city in Africa, 999 km²; Greater London 1569 km²; and, Mexico City Metropolitan Area 7866 km².

was defined, their superposition over existing political borders implied the need to adjust which country corresponds to each cell. Jose Arcadio described this:

The grids don't respect borders; we assign a nationality to the grid-cell by a majority. The country with the largest proportion of territory within the cell, that's the nationality of the cell [...] The grid structure doesn't respect any geographic features at all. Another problem is that there is a big difference in size in grid-cells; it depends on their distance from the Equator. But we can control that away, that's a simple relationship between latitude and area (Jose Arcadio 2019).

Figure 14 shows the PRIO-Grid monthly (PGM) forecasts for August 2020.

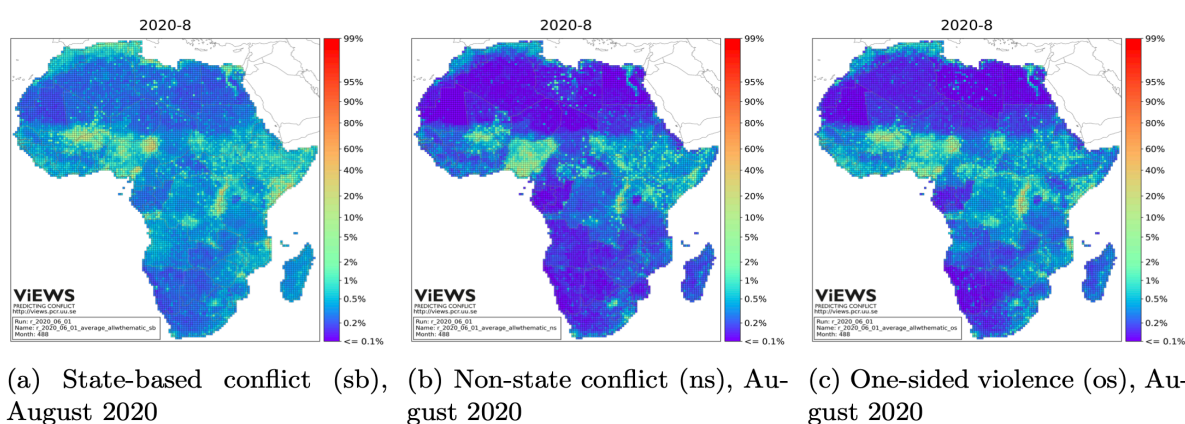


Figure 14 PRIO-Grid Monthly Forecasts August 2020

The production of both CM (figure 13) and PGM (figure 14) forecasts is done through extensive and thematic core models. CM is constituted by two extensive and six thematic core models, while PGM is based on ten core models (five thematic, two combined themes and three country-level predictors). These models are combined in ensembles to produce the forecasts; 24 models for the CM (figure 15) and 30 in PGM (figure 16). Each ensemble will be estimated for the three types of violence ViEWS forecasts.

Country-level Models		
Baseline Proportion of months in training period with conflict Conflict History Theme Lagged conflict (sb, ns, os) Decay functions ($2^{-m/12}$ where m is the number of months without conflict and 12 months the half-life parameter; sb, ns, os) Demography theme Population size Proportion of population between 15 and 24 with at least lower secondary education Proportion of population living in urban areas	Economy theme GDP per capita, oil rents only GDP per capita, excluding oil rents Growth in GDP per capita, oil rents only Growth in GDP per capita, excluding rents only Institutions theme Democracy Semi-democracy Time since pre-independence war Time since regime change Proportion of population excluded from power Time since independence	Protest theme Lagged protest Decay functions ($2^{-m/12}$ where m is the number of months without conflict and 12 months the half-life parameter; sb, ns, os) All themes Baseline + Conflict + History + Demography + Economy + Institutions All themes + Protest Baseline + Conflict + History + Demography + Economy + Institutions + protests

Figure 15 Monthly Country-level ViEWS Models

PRIO-Grid (PGM) level models		
Baseline Proportion of months in training period with conflict Conflict History Theme Lagged conflict (sb, ns, os) Months since last conflict (decay functions ($2^{-m/12}$ where m is the number of months without conflict and 12 months the half-life parameter; sb, ns, os)) Spatial lag of lagged conflict events (sb, ns, os) Natural Geography theme Distance to nearest secondary diamonds source Distance to nearest secondary petroleum source Proportion of mountainous terrain Agricultural area Forest area Shrublands Pasture land Urban Areas Social geography theme Distance to neighbouring country Travel time to nearest city Distance to capital city Population size Gross cell product	Infant mortality rate Number of excluded groups Country-level (cm) theme Democracy Semi-democracy Time since independence Time since pre-independence war Time since regime change Proportion of population excluded GDP per capita, oil rents only GDP per capita, excluding oil rents Growth in GDP per capita, oil rents only Growth in GDP per capita, excluding rents only Population size Proportion of population between 15 and 24 with at least lower secondary education Proportion of population living in urban areas Protests theme Lagged protest Months since last protests ($2^{-m/12}$ where m is the number of months without conflict and 12 months the half-life parameter; sb, ns, os) Spatial lag of protest	All themes, without cm Baseline + Conflict History + Natural geography + Social geography All themes + with cm In this model, predictions are either generated by (1) adding the 'cm theme' variables to the 'All themes, without cm' model; or (2) multiplying predictions from the 'All themes, without cm' model predictions obtained from estimation at the pgm level with predictions from the 'All themes' model estimated at the cm level. For details on (2), see section on cross-level representation.

Figure 16 PRIO-Grid-level Monthly ViEWS Models

Through Machine Learning, these levels are used as indicators to forecast the probability of conflict. The objective is to develop algorithms capable of self-improving the detection of patterns among data (Jordan and Mitchell 2015:255). In the case of ViEWS, these patterns are sought through what is known as Supervised Learning

(SL), meaning that patterns are searched among provided data and parameters (ViEWS' levels). The conditions were determined through the causes that triggered past conflicts.

The way these algorithms manage data is multiple. I will solely focus on those two used by ViEWS. *Neural Networks* (NN) refers to a web of algorithms that are interconnected between themselves, as the neurons in our brain. For an algorithm to 'make a decision', previous decisions were taken by other algorithms. For instance, to define what constitutes a house through NN different algorithms will decide possible shapes, materials, or locations. When brought together, the NN could suggest what a house is. Another way in which machine learning algorithms are organised is through Random Forests. In this case, we can imagine a forest full of trees where all belong to the same forest, but each one is relatively independent of the rest.

Given the focus on QD within the realm of environmental issues, as part of my participant observation, I was assigned to the Climate-ViEWS' project. This branch aims to expand the use of ViEWS' infrastructure into climate-related conflicts. This expansion will be made by integrating the IPCC socioeconomic scenarios²⁹ with the ViEWS infrastructure. This combination will provide Mistra's Geopolitics project with forecasts of conflicts and human displacements linked to climate change (DPCR 2017). In particular, the aim is to forecast the probability of conflict, within the next 100 years, due to agricultural changes related to droughts. My work for ViEWS consisted of developing the dataset that could be incorporated into the ViEWS pipeline to produce the drought-driven conflicts' forecasts.

5.2.1 The Swedish matter

Together with its Nordic neighbours, Sweden has often been portrayed as a progressive state with particular care towards the environment. In the last couple of years, Swedish-climate activist Greta Thunberg became an important figure calling for fewer words and more actions from politicians. Institutionally speaking, the Swedish

²⁹ These are established possible trajectories anthropogenic climate change could take based on the main driving forces (physical, ecological and socioeconomic) (Moss et al. 2010).

care for nature has its origins in 1909 with the Swedish Parliament passing two laws aiming to protect natural landmarks and National Parks (Sundin 2005:9). As part of these laws, the Royal Swedish Academy of Sciences was tasked to design how Sweden's nature could be protected. The Academy's involvement implied that a scientific committee was given the authority to proclaim which *landmarks* should be constituted as such. A sense of patriotism also inspired these early actions to protect the country's natural heritage. The nation moved from kings and warriors to natural wonders as the nation's distinctive element (Sundin 2005:11).

Swedish civil society pushed policymakers to transform the country into a "global policy driver in the field of environmental politics" (Thörn and Svenberg 2016:594). This push is required to be contextualised as part of the 1960's student mobilisations, where the environmental movement is perhaps the one that has gone through the clearest institutionalisation (Rootes 1999:1). As part of this institutionalisation, the Swedish Environmental Protection Agency was established in 1967 to show a "strong, modern welfare state meeting a new social issue or problem" (Breiting and Wickenberg 2010:13). In terms of policy, Lidskog and Elander (2012:417) describe Sweden through certain storylines where the hegemonic discourse is "proclaiming that sustainable development must be approached by a strategy characterised by *market orientation*, *collaboration* and *consensus* between economic, environmental and social values and interests in society." In this sense, environmental protection can be seen both as an appreciation towards the environment as much as an imaginary to project Sweden as a model state.

On the 22nd of May 1968, the Swedish representative to the UN, Sverker Åström (1968), proposed to the UN Economic and Social Council to organise an international conference on the human environment. The proposal argued for the urgent recognition that "uncontrolled" changes in the environment could bring negative social and health effects to humans. It also claimed that while these issues were more present in highly industrialised nations, they could eventually affect the least developed countries. The conference's goal was to widen the scope of environmental problems to push policymakers into an arena dominated by scientific experts (Åström 1968). The proposal was received with hesitancy in the Global South, who argued that such conference was a strategy to negate their right to development (Calvert and Calvert

1999; UN and École Pratiques des Hautes Études 1971) through the imposition of "stringent standards" (Ivanova 2007:342). Still, through lengthy negotiations,³⁰ the proposal was approved by the General Assembly. Simultaneously, a lack of technical and administrative expertise led the UN Under-Secretary-General for Economic and Social Affairs to often request advice from the Swedish delegation to deal with what became known as the "Swedish matter" (ibid:341). The 1972 United Nations Conference on the Human Environment can be seen as the first occasion in which Sweden exported³¹ its environmental sociotechnical imaginary: one that approaches the problems of the protection of the environment while ensuring economic growth through the implementation of policy *evidence-based* approaches.

Since the 1972 Stockholm Conference, part of the Swedish foreign policy has focused on ensuring open trade and peace by providing technical expertise in environmental issues and conflict prevention (Government of Sweden 2021). As with any other foreign policy, this focus should be understood as one that aims to benefit Sweden. In this sense, Thörn and Svenberg (2016) frame the Swedish desired future as one where sustainability is seen as ensuring economic growth within capitalist frames.³² For the capitalist project to succeed, multiple elements must be mobilised, including the imposition of ways of life and dispossession of land (Harvey 2010:312).

5.2.2 Climate Change and Forced Displacement

Between 2015 and 2017, over 300,000 Ethiopian pastoralists were displaced from their lands in the East after losing over 80% of their livestock because of a drought they called "Af-gudhiya" [nothing to put in your mouth]. The UNSC meeting of the 11th

³⁰ For a detailed account of these negotiations see: (Ivanova 2007; Engfeldt 2009).

³¹ It is important to highlight that Sweden was not the only country "concerned" about the environment, but it was one of the first to bring the discussion to institutional channels. For a detailed discussion on the Western development of environmental institutionalisation see: Death (2010); Dryzek (2005).

³² It might be important to highlight that in the case of Sweden think tanks and policy institutions have been historically used to frame the social life of the country. David Harvey describes the way in which the Nobel Prize of Economics – the only one not given by the Nobel Prize Foundation, was used in the 1960 as a way to stop the proposal of a plan to socially purchase companies through a social-investment fund. By awarding the Nobel in Economics to researchers prone to call for an increase in the privatization of the economy, including Hayek and Friedman, think tanks and the media argued that the country should follow what Nobels say. In the end, the Swedish government retracted from applying what had become known as the Meidner Plan (Harvey 2010:252; 2007:112-115).

of June 2018, referred to at the beginning of this chapter, started with the discourse on the effects of climate change in forced displacement by three non-UNSC members. While these interventions shared experiences in the Global South, their concerns are similar to those of the Global North regarding fear of losing their ways of life. However, while for the poorer countries, these changes could imply the loss of their homeland and sources of subsistence, for the industrialised nations, they represent a challenge in terms of incoming migrations and interruptions of supply chains. These different approaches were discussed in the literature review when analysing the increase in climate change's securitisation.

The first speaker was UN Deputy Secretary-General Amina Mohammed. While not speaking in the name of Nigeria, but as a UN representative, Mohammed claimed that "[F]ragile countries are in danger of becoming stuck in a cycle of conflict and climate disaster" (2018:2). She told the story of how as a child who grew up in the Lake Chad basin, she remembered that given the lake's size, people used to imagine that they could get to the UK by crossing it. However, the lake's current situation, which has shrunk by more than 90% since the 1960s, has "led to environmental degradation, socioeconomic marginalisation and insecurity affecting 40 million people" (2018:2). For Mohammed, this marginalisation has exposed the younger generations to the recruitment of extremist groups like Boko Haram. In response, she mentioned that the UN had been determined to increase the capacity of policy tools for security-risk assessments that incorporate climate change.

The second guest was Hassan Janabi, Minister for Water Resources of Iraq. For him, forced displacement is mainly caused by poverty, war and the lack of decent means of living conditions "resulting from the spread of desertification, global warming and biological diversity" (UNSC 2018:4). While not assuming that climate change is the sole responsible for forced migration, Janabi sets it as an important element that has aggravated existing conditions. Just as Mohammed, through a storytelling process, Janabi reminded us that it is in Iraq's lands where the first great civilisations established themselves. From Mesopotamia to the Sumerian civilisation, they depended on the Gulf at the edge of the desert to sustain their agricultural production. However, this land was not only "criminally and deliberately dried up by the *infamous* Iraqi dictator that was overthrown in 2003 [Saddam Hussein]" (UNSC 2018:5), but

after a period of recovery is now drying up again due to climate change. The figures are staggering; 90% of the historically fertile lands of Iraq are threatened by desertification. According to Janabi, these changes menace the survival of the descendants of the Sumerians, whose lifestyle and heritage depend on their water environment. Even more, he claimed that while the UN has managed to gather "frightening statistics" on displaced people, these numbers are not only short-from-reality but ignore all of those who have died while migrating.

The final guest was Hindou Ibrahim, from Chad, representing the International Indigenous People Forum on Climate Change. Ibrahim started her speech by telling the UNSC's members that the existence of the IPCC, the UNFCCC, or the council itself means nothing for millions of people. In this sense, Ibrahim claimed:

My people do not know that there is such a thing as a Security Council where a group of people sits and thinks about peace worldwide. My people are living in climate change. Climate change has an impact on their daily lives and gives them insecurity. When they sleep at night, they dream that they will wake up the next day and be able to get food or water for their children. They also dream that if someone gets to the resources before they do, they will have to fight for them. My people do not sit in offices all day and wait for their salaries to be paid at the end of the month so they can feed their families (UNSC 2018:6).

Ibrahim reminds us of the existing gap between those who imagine the world in the short term and those who do it in the long term; assuming that imagination is even possible. For her, while pastoralists deal with uncertainties that require immediate solutions, bureaucrats in NY take their time to debate. Given the importance of gender roles in Ibrahim's region, according to her, men's lack of possibilities to provide food for their families has often left them with two life choices to preserve their dignity as providers. They can decide to enrol with terrorist groups in exchange for food, or they can join the floods of internal and external migration looking for better opportunities (UNSC 2018:6-7). In this sense, she asked herself, what is the future of young generations? Would she find them as terrorists? Would they jump in the sea? Ibrahim finishes by reproaching the council that her community has no choices; climate change has become a survival issue.

These anecdotes demonstrate the urgency to recognise environmental issues as an increasingly important factor for national and international security. The three speakers shared a lived past where nature supported their everyday lives and a future where displacement and conflict arose. However, these discourses could help to reinforce a dominant narrative that sees dangers as always coming from the South into the West. In this sense, think tanks have argued that Europe is already under threat due to migration flows triggered by the Syrian Civil War and climate-induced conflicts (van Schaik and Fetzek 2018). This dominant discourse identifies diseases, terrorism, and chaos as things the West needs to be prepared to face as external threats. In this sense, it is vital to support the Global South to contain these dangers before they spread. This support will often be in the way of military interventions or through dependency policies, as will be argued later in this chapter.

The discourse of dangers as external creates an unwanted present-future (the future as we imagine it now). Instead, what is desired, is an extension of an imagined past where humanity thrived and in nature through a 'harmonious' relationship. However, as the consequences of climate change become more evident, a combination of power relations among societies and our unsustainable relationship with nature has limited the available futures of the dispossessed. For example, Belay and Mugambe (2021) discuss how western corporations sponsored by Bill Gates have for decades imposed agricultural practices in Africa with the promise of a better future that has never arrived. Another example is the coverage by news media over Afghanistan's humanitarian crisis. Three days after the Taliban took Kabul, CNN (Horowitz 2021) published an article titled: "The Taliban are sitting on \$1 trillion worth of minerals the world desperately needs." In similar terms, the Financial Times (2021) wrote: "Afghanistan minerals: A monkey trap for aspiring miners." In the name of a green economy, these articles expressed their concerns not towards the possible violations of human rights but on the difficulties mining companies would have to extract lithium and other minerals needed for electric cars. While the imaginary of a catastrophic future for some countries focuses on the disappearance of their land, for others, these become possible supply chains disruptions or migration flows.

5.2.3 Quantitative Devices and the Swedish Imaginary

The implementation of imaginaries, as discussed in the literature review, requires an infrastructure that mobilises social, political, legal, technological and scientific elements. The launch of the Stockholm Knowledge Hub should be understood as a scientific programme and an element of the Swedish sociotechnical imaginary of ensuring their role as global environmental knowledge providers rooted in a geopolitical strategy. Given the interest of this thesis, I will focus almost exclusively on the technological devices that promote the fulfilment of an imaginary (Jasanoff 2012b; Visvanathan 2005).

QDs do not operate in isolation, their producers require to be inserted in ensembles that allow their operation. Working in cooperation with the Hub, the MISTRA Foundation³³ developed a nation-wide³⁴ project to serve as a gateway for Sweden to increase its role within the geopolitics of climate change. While launched in 2017, one year before Wallström's announcement at the UNSC, this project is clearly included in the interests of co-producing environmental knowledge as a geopolitical strategy. In the words of two of its senior members, MISTRA-Geopolitics was described as the gateway through which Sweden could influence the implementation of environmental policies in other countries. Since the effects of climate change are transboundary, Sweden must have a full understanding of how circumstances elsewhere could impact the country. An example mentioned before, and also put forward in a meeting I attended in 2018 during my fieldwork, was how a drought in Brazil could trigger an increase in the price of coffee in international markets. Therefore, it was necessary to understand the probabilities of droughts in the region to support farmers' resilience as a way of securing a stable market.³⁵ These transboundary impacts are being forecasted through some QDs linked to MISTRA-

³³ MISTRA is a Swedish foundation focused on funding strategic research that can improve life conditions in Sweden. Interestingly, the initial endowment of MISTRA was obtained from the already collected money of the Meidner Plan (see footnote 31). While the board members are non-governmental officials, these are appointed by Governmental Ministries.

³⁴ The MISTRA Geopolitics project is composed by four Swedish universities (Stockholm, Uppsala, Lund, Linköping), and two Think Tanks (Stockholm Environment Institute and the Stockholm International Peace Research Institute).

³⁵ Coffee is an important issue in Sweden. Together with its Nordic neighbours, the country is one of the top importers of this crop.

Geopolitics, including the Transboundary Climate Impacts Index. The index, produced by the Stockholm Environment Institute, aims to quantify the risks posed to countries by climate change effects taking place elsewhere. Another project aimed to understand at a distance the consequences of climate change is the Climate Violence Early Warning System (Climate-VIEWS). This project, produced at the Uppsala University Department of Peace and Conflict Research (DPCR), aims to forecast the probability of forced displacements due to droughts.

5.3 The mundane production of Quantitative Devices

On the 1st of October 2018, four weeks after my arrival in Uppsala, I was admitted as a ViEWS' visiting researcher. It was on the second floor of a central building (see figure 17) that I spent the following months learning not only about ViEWS but about how quantitative researchers interact daily with programming techniques. The DPCR building is located next to the *Fyris*, the river that cuts Uppsala by half. Used to more conspicuous academic buildings, finding my way into the department for the first time was not easy. I went across the square looking for an "academic building"; instead, all I could find were stores, ATMs and cafés but not a university structure. After some time, I finally read the big poster at the entrance marked with a big number 3 and a directory of what was inside: DPCR and the Institute for Russian and Eurasian Studies (IRES) (see figure 18).



Figure 17 DPCR building



Figure 18 Directory at the entrance of the DPCR building.

Perhaps inconsequential, but an interesting aspect is DPCR's location. Internally, the building had three floors. The ground floor is used by businesses, the first and second by DPCR and the third floor is used by IRES. The interesting part is that one of the institutes in this building focuses on peace and conflict studies, while the other focuses on studying what is considered one of the main security concerns for Sweden: Russia (Braw 2020). During my time working as a research assistant, I never saw any collaboration between both departments; I even attended a couple of IRES seminars to see if any member of DPCR attended. Still, I found the location of both institutes to be more than a coincidence and more symbolic.

As described in the research design, between September and the beginning of October, while administrative procedures were being sorted out, I was asked to learn how to programme. On my first day at DPCR, I felt that I was ready to understand some programming jargon and conduct my duties. Based on my online training, the first step to start working on the Climate-VIEWS database was to conduct a "data cleaning" exercise to familiarise myself with its characteristics. Therefore, once I received a file from Pilar, I aimed to diligently start the steps I had written on my notes

(see figure 19). The steps in figure 19 steps are meant to be done to understand the characteristics of the dataset.

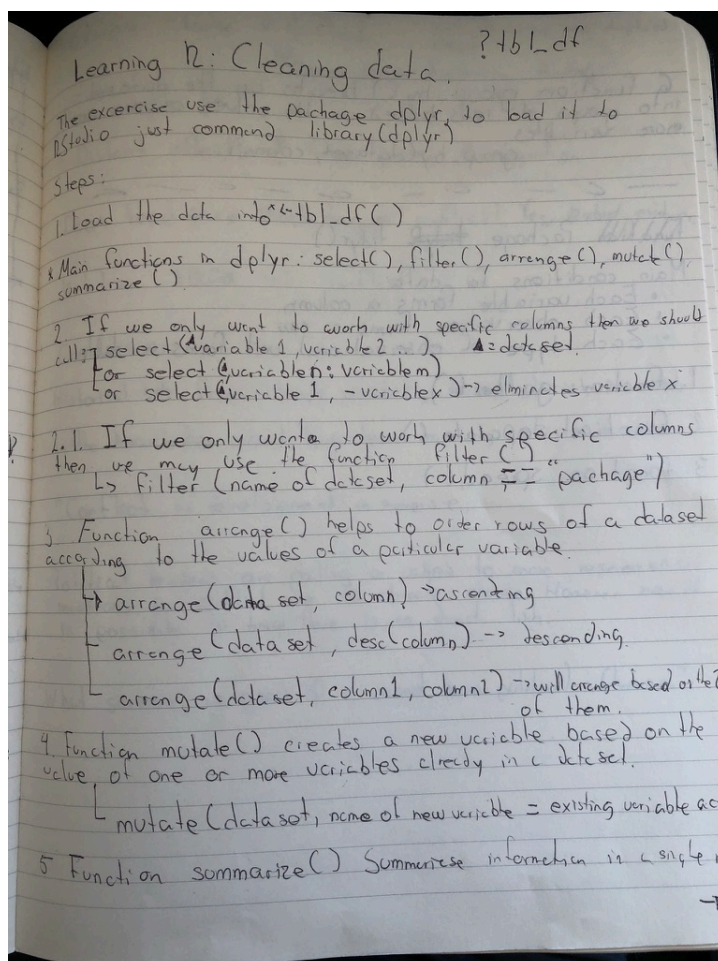


Figure 19 Personal notes on the steps to conduct a data cleaning on R.

After an hour or so, the steps I had written felt useless since I could not even open the file. Hence, I decided to visit Catalan, a junior researcher with knowledge in R. After showing my notes and R commands to him, I asked why, if I was rigorously following every step, I could not even start cleaning the data? Looking at me quite puzzled and laughing, he replied that he had never heard about those steps. According to him, programmers do not do their work as established by standardised prescriptions in their everyday life, they solve their tasks as their imagination suggests. This brought to my attention the gap between the way the construction of QDs is reported and how they are produced. During an informal conversation with another junior researcher called Mauricio, he mentioned that while the programming protocol requires

programmers to use Rubin's Rules³⁶ when conducting an imputation, in practice, they would skip it since it involves more steps. In this sense, the results are obtained through single imputations rather than multiple, increasing the amount of uncertainty in the results.

The lack of standardised processes would not represent an issue of interest if standardisation were not used as an argument in the dispute between QDs, qualitative analyses and scrutiny. In the case of ViEWS, the tool is presented as being replicable (Hegre et al. 2019:170) as a way to ensure public accountability. However, the lack of standardised procedures is an example of the way QDs are produced daily. By definition, mundane processes are unrecorded, and this is perhaps the main reason for replication to be unachievable. Currently, codebooks and guides are provided by ViEWS as a way to allow others to replicate the forecasts. However, the ViEWS' team is aware that it is almost impossible for anyone to repeat it outside of Uppsala. For most of the group, coding is a process so individual that even trying to read someone else's code is not always possible. If the same task is requested to two people from DPCR, while both might obtain a similar result, the process of arriving at it will differ. For example, when I asked Herbert about the mundanity of programming, he was very clear about the unique way each programmer does their job:

Yeah, there is a lot of subjectivity; we might even choose a different subset of the programming language. My code is completely different, I can recognise it within seconds from Frederick's code. And of course this is very different, it is a very subjective process. If you show me one page of the ViEWS' data, I can tell you whether it is mine or not without even looking at what the file is, just by screening it (Herbert 2019)

Herbert claims that he is capable of recognising his own coding from that of his colleagues. Even though there is a process of tacit knowledge as a team, and some

³⁶ For Rubin (1987:2) "multiple imputation is the technique that replaces each missing or deficient value with two or more acceptable values representing a distribution of possibilities." To reflect the uncertainty behind obtaining missing data, the imputation step is repeated multiple times - hence the appellation "multiple" - and then averaged. Taking the average of multiple imputations makes the final figure more likely to resemble missing one.

of the codes will include the name of who wrote certain parts, Herbert refers to the individual programming style each one of them has developed.

The importance of tacit knowledge in programming projects has been discussed through what is known as the *truck factor* (Avelino et al. 2016). The truck factor refers to the number of people within a team of programmers that can be "hit by a truck (or quit) before a project is incapacitated". While I wish to be less dramatic and do not expect anyone to be hit by a truck, this exercise done by Avelino highlights the importance of individuals within programming teams. Coincidentally, Brown mentioned that the project could not continue if one of his colleagues were to be run over.

If Frederick was hit by a bus, Mihai might be able to paste together the stuff that Frederick has done, but that would take a long time. Mihai is also super crucial; he is sitting on a lot of information that would be incredibly difficult to extract if he was gone. I think that for our replication stuff, we upload all the code, and then if you run the code, you would be able to replicate it. But then, I don't think that anyone would be able to replicate it from scratch. Like in the variables, they would run like copy-paste but trying to figure out what each part does, that might be difficult (Brown 2019).

The issue of not knowing how others coded a model is that if the person is absent, the project might not even be able to continue. For Brown, there are individuals within the team whose degree of tacit knowledge is so high that without their directions, ViEWS might not be replicated. For him, someone could copy all the codes and obtain the expected results, but this would happen without an accurate understanding of how it was built. A possible solution for everyone, at least within the team, to be aware of how a tool was made is through standardisation. Later in this chapter I discuss the idea of 'coding hygiene', understood as a push to decrease the dependency of entire projects on specific individuals.

5.3.1 Cautious influence

For its producers, ViEWS is still a pilot tool trying to show that forecasting conflict is possible. The final goal for them is to influence policymakers (Hegre et al. 2019) at the

World Bank, UN Agencies and the European Commission. While this point has not been reached yet, its possibility has divided the team. In particular, this division is more visible between senior and junior researchers. For junior researchers, there is a lack of internal discussion around the possible effects ViEWS could trigger (i.e. military interventions as a pre-emptive strategy to avoid conflict). At the same time, senior researchers used to downplay ViEWS' possible influence. For instance, Pilar – a senior researcher, explained how the tendency of policymakers only to follow the advice that confirms their stances can work as a preventive mechanism against ViEWS possible over-misguidance by limiting the potential users:

I think that we influence policy; for example, Håvard is now going to the IPCC meeting. The IPCC report is the scientific report that will influence policy in some way. Sometimes I guess also policy is more likely to use research, but this is a bit of a different topic, to use the research they like to hear and say "well, research is telling us we should be doing that" you know? [Pilar laughs], so they would be more likely to listen basically to something that confirms their conceptions or something that can be useful for making their case (Pilar 2019).

Pilar claims that their work is influencing policymakers. However, she recognises that this influence, rather than being based on something novel, will likely rely on policymakers finding the suitable tool to endorse a preconceived idea. In this sense, Stewart and Smith argue that there is little evidence of policy tools impacting policymaking; even when under claims of evidence-based policy (Stewart and Smith 2015). The IPCC publishes work produced by a wide variety of researchers from across the globe. Rather than contrasting, IPCC reports tend to include articles that confirm each other (Sundqvist et al. 2015). Therefore, if ViEWS were to suggest something radically different, it might be discarded by the rest of this social world since it goes against current paradigms (Fischer and Forester 1993).

Policy committees are not the only source of preconceived ideas ViEWS sees as an obstacle to disseminating their findings. The way the media has portrayed the link between climate change and forced displacement is one of the main concerns for the team regarding how to present their own work. As the stories introduced at the beginning of this chapter showed, conflict and displacement are not uniquely provoked by climate change. Instead, climate change should be understood as an accelerator

of existing perilous living conditions. At the same time, those at ViEWS perceive that the media has tended to ignore these underlying conditions and signal climate change as a sole trigger. For instance, in 2018, The Guardian reported that a caravan of migrants from Central and South America was heading towards Mexico and the US due to droughts that had affected coffee plantations (Milman, Holden, and Agren 2018). This report ignored an existing political crisis, including violence and a lack of capacity to deal with these problems. In the case of Climate-ViEWS, the argument is that the effect of climate change on forced displacement is not visible yet. While the project argues that, unfortunately, it will eventually occur, at this time, most conflicts and displacements should be linked to the political conditions of the sending countries. Earlier, during the literature review, it was argued that while droughts could be associated with the Syrian Civil War, it was a fractured political system that ultimately caused the conflict. These interrelations (see Figure 19) between climate and security were presented during a public seminar in Uppsala by Halvard Buhaug, a climate-views associate. Figure 20 Scheffran, Link, and Schiling (2009) shows the complex interactions triggered by droughts and conflicts in the Nile River Basin³⁷.

³⁷ Figure 20 "shows the essential relationships of the water conflict in the Nile region in an impact diagram. Changes in environmental conditions have an influence on water and land availability, which in turn affects economic production. Since human welfare and consequently societal stability depend on wealth, any deterioration of the economy has negative implications on society as well. Since the water availability and thus the conditions for agricultural production depend on the water use further upstream, two main geographic regions (upstream and downstream) are distinguished. Also, there is a differentiation between the population of rural and urban areas along the Nile River, as economic activities differ substantially, and the effects of climate change vary accordingly. Any large scale change in the structure of society, which may be caused by migration or population growth, triggers feedbacks that affect the economic output and subsequently the distribution of the remaining land and water resources" (Scheffran, Link, and Schiling 2009:17).

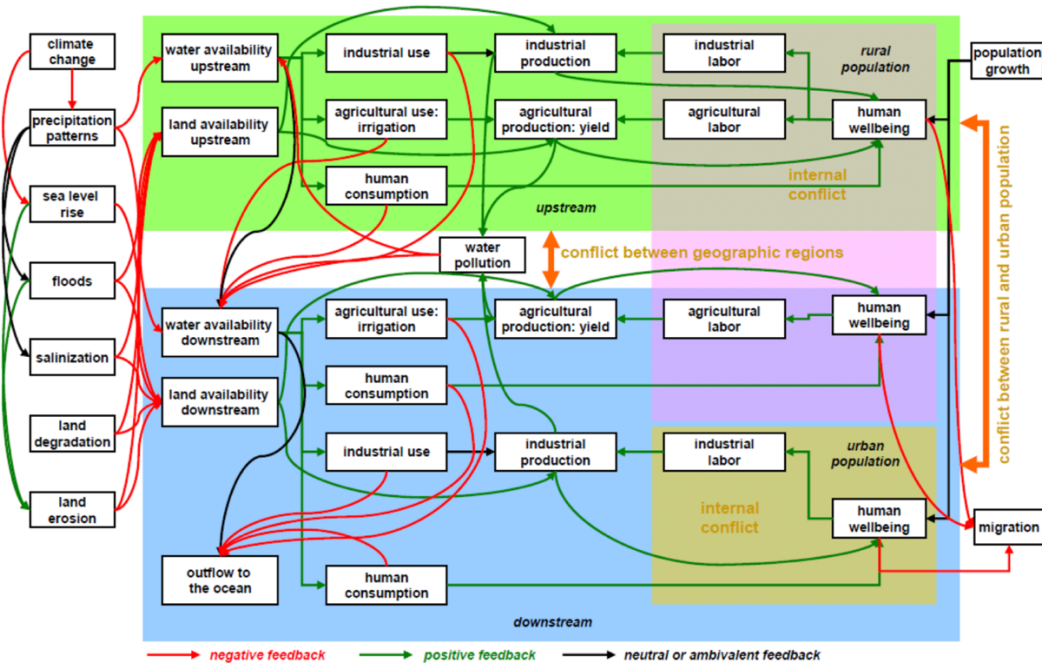


Figure 20 Schematic overview of the water conflict in the Nile River Basin

The black boxing by the media of the relationship between droughts and forced displacement seems to have pushed researchers to be cautious with their claims. For instance, Alvaro seeks to provide more nuanced interpretations based on the multiple, complex and contradictory nature of climate change. In particular, about the multi causality of migration movements which highlights the paradoxical nature of his work: not to over-simplify and not to over-complicate his explanations. So, it is about how to be relevant and honest about his work

I approach this issue and this topic of climate and security with healthy scepticism and with a sense of obligation that I shouldn't assist the policymakers in reaching simple and catchy conclusions about migrations being climate driven when we know that migration is multi-causal. At the same time, I need to be careful not to make myself irrelevant by stressing only the complex nature of things because then we can't say anything. Finding the right balance is super challenging but is also part of what makes this work interesting (Alvaro 2018).

For Alvaro, it would be irresponsible to base decisions on a single device. At the same time, he claims the personal necessity not to *dilute* its input into a large ensemble. In this sense, researchers are required to control a double-edged issue. On the one

hand, acknowledging that climate-related issues are too complex to be solved or approached through a single device requires more QDs. On the other hand, they need to control the rest of the devices involved in solving an issue to avoid diluting their inputs. In the case of Climate-VIEWS, being part of a nationwide project as the MISTRA's initiative could require them to work with other devices while trying to maintain their own expertise relevantly. Simultaneously, senior researchers often refused to acknowledge the possibility of full responsibility if an action was based on their forecasts. For these researchers, it is the responsibility of policymakers to pounder among the ensemble of all inputs before taking any decision. Hence, the full responsibility of an action will never be on a single QD – or in its producers.

5.3.2 Uncertainty

My work for CV was limited to developing the primary dataset on which to forecast conflicts due to droughts. This dataset was not a work I started from scratch, but I had to finish the work done by previous research assistants. The main task was to fill in existing missing data about countries. The "filling" term refers to using existing data to create the most likely value that it is missing (see figure 21). To provide a better explanation of the multiple processes that I conducted, I will include screenshots from my programming tasks. Multiple statistical methods can be employed for the filling process. In this case, two techniques were suggested: linear interpolation and multiple imputations. The former can be used on two occasions when we have values A and C, and we want to know B, or when we have values B, C, D, and we want to know values A or E. Following figure 21, this implies that the cells with the legend "NA" could be filled based on the data within the same column as long as they are from the same country. The idea is that there is a linear pattern from which we can infer the missing values. Figure 21 shows how in the case of Angola and Albania, none of them possesses values for all years in all domains.

wdi

	iso3c	date	iso2c	country	NV.AGR.TOTL.CD	NV.AGR.TOTL.ZS	SP.POP.TOTL
100	AGO	1988	AO	Angola	NA	NA	11068050
101	AGO	1989	AO	Angola	NA	NA	11454777
102	AGO	1990	AO	Angola	NA	NA	11848386
103	AGO	1991	AO	Angola	NA	NA	12248901
104	AGO	1992	AO	Angola	NA	NA	12657366
105	AGO	1993	AO	Angola	NA	NA	13075049
106	AGO	1994	AO	Angola	NA	NA	13503747
107	AGO	1995	AO	Angola	368504825.790174	6.65321372200356	13945206
108	AGO	1996	AO	Angola	528873555.808731	7.02686916586973	14400719
109	AGO	1997	AO	Angola	688508306.952096	9.00201794169947	14871570
110	AGO	1998	AO	Angola	840031172.522658	12.9111824086392	15359601
111	AGO	1999	AO	Angola	387034655.565374	6.29025682837342	15866869
112	AGO	2000	AO	Angola	517163204.882735	5.66468956353549	16395473
113	AGO	2001	AO	Angola	728859048.232153	8.15637702246655	16945753
114	AGO	2002	AO	Angola	892609948.954978	5.8395499748266	17519417
115	AGO	2003	AO	Angola	1104099935.26016	6.19838433868839	18121479
116	AGO	2004	AO	Angola	1472209717.57715	6.25087653552132	18758145
117	AGO	2005	AO	Angola	1870877459.72595	5.06040294790886	19433602
118	AGO	2006	AO	Angola	2719244833.46004	5.19128018876127	20149901
119	AGO	2007	AO	Angola	3421449079.01718	5.24227833734658	20905363
120	AGO	2008	AO	Angola	4254580694.73061	4.80533931673356	21695634
121	AGO	2009	AO	Angola	4655175861.79946	6.62119707047771	22514281
122	AGO	2010	AO	Angola	5179054574.41704	6.18029318057362	23356246
123	AGO	2011	AO	Angola	6534868426.82371	5.84568096888111	24220661
124	AGO	2012	AO	Angola	7772334516.27771	6.06963007473451	25107931
125	AGO	2013	AO	Angola	8896384125.08302	6.50749253992601	26015780
126	AGO	2014	AO	Angola	10996982491.7805	7.5470567791822	26941779
127	AGO	2015	AO	Angola	10599805694.1197	9.12253447070414	27884381
128	AGO	2016	AO	Angola	9941656304.30585	9.83116860869256	28842484
129	AGO	2017	AO	Angola	12233138227.1752	10.0169958599555	29816748
130	ALB	1975	AL	Albania	NA	NA	2404831
131	ALB	1976	AL	Albania	NA	NA	2458526
132	ALB	1977	AL	Albania	NA	NA	2513546
133	ALB	1978	AL	Albania	NA	NA	2566266
134	ALB	1979	AL	Albania	NA	NA	2617832
135	ALB	1980	AL	Albania	NA	34.8239757683613	2671997
136	ALB	1981	AL	Albania	NA	33.567399072847	2726056
137	ALB	1982	AL	Albania	NA	32.841582763367	2784278

Figure 21 Dataset extract showing missing data.

As we can see (figure 21), while some cells are filled with data, some have values of NA, signalling missing data. Through a linear regression, we could calculate the missing data for Angola (yellow cells) based on the existing data within the same column until before those in red since they are values for Albania.

The second method, multiple imputations, helps to obtain data when dealing with – for instance, multiple countries and some could have data about an indicator but not about others that a third country does have. In this sense, the idea is to obtain missing data based on existing information of the same country but through different indicators. While in the previous method I mentioned that the considered cells were only within the same column (and country), in this case, the codes are written so that

it considers all columns and rows within the same country. In simple words, we could try to guess the missing data in all orange cells (figure 22), based on all existing data about Greece.

1	v1	country	iso2c	country	slagremplzs	ssp2_pop_iliaa	ssp2_edu_sec_15_24_prop	ssp2_sec_edu_prop	ssp2_non_workagepopprop	ssp2_gdppc_oecd	ssp2_gdpppp_oecd	ssp2_gdppc_oecd_oil	ssp2_gdppc_oecd_nonoil	NVAGRTOTLZSSTATATA	nvagrtotlzs
2489	2818		GW	Guinea-Bissau	83.59799957275390	1.7667811	0.34582988	0.22170854	0.56621822	1592.9715	2807.9858	0	1660.7057	46.3483590103277	46.3483590103277
2490	2061	Greece	NA	NA		9.046541	0.63913763	0.29364903	0.63850113	17703.991	160159.86	0	17703.991	23.18340570965460	
2491	2062	Greece	NA	NA		9.18815	0.65518942	0.3038118	0.63914818	18631.952	171193.17	0	18631.952	22.40252573845400	
2492	2063	Greece	NA	NA		9.308479	0.67171003	0.31429338	0.63943317	18934.851	176254.66	0	18934.851	21.61164577029330	
2493	2064	Greece	NA	NA		9.429959	0.68871445	0.32495581	0.63976648	20052.763	189096.73	0	20052.763	20.80276580205800	
2494	2065	Greece	NA	NA		9.548258	0.70621815	0.33579845	0.64011845	20457.764	196336.01	0	20457.764	20.02986583385200	
2495	2066	Greece	NA	NA		9.642505	0.72423715	0.3466305	0.64051938	20395.899	196655.63	0	20395.899	19.23900585655130	
2496	2067	Greece	NA	NA		9.72935	0.73999095	0.35781857	0.6431572	19897.953	193594.14	9.7012545	19868.251	18.44812589745060	
2497	2068	Greece	NA	NA		9.789513	0.75617755	0.36937156	0.64583984	19550.514	191390.01	33.096108	19517.418	17.65724592924990	
2498	2069	Greece	NA	NA		9.846627	0.77281334	0.38100993	0.64850646	19226.371	189314.9	48.045029	19178.326	16.86636596104930	
2499	2090	Greece	NA	NA		9.895801	0.78991556	0.39272215	0.65133615	19517.503	193141.33	51.730845	19465.772	15.075485928486	
2500	2091	Greece	NA	NA		9.9343	0.80750225	0.40435056	0.65414804	19332.352	198013.97	51.224995	19881.127	15.28460602464790	
2501	2092	Greece	NA	NA		9.967213	0.81644071	0.41616253	0.65750636	19969.913	199044.38	17.456873	19952.456	14.49372605644730	
2502	2093	Greece	NA	NA		10.000595	0.82569179	0.42815208	0.66084826	19451.343	194525.01	21.691958	19429.651	13.70284608824660	
2503	2094	Greece	NA	NA		10.036983	0.83526783	0.44011525	0.66416734	20216.283	202910.49	13.309838	20202.974	12.91196612004590	
2504	2095	Greece	NA	NA		10.089498	0.84518157	0.45204263	0.66746929	20879.349	210662.15	17.098637	20862.251	12.12108615184530	
2505	2096	Greece	NA	NA		10.196792	0.85544618	0.46363487	0.67075184	20659.65	210662.15	17.105211	20642.545	11.33020618364460	
2506	2097	Greece	GR	Greece	22.1700000762939	10.319927	0.85883335	0.47543897	0.67279685	21049.31	217227.34	7.7441896	21041.566	10.539382621544390	
2507	2098	Greece	GR	Greece	21.8570003509521	10.399061	0.86237207	0.48746662	0.67468661	21036.121	218755.91	6.0157444	21030.106	9.748446247243240	
2508	2099	Greece	GR	Greece	21.2840003967285	10.460415	0.86607129	0.49898201	0.67641652	20576.399	215237.67	5.0136644	20571.385	8.957566279042570	
2509	2100	Greece	GR	Greece	20.8099994559424	10.512922	0.86994059	0.51012419	0.67798218	20885.264	219565.15	4.0716503	20881.192	8.166686310841900	

Figure 22 Dataset extract showing missing data for Greece

In figure 22, I highlighted in orange a column under the code *slagremplzs*, which is an acronym for *employment in agriculture (%of total employment)*. This code was not produced by ViEWS, but it was taken from the World Development Indicators (WDI) produced by the World Bank. This is highly relevant for this thesis since it is an example of how the terms in which this device will seek to forecast have already been categorised (framed) by the institutions developing these indicators. This is not the only case; the entire framing of the forecasts follows codes developed, mostly, by the World Bank. Figure 23 shows some of the variables that belonged to the dataset I worked on. While the meaning of some of them might be obvious (*countryname* or *year*), the great majority will require access to the WDI appendix to know what they refer to. The variables through which the multiple imputations are produced are selected based on their relevance towards climate and conflict.

```

107 #masterdata was added here. this dataset contains information about [ask gullid], a subset of no_ryggdattene
108 #which measures the relation between a given country and its
109 #neighboring ones in relation to the agricultural dependence.
110 #Only SSP2 variables were used. Some variables had to be eliminated due to the amount of NAs within them,
111 #the number was so big that it was making Amelia to crash.
112 #These variables are: wdi$PKOprotection, PKO_Previous all of them had more than 4915 NAs from 6798 observations
113 MasterData <- read_csv("MasterData.csv")
114 MasterData <- as.tibble(MasterData)
115 MasterData_sub <- MasterData[, (colnames(MasterData) %in%
116                               c("countryname",
117                                "gwno",
118                                "year",
119                                "independence",
120                                "polity",
121                                "durable",
122                                "bdbest_tot",
123                                "conflict4",
124                                "TimeSincePreIndepWar",
125                                "conflict",
126                                "conflict0",
127                                "conflict1",
128                                "conflict2",
129                                "timeinstatus",
130                                "timeindep",
131                                "PKOs",
132                                "PKOmandate",
133                                "PKObudget",
134                                "YMHEPSSP2",
135                                "v2x_polyarchy",
136                                "v2x_liberal",
137                                "v2x_partip",
138                                "v2x_egal",
139                                "v2x_delib",
140                                "v2x_elecoff",
141                                "v2xel_frefair",
142                                "v2x_freexp_thick",
143                                "v2x_frassoc_thick",
144                                "v2x_suffr",
145                                "v2xcl_rol",
146                                "v2x_jucon",
147                                "v2xlg_legcon",
148                                "v2x_cspart",
149                                "v2xdd_dd",
150                                "locregelec",
151                                "FVP_electoral",
152                                "FVP_liberal",
153                                "FVP_participatory",

```

Figure 23 List of ViEWS variables

Given my lack of expertise in programming and advanced statistical processes, before applying any of the two proposed methods, I had to learn. Fortunately, the ViEWS team always practised an open-door policy and a lot of patience to teach me. In this sense, I truly learned from my research participants how they do their work and some of their techniques to perform their job. At the same time, every occasion I went to an office to ask for something, it was an opportunity for me to learn their perception of statistical methods and the uncertainty behind them. For instance, while I was trying to understand the entire idea of linear interpolation one night, one of the ViEWS members took two hours to explain me statistics. This is a clear example of ethnographic research as a learning process. My quick course of statistics 101 served for me to learn the way in which researchers engage with the advantage and limits of statistics. On that particular occasion, while Mihai explained to me quadratic interpolation, he told me that the decision between choosing linear or quadratic was

technical and based on the country's political conditions we were trying to "obtain" data from. For instance, if we had data from 1968 and the following available data was from 1980, rather than just assuming a linear connection between both, it was essential to consider wars, economic crises or other social events that could prevent the relation to be "linear." In this sense, rather than assuming statistics is a "one method fits all", I was told that using a single method to obtain data for a dataset with over 180 countries would not be ideal since every nation would have its own social and political characteristics.

At the same meeting where I was given the task to complete the droughts dataset, I was told to use Amelia's open-source programming package. This package, a set of algorithms, had been designed by "someone"³⁸ to produce multiple imputations. Interestingly, no one knew what Amelia had been initially created for. Also, for most, it seemed irrelevant if the original purpose of the package was to impute data about sports or clinical issues. Brown referred to this lack of knowledge as a distance between Amelia's producers and ViEWS:

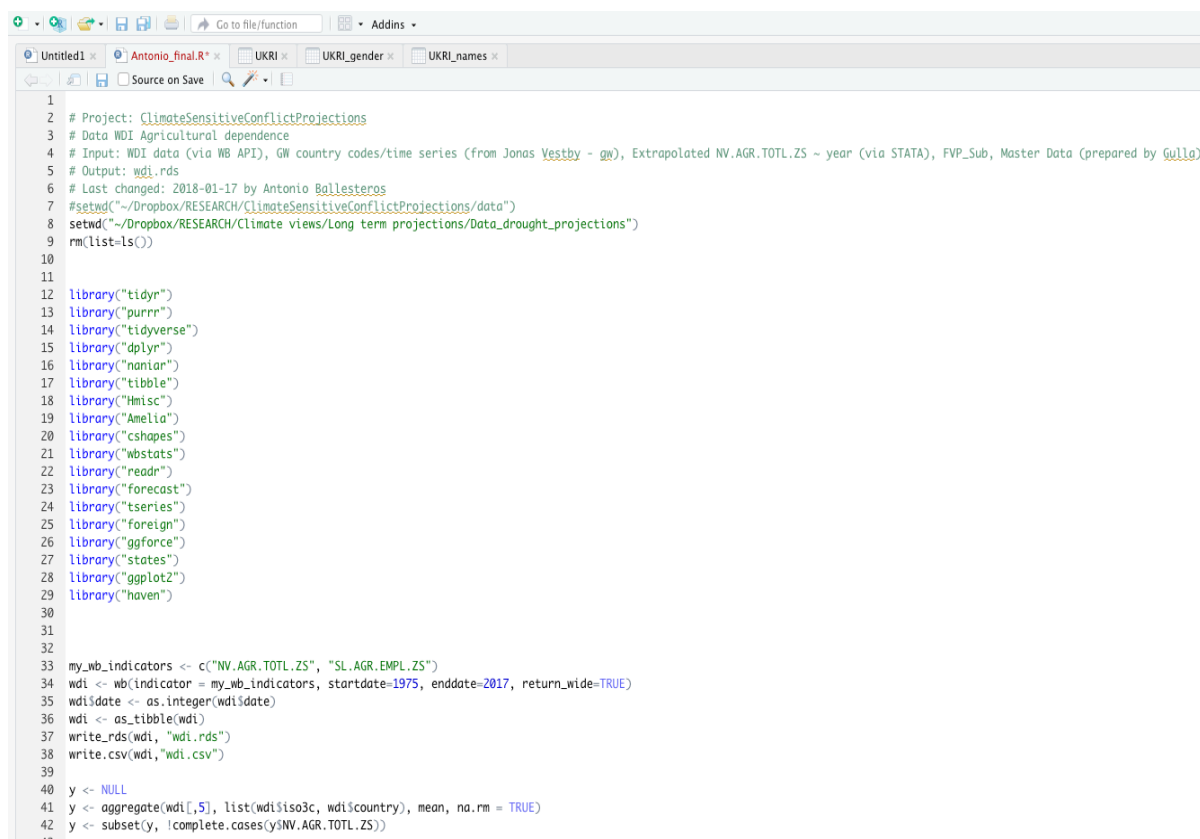
Right now, the distance between the people who made Amelia and what we are using Amelia for is so great that we actually don't know if Amelia is good to use in a prediction setting because no one has evaluated it in the prediction set. No one knows exactly what it means for types of methods. Are the imputations by Amelia, in fact, a random forest task rather than just a regression? We don't know because that's not what Amelia is developed for (Brown 2018).

Brown seemed to hint that some programmers tend to go for what works rather than exploring the origins of the package. The important element is to obtain the results even if the way this is done is uncertain or, even, unknown.

The documentation of most packages can be downloaded, which includes an explanation of what each function will do to obtain the results. Therefore, before using Amelia, I had to read about how to use it properly. Unfortunately, after a couple of days of trying to use Amelia's functions to produce the imputations, I failed. However, Brown's claims seemed to be confirmed when no one within ViEWS could understand why we were not obtaining any results even if we were following the steps we were

³⁸ In practice it is possible to know that Amelia was created by Matthew Blackwell (N/D). I refer to him as "someone" to signal that those at ViEWS found irrelevant to know who had created it.

supposed to. Therefore, I was helped to develop an algorithm of my own, one that could produce these imputations. The multiple imputation algorithm I developed inferred values based on existing data from a country and others that shared particular characteristics. Figure 24 shows how most R programming projects start. To keep track of who makes what, the last person who modified the project should write their name. Also, the words in blue represent the multiple packages that are required to be installed. If you look closely, you might find Amelia.



```

1
2 # Project: ClimateSensitiveConflictProjections
3 # Data WDI Agricultural dependence
4 # Input: WDI data (via WB API), GW country codes/time series (from Jonas Vestby - gw), Extrapolated NV.AGR.TOTL.ZS ~ year (via STATA), FVP_Sub, Master Data (prepared by Gulla)
5 # Output: wdi.rds
6 # Last changed: 2018-01-17 by Antonio Ballesteros
7 #setwd("~/Dropbox/RESEARCH/ClimateSensitiveConflictProjections/data")
8 setwd("~/Dropbox/RESEARCH/Climate views/Long term projections/Data_drought_projections")
9 rm(list=ls())
10
11
12 library("tidyr")
13 library("purrr")
14 library("tidyverse")
15 library("dplyr")
16 library("nanian")
17 library("tibble")
18 library("Hmisc")
19 library("Amelia")
20 library("cshades")
21 library("wbstats")
22 library("readr")
23 library("forecast")
24 library("tseries")
25 library("foreign")
26 library("ggforce")
27 library("states")
28 library("ggplot2")
29 library("haven")
30
31
32
33 my_wb_indicators <- c("NV.AGR.TOTL.ZS", "SL.AGR.EMPL.ZS")
34 wdi <- wb(indicator = my_wb_indicators, startdate=1975, enddate=2017, return_wide=TRUE)
35 wdi$date <- as.integer(wdi$date)
36 wdi <- as_tibble(wdi)
37 write_rds(wdi, "wdi.rds")
38 write_csv(wdi, "wdi.csv")
39
40 y <- NULL
41 y <- aggregate(wdi[,5], list(wdi$iso3c, wdi$country), mean, na.rm = TRUE)
42 y <- subset(y, !complete.cases(y$NV.AGR.TOTL.ZS))
43

```

Figure 24 Extract of WDI Imputations.

Uncertainty was not only present on the origin of the tools used; their capacity to communicate machine learning as a field of uncertainty was also a common topic of conversation. For instance, Fernanda told me:

I think there's, inevitably, always that uncertainty attached to it because anything you can say is just. The data is not always great, the method is not always optimal, and that's sometimes the best you can do, but there's great uncertainty to that as well, and we accept that as well, I guess (Fernanda 2018).

While those at ViEWS acknowledge the limitation within their tools, they also feel that policymakers and the public tend to request a degree of certainty the devices cannot provide. Just as in the case of understanding the relationship between climate change and conflict, this is another issue where researchers aim to keep a balance between preserving their authority and being open with their limitations. For instance, during an informal conversation with Pilar, she told me that while aware that CV's predictions would be full of uncertainty, they avoid expressing this in the documents that policymakers read like the executive summaries. The statistical explanations of the degrees of uncertainty are reserved for the technical appendixes, rarely read by policymakers. The rationale behind this is not a lack of transparency but a risk of misinterpretation of non-technical language like "we do not have full certainty of X happening" perceived as indecisive. For instance, Melquiades explained how, while he would like to be transparent about the uncertainty of statistics, this might not be what users want to read:

Because to me it is sort of statistics, it is all about uncertainty, is basically what it is, so we know that... After teaching some statistics, I found a great source from a professor, and he said, "Statistics is the mathematics of uncertainty" so should sort of, when you go in, this is what you should know: everything that comes out here has some air around, and that's very difficult to communicate. I think because people want clear answers and things are formally less clear answers (Melquiades 2019).

It is clear that internally those producing ViEWS understand their results as highly uncertain. However, they acknowledge frustration when communicating this uncertainty to avoid being seen as not providing a robust policy tool. While the ViEWS' manual describes uncertainty only in statistical terms, the team is aware that they can only communicate how uncertain the results are in a limited way. This existing uncertainty should be understood at two levels: first, the general acknowledgement of statistics as a methodology that provides uncertain results. This position was shared among all members who were very clear to me about the limits of ViEWS and CV's forecasts. The second degree of uncertainty was not shared in the same way. In this case, it is referred to the auxiliary devices that are required, particularly Amelia. As a technical decision, for a few, the use of a package that fills missing data was dangerous given the lack of knowledge about its origins.

In sum, while the Stockholm Hub aims to boost the Swedish project of providing tools that global leaders use for decision making, it is possible to observe in ViEWS a degree of uncomfortableness about the potential influence they could have. This discomfort is based on two interrelated concerns: first, a lack of internal discussion around the ethics of using tools without the proper communication of statistical uncertainty. There are concerns that presenting forecasts as a statistical probability (i.e. there are 70% chances of a conflict to continue) could be read by policymakers as vague. At the cost of internal discomfort towards the use of their own tool, ViEWS seems to value more the development of their authority rather than expressing words that, for non-experts, could be misinterpreted. Therefore, the presentation of statistical uncertainty has been left to what policymakers will rarely read: technical appendixes. The second concern is that without the proper communication of uncertainty, policymakers could trust too much on the ViEWS' forecasts.

5.4 Replication and dependency

Like most languages, while there are rules in the way we can use them, there are also gradients of freedom to express our individuality. ViEWS codes are written in two of the most popular programming languages: R and Python. Regardless of the language, programmers perceive standardisation as going against the nature of coding (Plantin 2021; Thayyil 2018); just as Herbert told me:

No, it can't be. It is as if you ask a poet or a writer to standardise their writing; it will never happen. It's the same as programming (Herbert 2019).

Individuality seems to be acknowledged as so essential that it should not be restricted. In this and the following section I will discuss how the ethical considerations around the use and production of QDs should not be limited to the possible effects their measurements could cause, but it should be expanded towards the possibility that those affected by the devices have to challenge them. Some of the elements that conform the ensemble that make QDs possible include: data producers, institutions, imaginaries and programmers who tend to belong to scientific or academic social worlds (Star and Griesemer 1989). While interactions among these constitutive

elements are constant, the possibilities for external actors to challenge the proposed futures remains limited. An example discussed with my colleagues at ViEWS was how forecasts could prevent international investment in regions seen as prone to conflict while local actors could do very little to scrutinise the calculations. I refer not to local farmers who can be deemed as a lay public, but mostly to programmers outside of Uppsala.

This section will use my initial limitations of the understanding of programming to prompt the discussion around how achievable is ViEWS' objective of being replicable. As a fundamental element of programming, the recognition of individuality clashes with ensuring that individuals outside of ViEWS can fully understand how the forecasts were produced. I discuss what implies that those affected by QDs have, at best, a limited understanding of how these devices are produced? Hence, I divide the discussion into two aspects. First, the possibilities that fellow programmers, particularly those located in communities in the Global South (such as the ones being analysed by ViEWS), have to reproduce QDs given the existence of technical limitations. Second, the requirement for highly technical devices such as ViEWS to provide lay explanations to citizens being affected by these forecasts without the need to become expert programmers.

5.4.1 Coding hygiene

Data hygiene refers to standardisation that could ensure an understanding and replication of a programming project. This also includes documenting as much as possible the rationale behind every decision. The objective is to ensure that the continuation of a project does not depend on particular individuals but on following the right steps. However, during an interview, Brown acknowledged that this was not the case of ViEWS [and brought the vehicle accident against Frederick too]:

We have zero coding hygiene. It would be impossible to enforce that on a wide enough basis for it to be useful. It would be useful if we had some programming hygiene in ViEWS. So that for instance, if Frederick with his job, got hit by a car, the entire project wouldn't crash and burn (Brown 2019).

For Brown, a lack of standardisation could jeopardise the entire project. For him, existing tacit knowledge is not even shared among the team. Mauricio highlighted the difficulties of sharing tacit knowledge and the consequences of not doing it:

You want it to be replicable, and not just replicable as: "oh, run the same code and get the same results." Of course, that's how computers work, you give them a number, and it's all known. First, we have to resolve that problem of making it reproducible on someone else's computer and that they can run the same thing. But also, being open in our process, and in each change, we say why we made that change. But it's really difficult because the system is so complex and there's so much going on that it would take an external person, ages to go through it and see all the decisions we've made and the changes we've made and what effect they had. It's a really difficult problem, I think, and it's super interesting of how making it reproducible and making it obvious to people, why we do the things we do? I think it's a goal in itself. I'd rather have a system that was open and transparent than one that makes the absolute best predictions. I want everyone to be able to look at the code and be like "oh! It's obvious what happens here"; a clear understanding, but right now, we don't have that (Mauricio 2018).

Mauricio mentions a crucial point for this chapter: the notion of replicability implies that processes should be possible to be done by someone else intuitively. In this sense, for him, it would be better to have a limited tool that everyone can understand than extremely accurate results where accountability is not possible. However, this objective seems to be something unachievable, and the lack of full replicability can be seen to ensure dependency on the tool and its producers. In this sense, the Swedish imaginary of strengthening its influence through QDs would be reinforced.

In sum, even if standardisation is recognised as a limitation towards programming freedom, it is also acknowledged that it could ensure ViEWS' longevity. Standardisation could also imply a problem for those being affected by the forecasts. For instance, if ViEWS succeeds in becoming influential among international organisations (i.e. the World Bank or the European Commission), local communities affected by policies guided by the forecasts will have no chances to replicate the tool as a way of corroboration. Therefore, replication becomes relevant in opposition to mere reproduction. Unlike experiments in the natural sciences, obtaining the same results might not be enough. The main reason is that given the stepwise way models

operate, if we copy and paste a set of algorithms into a different computer, it is clear that we will get the same results. However, crucially, we will not know how these algorithms worked or why their producers decided to do things that way (see figure 25).

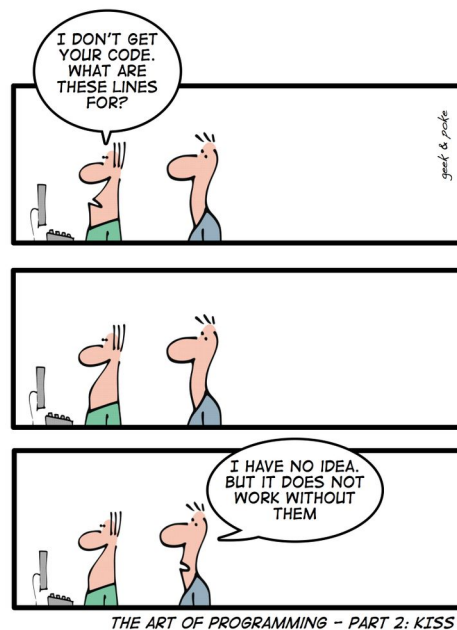


Figure 25 The Art of Programming – Part 2: Kiss (Geek and Poke 2009)

5.4.2 The elephant in the room

As part of the agreement to stay at ViEWS, I committed myself to deliver a seminar by the end of my fieldwork to provide preliminary insights into my participant observation. Given the lack of time to thoroughly analyse my data before this presentation, I focused on the team's most discussed topic: ethics. Ethics was sort of the *elephant in the room* in the sense of being a topic most of the individuals at ViEWS considered important but unspoken. In particular, those worried about some of the possible consequences of ViEWS: its influence in launching peacekeeping operations; and the lack of opportunities external individuals to ViEWS had to replicate the tool outside of Uppsala.

To deliver a decent presentation, given the lack of time I had to analyse my data thoroughly, I focused on the informal conversations that I had had rather than on my interviews. During these conversations, there were two common perceptions: first, the heterogeneous understanding of what ViEWS is. Second, what a lot of people thought they were unique about: being the only ones reflecting about the ethical consequences of ViEWS.

While everybody was aware of the importance of talking about the ethics of forecasting, there was a shared understanding that it was not openly discussed. It seemed as if this conversation was not needed because it had already happened while planning ViEWS; or at least that was Brown's opinion:

I've always worked under the assumption that these discussions have been had before presenting the project proposal and maybe within the application process. But is not something I'm sure of; but I assume that this is something that has been thought about (Brown 2018)

This presentation was one of the most challenging processes during my fieldwork; it forced me to talk about a group of people to themselves. As with the rest of the seminars organised by ViEWS, it happened at lunchtime in a brown bag style. Attendants were almost all the ViEWS members, plus some people from the department. While challenging, it served as a mechanism to clarify if some of the interpretations about their everyday life were shared. Given the awkwardness of analysing the performances of people to themselves, I tried to fill the space of uncomfortableness with nice images in my slides. However, these were not just any type of images, they acted as a way to demonstrate that I had paid attention to the tiniest details when talking to them. Hence, I used plenty of *Tin Tin* images since I had been told that all of the supercomputers at Uppsala were named after characters of the series. Figure 26 is a screenshot of the last slide of my presentation which includes a cartoon of *Red Rackham*, a *Tin Tin*'s character and the name of one of Uppsala's supercomputers.

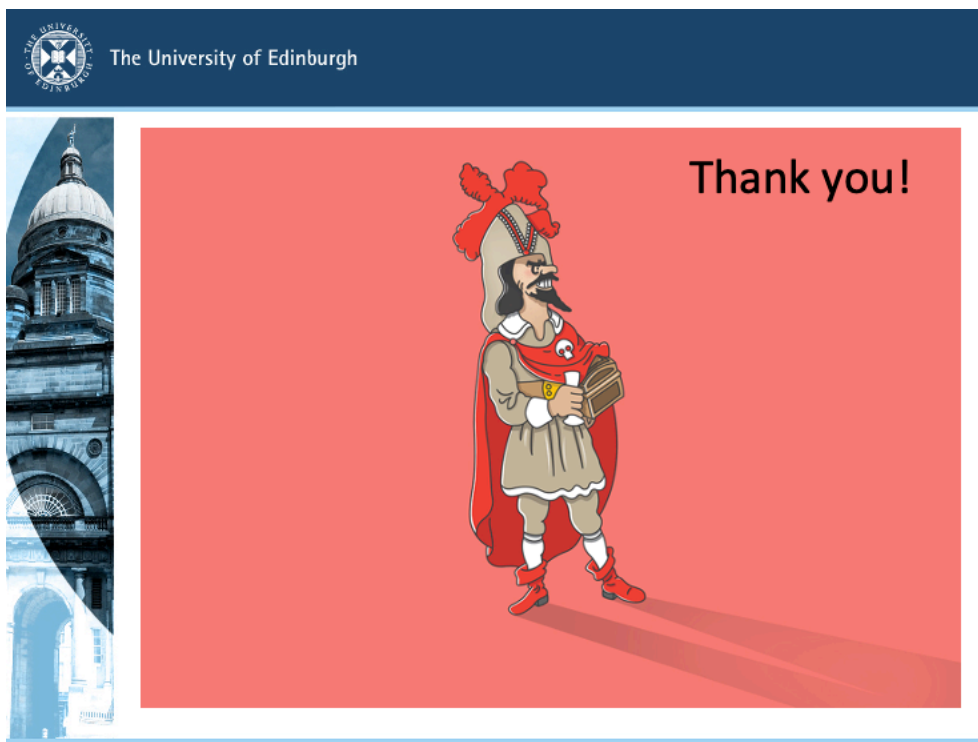


Figure 26 Slide showing Red Rackham

The Tin Tin strategy worked, although not in the same way with everyone. The people that work closer to the physical aspects of the infrastructure, like building the servers or buying the equipment, understood the link between the cartoons and my presentation. At the same time, those who focused exclusively on programming were completely unaware of the origin of these names. The nickname of each supercomputer is established by the management team at the Uppsala Multidisciplinary Centre for Advanced Computational Science (UPPMAX). After my presentation, a senior researcher told me that even though he was unaware of the origins of the supercomputers, it did not come as a surprise given the *geek* profile of those at UPPMAX. This shows the existence of different cultures within the elements that allow the production of QDs. It also highlights the relationship that humans develop with their supercomputers. For instance, it was common to hear people saying, "I will ask Rackham to do this" or "Rackham can be moody." Actually, I must recognise that it took me over a month to realise that Rackham was a supercomputer and not a person at UPPMAX to whom they were sending the material.

To exemplify the heterogeneous perceptions of ViEWS, I focused on the characteristics, limitations and concerns people have of the device. Amaranta and Brown believed that the device was "too quantitative." They both agreed that while

machine learning was a powerful approach to deal with a large amount of data, it could forget the use of theoretical approaches. Some argued that the processes of how to obtain forecasts are not important; however, for others, results should be presented in larger narratives that allow a humanisation of numbers.

By the end of the seminar, a senior researcher commented that my perceptions towards ViEWS were incomplete. For this person, I had only been able to observe the production but not the effects or even survival of the device. Therefore, my appreciation of ViEWS as lacking internal discussions about the consequences of the device was limited since there had been no influence on policymakers yet. My reply was that while the comment was right on my time span limitation, my claims were based on the internal perceptions towards the device and not on whether ViEWS itself had ethical issues. Hence, I did not need to be 'present' at the time that ViEWS had become influential if that was the case.

The day after my presentation was just as uncomfortable as the seminar itself. I had sensed some tension towards me from the moment I arrived at the department (perhaps with a degree of paranoia). A non-ViEWS researcher, who had attended the seminar, even told me, "Oh! You must be brave, you even came back after yesterday's presentation." This comment increased my fears but also confirmed my desire to approach all team members to ask if they would like to clarify anything that I had said about them as a team. In principle, junior researchers agreed with my interpretations about their everyday life. Some even thanked me for, hopefully, triggering this very much needed conversation. This appreciation highlighted the difference in opinion towards the project between senior and junior researchers. While junior researchers were "thankful", senior researchers showed less enthusiasm. During my post-seminar conversations, a senior researcher told me that while their perception was that ethics were discussed enough, they would organise a panel on the ethics of forecasting to increase the conversation.

5.4.3 Infrastructure inequalities

As my understanding of R language increased, I was able to fulfil the tasks I had been requested to do. Still, the main one was to fill the missing values of the dataset. A

solution would have been to use the dataset, respecting the fact that some countries had not reported data for multiple reasons. However, for the senior researchers, the number of missing values was too high, and therefore I was requested to fill them. It is essential to highlight that not all countries were considered relevant. The pertinence of a country was linked to how interesting for conflict studies it was.

Figure 27 shows the countries that were used to fill data about North Korea, South Sudan and Taiwan. At the same time, other countries like Iceland were regarded as "irrelevant"; therefore, I should avoid spending too much time with them. In these cases, the cells were filled with data from countries that are considered similar. This can be very problematic since North Korea, which has a communist government, was assumed as similar enough to South Korea, which runs a capitalist market system. This was a discussion that I raised; the conclusion to which we arrived was that indeed both countries had followed entirely different economic models, but we had few options to find data for North Korea. Figure 27 shows how countries are used as proxies to fill data about others.

```

75 ##### Three countries presented 100% missing values in the NV.AGR.TOTL.ZS variable, because of this, model countries where selected based on
76 #economic and political similitudes. In the case of Taiwan and North Korea, the first five years where used (1975 - 1990)
77 #while in the case of South Sudan, two years were used. The number of years will allow to conduct linear extrapolations and linear interpolations.
78
79
80 #The People's Republic of Korea (North Korea) will use the data from the Republic of Korea (South Korea)
81 wdi[5791:5795, 9] <- wdi[5833:5837, 9]
82
83 #South Sudan will use data from the Sierra Leone
84
85 wdi[4800:4801, 9] <- wdi[3281:3282, 9]
86
87 #Taiwan will use data from the Republic of Korea (South Korea)
88
89 wdi[5749:5753, 9] <- wdi[5833:5837, 9]
90
91 write.csv(wdi, "wdi.csv")
92
93 ## WDI will be employed later
94
95 wdi.log <- wdi
96 write.csv(wdi.log, "wdilog.csv")
97
98 ##WDI was taken out from R and used in STATA to conduct an interpolation and extrapolaiton to fill-in missingnes.
99 ## WDI has been returned, this version contains a process of interpolations and extrapolations over NVAGRTLZS made in STATA.
100 wdi_Stata <- read_dta("Draughts Stata.dta")
101 wdi <- wdi_Stata
102 wdi$V1 <- NULL
103 wdi <- as.tibble(wdi)

```

Figure 27 Screenshot ViEWS' proxies

Technology in itself does not eliminate inequalities. During my participant observation, I experienced, though on a much insignificant scale, what millions of people go through every day in the world: access to the right technology to be self-sufficient. The multiple imputations we discussed earlier, when Amelia seemed unfit for our purposes, require computers to process thousands of operations. For this, a computer with a specific power is needed. While trying to perform these operations

that can take more than 12 hours, my laptop crashed on multiple occasions. It was evident that I did not have the power to conduct these processes. There were days in which my computer was unable to perform even the minor calculation. It was evident that I was at a disadvantage with the rest of the team and that I could not accomplish what I had to. I was told that since I was not a student in the department, I could not get a computer from them. Unfortunately, after struggling for a couple of weeks, my laptop stopped working altogether. After a technical examination, it was diagnosed with irreversible damage due to corrosion probably caused by humidity. Luckily, I was supported by my home university through an insurance and was able to get a new version of my old computer able to perform most of the multiple imputations. However, it is essential to acknowledge that we live in a world where most people cannot afford such computers. This small, and perhaps oversimplistic, experience illustrates how technology is not enough; it is essential to access the *right* one.

Even if ViEWS made all of its coding open source, the inequality in terms of technological access makes replicability an unachievable goal. The dataset I was working on was a 3GB file with around 18,000 different values (cells with data). While I could open the file before my previous laptop crashed, it was clear that it was not powerful enough to conduct the thousands of required calculations for the multiple imputations. ViEWS' dataset is a 200GB file with over a million values. For Catalan, while it would be possible to open ViEWS' file on a personal computer, the amount of power required to conduct all processes could be a limitation:

So you have to sort of outsource that process, and it is faster. You wouldn't be able to recreate the same power locally, and definitely not your MacBook [we both laugh]. You are definitely able to run ViEWS on your local machine, that's fine, I did that during my internship multiple times. But other more intensive procedures such as the imputation things, and especially the computational spatial parts, would take a lot of time doing everything on your local thing. I mean, it is possible to run it locally, I've done that, even though you leave it open during the weekend. [...] So it is possible, but if you send it to a supercomputer, it's done way faster, that's all it is (Catalan 2018).

The limitations of conducting all the processes on a personal computer are clear. Figure 28 shows that the imputations processes are just one of the multiple

calculations needed to build ViEWS. On some occasions, these procedures will be conducted simultaneously, requiring the so-called "supercomputers." The lack of possibilities of those being measured to challenge these measurements should be a significant concern.

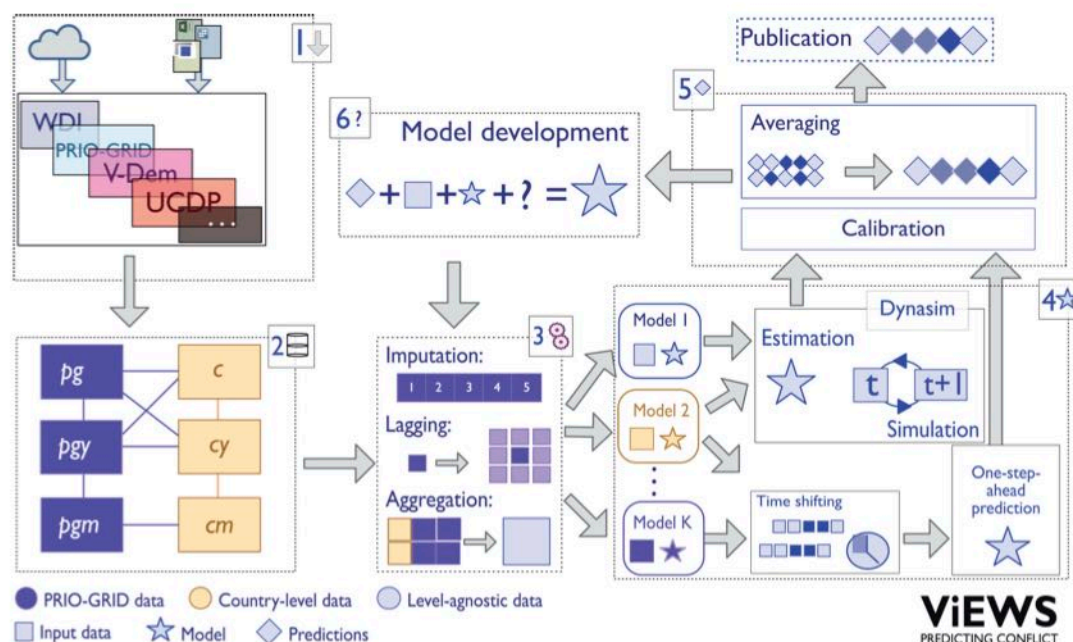


Figure 28 ViEWS Pipeline³⁹

The possibility to replicate tools like ViEWS seem to be limited not only in terms of tacit knowledge but also in terms of infrastructure. The prefix "super" refers to those computers whose processing power is a lot greater than the average commercial computer. And not everyone has access to these supercomputers:

The supercomputer capacity that we are using every month is more than, essentially, most African countries possess. Most African countries don't possess any access to a supercomputer technique. I know of five European countries, at the country level, that would not be able to replicate ViEWS because they don't have the infrastructure, and this we are talking of the whole country. That in itself is a problem. You need to run a project like this in a country

³⁹ "Steps: (1) collect data from various sources; (2) transform data to the six main ViEWS levels, store in database; (3) create individual datasets for each model, manipulate data as needed; (4) estimate models, create forecasts for each of them via one-step-ahead or DynaSim; (5) calibrate and compute ensemble forecasts; (6) publish results and/or evaluate and improve ensemble." (Hegre et al. 2019:158).

*like this [Sweden] because otherwise, there is no money to do it
(Herbert 2019).*

It is clear that QDs such as ViEWS require an infrastructure most countries do not have. In contrast, Uppsala University has four supercomputers, all of them part of UPPMAX. While not part of the Top500 ranking of supercomputers, Rackham is powerful enough to process ViEWS. The awareness that replicability is not possible in real terms was shared among ViEWS. However, their position towards what else they could do was diverse. This underlines the idea of Sweden creating policy tools but not the tools to allow the production of the devices elsewhere. This brings us back to the discussion at the beginning of the chapter around the need to fulfil the promise of technological transfers rather than creating a new way of dependency. While Mauricio claimed that the team should record their work in more detail, for others like Jose Arcadio, an existing inequality was beyond them:

As you said, this is a problem in all sciences or in all sciences that require laboratories. At least we have, in principle, made our entire laboratory available online. You can actually run it on your own supercomputer if you know how to do it if you have one. But there are supercomputers in many places globally, and you can also rent one from commercial actors. But the most important thing about replicability is not that everybody can do it, but that someone independently from you can do it; someone who is, has no interest in agreeing to what you are doing (Jose Arcadio 2018).

Jose Arcadio's claims contrast to those of Mauricio, who argued for replicability to be more than reproducibility. Jose Arcadio, partially ignoring an existing technological gap, sees running the model as enough. These contrasting approaches within the same team indicate that we may need to talk about different types of replicability based on their objectives. On the one hand, Jose Arcadio seeks to build a tool replicable by his epistemic community. His goal clearly is to demonstrate the scientific authority of the device. On the other hand, Mauricio takes Visvanathan's (2005) side regarding the ethical duties and responsibilities that technoscientific projects should have: those projects affecting communities should be explained and delivered in plain and simple "lay" language.

The lack of replicability decreases the probability of a tool being fully accountable. If ViEWS aims to influence policymakers which could end up affecting communities, the spectrum of accountability should increase. Still, for Jose Arcadio, replicability is not intended for the measured communities but for scientific communities. Once again, it is possible to observe how QDs' producers use the discourse of being ruled by a methodological approach or aiming to influence policymaking to avoid scrutiny.

5.4.4 This is not a black box

Think of it as weather; we have a model of weather. To me, modelling as a scientist is simplifying reality to a still working mechanism that eliminates all the noise and simplifies it to something practical, running it, and then adding the uncertainty; we don't have that for conflict! (Herbert 2018).

As we have discussed, the team acknowledges that ViEWS can be reproduced without understanding all underlying decisions. Still, for them, this is not a black-boxed technology (Latour 1987; Shindell 2020) simplified through quantification, given that if requested, they can explain how all algorithms delivered a forecast. However, they also acknowledge that even if explained, there is a limit on how much others could replicate and even understand. As I point out earlier, the number of operations neural networks process simultaneously escape human imagination. The complexity involved in creating ML models creates almost no incentives for researchers to disassemble them once they are finished. We can imagine a ship inside a bottle; the detail and care needed for their construction might not invite us to modify it once it has been finished. However, we will understand and know all the pieces that make the ship possible. Brown suggested this metaphor:

I think it might be like a ship in a bottle. They're very complicated to make, and when they're done, they are very difficult to take apart. You can observe it from the outside, you can possibly tinker within it, but it's very messy; you would have to take the cork and, with some tweezers, manage to get the mass out and then pull out the ship in order to change anything. It is not impossible to go inside it, but it is very complicated (Brown 2019).

The ship in a bottle metaphor signals that the way algorithms act is explainable. However, it is not possible to comprehend every single operation; some will have to be ignored. This makes us question the degree of accountability we could expect from ML. While their producers can tell us how algorithms will cluster the data they use, they cannot let us know in which way their algorithms operate. A policymaker would not be able to access the details of a tool fully. In this sense, Herbert compares our brain to a computer:

We aren't yet using any representational kind of algorithms that are entirely uninterpretable. But even those, you can know how they work; you can break the neural net apart and see the activation functions of neurons. The only thing is, the computer might not interpret the representation that has learned in the same way, so you might transform an image in various ways that you had never thought as possible or meaningful, but for the computer is. (Herbert 2019).

For him, the fact that we cannot understand how an algorithm operates at a granular level is not a lack of transparency of the tool but a limitation of the human brain. This claim keeps us within the discussion of what drives this tool. While ViEWS seems to be governed by theoretical understandings, Herbert hints on how the algorithms could improve what humans suggest if the methodology could play a more critical role. We can see how, while the push is to become a policy tool, there is a constant interest to prove the power of their methodology as part of an academic project. A debate not only in ViEWS but also within DPCR was about the role that machine learning should play in forecasting conflicts. On the one hand, part of the department claimed that forecasts should be governed by theoretical understandings. For this sector, data should be clustered around what theories deem as the causes for conflict to arise. On the other hand, for some, current theories are only able to explain why conflicts continue but not why they appear. For this other group, machine learning could model millions of possibilities without being limited by what had been theorised so far. Instead, these models are obtained by matching data without the pre-existing constraints that literature represents. Until now, ViEWS is still governed by a theoretical approach. Still, debates like these keep showing us the internal discussions that exist while creating QDs.

In the case of machine learning algorithms, the boat's metaphor seems to fit better than the black box one. While the input and output elements remain the internal aspect changes. The unknown is not merely inside; the inside can be observed, touched, and even disassembled. However, while manipulable, the incentives to do it are minimal. Unlike a black box, there is no need to travel to the past before its closure (Shindell 2020:569). The bottle can be opened at any moment, although the tool might not be the same once inside. Even more, what is inside are not "details" (MacKenzie 2005:558), without which the tool could stop operating. Every time the tool is opened, a new version will be created. However, it is always possible to understand the processes that allow an output.

This section has shown how the pillar of replicability seems to be part of an aspiration or a public relations discourse. While ViEWS is shared as a tool allowing everyone to replicate it, the replication of QDs might be limited to simply being copied in practice. Rather than allowing every interested actor to fully understand the decisions and intricacies that make the tool, in the best-case scenario, users would be able to copy + paste a set of indications. This creates an issue of disparity between those who can forecast, and the communities being used as case studies. The later ones are unlikely to hold accountable a tool that could impact them directly. However, for some at ViEWS, there seems to be no interest in that.

5.5 Conclusion

This chapter started by referring to how infrequently meetings at the UNSC focus on climate change as a global security matter. In more than 70 years of existence, only on five⁴⁰ occasions the issue has been discussed. Except for the Dominican Republic in 2019, all four previous discussions were brought by European nations: the UK in

⁴⁰ These five occasions refer to those where the presidency-in-turn of the council has organised a debate focused on the topic. Might be worth noticing that the presidency election of the UNSC lasts for one month and it follows an alphabetical order among its members.

2007, Germany and Portugal in 2011⁴¹, Sweden in 2018. However, on all five occasions, the link between climate vulnerabilities and forced displacement was central. For instance, during the 2011 debate, the then-UN High Commissioner for Refugees António Guterres used the example of Somalia to exemplify the tragic example of a country where all the possible worst-case scenarios met. For Guterres, Somalians have faced: "persecution, violence, authoritarian rule, failures of governance, economic collapse and natural disasters" (S/PV.6668 2011). These elements, which are the indicators ViEWS uses to produce the monthly forecasts, also represent a division in the way the future is understood. For instance, the then Portuguese Minister of State and Foreign Affairs, Paulo Portas, did not only remind us of the almost inevitable forced displacement populations from small islands would face but also launched a question: "what shall we do with these uprooted populations?" (S/PV.6668 2011). During the 2007 debate, the Belgian representative mentioned the acceleration of international migration flows as one of the main issues (UNSC 2007) for Europe.

The discussions have been centred on the link between climate vulnerabilities and forced displacements. For instance, migration flows are almost unanimously recognised as being primarily internal; however, it is also understood that a lot of the displacements will be transboundary. In this sense, while some countries argue that one of the main problems is dealing with incoming flows, others are losing their land.

The Stockholm Hub was launched aiming to support nations to forecast possible scenarios related to climate change. However, ViEWS' production depends on sociotechnical systems that often highlight power relations and infrastructure inequalities among countries. For instance, ViEWS relies on highly educated individuals and supercomputers, which many countries are deprived of. The lack of these sociotechnical elements rather than supporting communities to evaluate their risks independently creates a relationship of dependency towards Swedish QDs.

⁴¹ Interestingly, UN accounts do not consider the Portuguese occasion (see: Turley Toufanian 2020; Montilla 2019). This could be because, unlike the other four cases, the discussion was focused on three issues "three of the defining challenges of our times: transnational organized crime, pandemics and climate change." This signals that rather than observing the three issues in a holistic way, they were treated as silos. I do include the Portuguese presidency since the UN itself has since then discussed the interrelation between loss of biodiversity and pandemics for instance.

These limitations were acknowledged by most of the people working at ViEWS. More than just technical restrictions, there needs to be an increase in the participation of those whose lives might be affected. However, in the case of ViEWS, *a priori*, it is being recognised that any degree of involvement might not be possible since their processes and technology cannot be transferred. Rather than allowing other countries to evaluate their own futures, assistance through QDs implies only the operationalisation of algorithms that have been locked inside bottles.

This chapter has shown how the lack of research on the micropolitics of QDs could lead us to ignore ethical concerns being expressed even by the people making these devices. As it was argued, existing shared concerns about the loss of scientific authority has made some of the most critical voices in the team express with nuance the limitations of the forecasts they produce.

This participant observation has shown contrasting perceptions towards the use of forecasting in the realm of environment and conflict. Sweden's geopolitical interest to use environmental QDs as a soft power mechanism clashed with some concerns raised by those making the devices. The division is not only between a national imaginary and individuals but mostly among those making ViEWS. Three ongoing debates were analysed: first, the perception by junior researchers to urgently discuss the potential ethical consequences of the forecasts. Second, a dispute on the role that theory and methodology should play in producing the forecasts. And third, the degree – and consequences, to which machine learning devices are replicable. Without the means to achieve a *conscious replication*, I argued that machine learning projects will reinforce existing dependencies rather than allow communities to take conscious decisions. In Foucauldian (1982:220) terms, forecasting is used to exercise power by modifying the actions of the *free* communities to which possible futures are imposed. I refer to it as *imposed* to highlight that without a conscious replication, forecasts are not fully disclosed to communities.

6 Limited metrics

This thesis started with a reference to *The Lorax*. With it, I wanted to bring the reader into the way Dr Seuss warns us about the multiple consequences of environmental degradation and how different elements of an ecosystem experience it. The exhaustion of resources could at least trigger multi-species forced displacements, prevent economic growth and increase conflict among communities (Homer-Dixon 1994). *The Lorax* ends up reminding us that "unless someone like you cares a whole awful lot, nothing is going to get better" (Geisel 1971). This final quote highlights the importance of caring for something as the only way to change things for the better. Caring is what the researchers working at research centres like YCELP and DPCR claim to do. For those working on the EPI, caring implies promoting a healthy economy in balance with a healthy environment by evaluating the policies national governments implement. For ViEWS, it is crucial to forecast the possibility of armed conflicts linked to climate change to prevent them from happening. Together with these two research centres, dozens of other organisations work to improve the living conditions on this planet. However, the notion of *caring* requires us to consider existing power relations among the all parties interested in achieving their desired world (Fisher and Tronto 1990:40).

As I have argued throughout this dissertation, the environment is a space of hope and contestation, where power dynamics are exercised to drive particular imaginaries and expectations, including the best ways of *caring* for the environment. In the name of *caring*, these dynamics could facilitate the imposition of worldviews without a re-contextualization of what numbers tell or a lack of interest in understanding local needs. In this sense, while acknowledging the good intentions of those researchers aiming to influence policymakers, this thesis has provided a critical analysis of the construction of QDs. This examination fulfilled the proposed objectives during the first chapter that, to refresh the reader, sought to analyse: the narratives of possible futures that may be developed through QDs; what knowledges are salient during the quantification of the environment; the role that sociotechnical systems and tacit knowledge play during the construction of QDs and their relation to the notion of replicability; and finally, to identify the role of mundane activities.

The case studies showed how QDs' producers in both institutions benefit from existing power relations which awards them access to sociotechnical resources that most countries do not have. In return, this has created categories of countries that measure and countries that are only measured, As described when introducing the EPI and ViEWS, as practice of transparency, the publication of both is supplemented with technical appendixes where methodologies are explained in detail. However, these documents, rather than transparent lenses through which we are invited to see how QDs are done, represent edited versions where the authors have decided what is “worth” including and what is “irrelevant” – not worth including. In Goffman’s (1973) terms, technical appendices are librettos of how researchers want to present themselves to the public. Both devices were presented by their authors as the embodiment of objectivity and truth, even though their construction is produced through social and technical processes rarely precise (Tichenor et al. 2020:2). For example, more often than not, the decision of including an indicator within an index corresponded to pragmatic decisions rather than technical ones. Also, producers often faced limitations that made them negotiate between their worldviews and what could be measured given the availability of data. These everyday decisions, frustrations and negotiations at a research centre constitute part of the politics of knowledge analysed through the empirical chapters.

While the participant observations for this research took place exclusively in the Global North, through an analysis of the public claims made by representatives from the Global South at the UN Security Council, it is possible to develop speculative reflections around the implications that devices such as the EPI and ViEWS could have concerning global development. The clearest possible consequence is how through naming and shaming strategies (Bevan and Fasolo 2013), implicit in both devices, communities without the sociotechnical means to consciously replicate QDs could be cornered to appropriate external interpretations of their realities as the only pathway to achieve a “better score”. Therefore, it is possible to argue that the influence those creating QDs seek to achieve may not be by proposing particular changes in policies but by limiting the possibilities to improve scores to particular policy agendas. In this sense, the quantification of the environment was proven to affect our

relationship with nature, by processes of assetisation (Levidow 2020) where the environment represents opportunities for the continuation of unequal relationships between societies.

The empirical chapters of this dissertation allowed me to provide findings that contribute to current debates within critical data studies, STS and environmental justice. While the sociotechnical elements around the construction and goals of ViEWS and the EPI defer from each other, the notion of Quantitative Devices allowed me to argue that the emphasis was not on whether these devices were ranking or forecasting but that there are crucial sociotechnical elements that both devices share. Hence, even if ViEWS is created and supported by socialist Sweden or a capitalist university such as Yale, the production of both devices follows similar assumptions, interests, limitations and advantages. For instance, the historical account of Sweden's environmental policy showed that it is based on the protection of a market economy just as the EPI. Even more, both allowed me to argue that QDs play an essential role in setting the *right* price for ecosystems by measuring environmental issues in financial and market terms. While the EPI seeks the protection of the environment without compromising economic growth, ViEWS seeks to prevent conflict to avoid its economic consequences.

The **first finding** developed from the analysis of both case studies was how regardless of the stage in their careers, researchers showed conflicts between their role in academia and policy. The **second finding** was the way in which the construction of QDs is influenced by the sociotechnical systems in which they operate. This was observed in the limitations of what can be measured either because of data availability or interests of potential users. A **third finding** was around the idea of replicability which was challenged in multiple occasions by those producing the devices. Researchers at ViEWS and the EPI challenged the possibility of anyone outside their centres to be capable of replicating the devices and understanding how they were produced. **Finally**, I found that QDs provide problematic representations of the realities they aim to present given the multiple temporalities of the datasets they use as sources.

As proposed at the beginning of this dissertation, if observed as *sociotechnical systems* (Edwards 2003) within the *sociotechnical infrastructure* of quantification and

datafication (Redden 2018; Micheli et al. 2020), QDs are required to be analysed through an infrastructural inversion (Bowker 1994). This inversion included an analysis of the historical development of the multiple imaginaries, the production of QDs and contestations from the Global South. This dissertation has shown existing epistemic injustices (Fricker 2007, 2012) towards the conditions in which communities can access their datafied realities. For instance, the Stockholm Hub was launched to allegedly support nations to forecast possible scenarios related to climate change. However, ViEWS' production depends on sociotechnical systems (Edwards 2010) that often highlight power relations and infrastructure inequalities among countries. ViEWS relies on highly educated individuals and supercomputers, of which many countries are deprived. The lack of these sociotechnical elements rather than supporting communities to evaluate their risks independently, creates a dependency relationship towards Swedish QDs. These limitations were acknowledged by most of the people working at ViEWS. More than just technical restrictions, there needs to be an increase in the participation of those whose lives might be affected. However, in the case of ViEWS, *a priori*, it is being recognised that any degree of involvement might not be possible since their processes and technology cannot be transferred. Rather than allowing other countries to evaluate their futures, assistance through QDs implies only the operationalisation of algorithms in limited ways.

This thesis has focused on how non-state organisations use quantitative devices to provide policy advice. As Dan Esty from the EPI signalled, they aim to move from guru-led policy into a data-driven world. Through public documents, QDs tend to be presented by their producers as technologies that can provide unbiased and detached advice through standardised procedures. In particular, it was possible to analyse how central claims in which the authority of QDs rests (such as standardisation and replicability) are, more often than not, unachievable. Even more, the role of QDs in perpetuating global power dynamics was also discussed.

This chapter is devoted to the multiple questions opened during this thesis. To achieve this, I have divided the chapter into four sections: first, I examine the struggles of researchers positioning themselves between policy and academia. The second section represents an evolution of my initial thinking at the beginning of my PhD. I tended to think that research centres could set standards on their own by co-producing

(Jasanoff 2004) knowledge through QDs. However, as I have demonstrated, are the sociotechnical infrastructures in which QDs operate the ones framing and setting the standards. The third section discusses the implications of the lack of replicability within QDs for the notion of epistemic justice. Finally, the fourth section re-examines in more depth the idea of *environments in-vitro*, seen as the creation of worlds through QDs.

6.1 The presentation of QDs in everyday life

A central interest of this dissertation was on the performativity of the individuals (Butler 2006) and teams (Goffman 1973) producing QDs. Participant observation made it possible to access and study the divergence between the presentation of QDs to their audiences and both teams' reflexive critiques about their tools. ViEWS and the EPI have publicly expressed their intentions to influence policymakers. However, internally this idea has been received with opposition and concern. On the one hand, voices called for incorporating peer review processes to signal scientific and academic rigour. On the other hand, some were concerned that QDs would increasingly depend on the power of algorithms rather than the theoretical understandings of what they quantify. Both concerns represent ongoing internal debates around the recognition of QDs as either policy or academic devices.

Publicly, QDs are employed to call for an increase in the use of data as a way to move away from what has been referred to as "gurus" (Esty and Emerson 2018). Quantitative data is promoted by these researchers as a form of knowledge detached from human emotions and ruled by algorithmic truths. However, this thesis has shown that only a minority of people within these teams defends algorithms as unbiased processes. Interestingly, those like Alfonso, who defended the natural neutrality of quantification argued that the aim to influence in policy and processes of quantification should remain separate aims:

The role of the data team is to do the best job that we can with available information and be as transparent as possible. Because I actually do believe that by doing that, we are giving the EPI the best chance to influence policy, and I believe that if we are seen as being objective and independent and we are not tied to any country, then our analysis will be more trustworthy and more likely to influence policy'; I believe that. They are related, and yet I'm not sitting around

saying "oh I need to figure out how the EPI can better influence policy, no that's not me at all; that's you guys! (Alfonso 2019)

The relevancy of Alfonso's claims rests in a clear divergence between the aim of using quantification for policy and the development of quantitative devices. For him, the process of quantification is one of proving that numbers are better advisors than humans. However, he recognises that his own goal is not to influence policymakers since that is someone's else job. In particular the team developing the narratives sustaining the EPI results.

Those supporting algorithms as technologies capable of providing advice fully detached from human emotions were people at the highest positions in both teams. This position towards algorithms as unbiased elements is rooted in the fact that QDs constitute the lifework of most of those individuals, in opposition to junior researchers who see ViEWS or the EPI as a starting point in their careers. Through both empirical chapters it was clear that when speaking among themselves, there were very few critiques or objections against the entire process of quantification. However, when interviewed, researchers outspoke their sentiments towards QDs. This discrepancy between a public voice and internal considerations is an exemplification of the performativity within a team, where people will perform behaviours that at the individual level do not believe (Goffman 1973). Still, these critiques were not always openly shared with me. Interviewees showed a fearful attitude towards criticising their own work inside their working spaces. This was clear when most of the critical participants requested their interviews outside their office space. This was not only an exemplification of the everyday performativity among QDs' teams. Expertise is also a performance among the team members. While most of the EPI team situated Daniel Esty as a politician, he assumed the role of expert (Esty and Emerson 2018) in statistical modelling on two occasions. First, when deciding which datasets should be included; and second, every two years when launching the EPI.

A shared perspective was that even if algorithms provided biased results, the bias (Bollier 2010) would be uniform since the same rules apply to all the data. Instead, most researchers working in both teams saw QDs as able to provide essential hypotheses required to be tested with empirical and theoretical evidence, rather than the devices being the evidence themselves.

Claiming that the production of QDs is based on unbiased scientific methods responds to the discourse of *listening to science* preferred by policymakers (Jasanoff 2012b). Researchers working on QDs are aware that policymakers and the general public often see uncertainty as a weakness (Scoones and Stirling 2020) rather than as intrinsic to statistics. Therefore, communicating the limits (Bollier 2010) of their devices too directly rather than providing a sense of transparency could backlash against them by showing them as incapable of offering assertive and firm results. For Mayernik (2017:3) research institutions conduct projects where data is shared but with minimal details on how people created that data representing a *soft* and *opaque* regime. These types of behaviours were constant both in ViEWS and the EPI, where data is available online, but discussions around the meta processes through which data is processed do not take place. There is a recognition that claims done through QDs are often limited and could be strengthened by other disciplines or even types of knowledge in the teams. However, this *humility* (Jasanoff 2007) towards their own devices is internal only given their perception that scientific authority is built through definitive claims. Mauricio, one of ViEWS' researchers, shared his desire to make the production of the device more open and transparent, while recognising the risks this could have for their reputation:

I think if we move the whole development into the open, so if we did it with a version control system that was public, and anyone could read our day-to-day workflow, then I think that could be really good. But there's a cost in doing that, you can embarrass yourself, you can make some code that was really bad and you committed when everyone can see it's like "oh my God, they did this stupid mistake!" And now I feel, oh! We should have done that in private before, I wish we had done that in private so that I didn't have to do a fool of myself. But I think we have to, and I think that's how most people think. You wouldn't write your thesis on like a public Google Word document where anyone can watch while you write your thesis, because you would start with something that it was wrong. But I think we should, I think everyone should try and do as much work in public as possible (Mauricio 2019).

For Mauricio, while there are risks in sharing the daily production of scientific knowledge, there is no conundrum between public accountability and self-protection. For him the risks behind demonstrating that science is done through trial and error is

more important than the public perception. So far, the only solution to this conundrum between accountability and the construction of authority has been to provide technical appendixes that work as explanatory documents to restricted audiences. This reliance for accountability on a single document that has been tailored to show a smooth production of the device, without showing all the sociotechnical limitations that had to be sorted for its operation, could provoke a false perception towards replicability.

As established during the methodological chapter, my participation during the construction of ViEWS and the EPI was not limited to 'just' observing, but it moved within the third wave of laboratory studies (Clark 2011:XIX; Gjefsen and Fisher 2014). In the case of the EPI, a critical engagement during its production allowed me to impact the presentation of the EPI. With a degree of humility, I dare to assume a some of influence on these changes since they reflect my formal and informal discussions with the teams' members, analysed in chapter four. Figures 29 & 30 show the differences between the 2018 and 2020 EPIs. When compared, we can observe a more nuanced approach towards replicability by moving from *fully replicating* as the only option to recognising that other assumptions are possible, which will create new results.

2018 Environmental Performance Index

Technical Appendix

This technical appendix is a companion document to the 2018 Environmental Performance Index (EPI) Report. It contains additional details about the methods used in the 2018 EPI. Along with the files available online, the purpose of this technical appendix is to provide all information necessary for **fully replicating** the analysis. Throughout this appendix *TLA* is used to refer to the three letter abbreviations of the input data sources and resulting indicators.

Figure 29 2018 EPI replicability information

2020 Environmental Performance Index

Technical Appendix

This technical appendix is a companion document to the 2020 Environmental Performance Index (EPI) Report. It contains additional details about the methods used in the 2020 EPI. Along with the files available online, the purpose of this technical appendix is to provide all information necessary for **fully replicating the analysis or re-running the analysis using different choices and assumptions.**

Figure 30 2020 EPI replicability information

As proposed during the research design, this dissertation sought to engage with the third wave of laboratory studies (Clark 2011:XIX; Gjefsen and Fisher 2014) by critically involving in the construction of knowledge. This was achieved through the analysis of the importance of *lag* in datasets. Figure 31 compares the approach towards "the latest data" between the 2018 and 2020 EPIs. As we can see, the 2020 edition included a more nuanced explanation of the limitations that using data from multiple sources and time (Walter and Wansleben 2020; Visvanathan 2005) can create. This was one of the topics that I often discussed with senior researchers, as analysed in the EPI chapter.

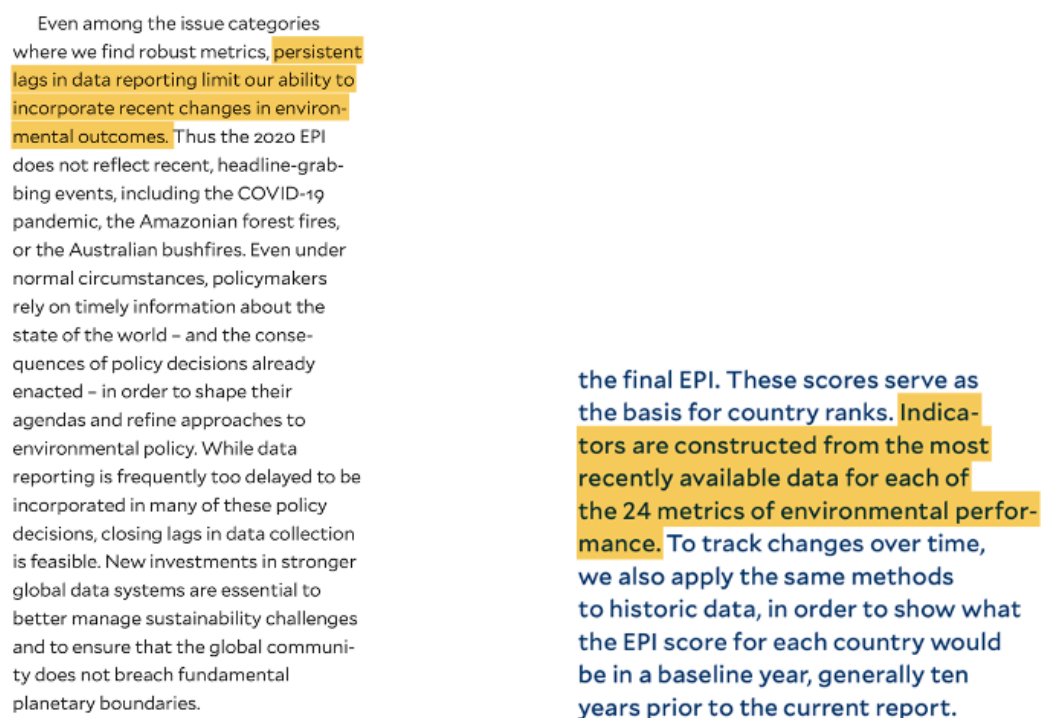


Figure 31 Approach towards data lag between 2020 EPI (left) and 2018 EPI (right)

These two examples display QDs' producers as being interested and open in sharing the limitations of their devices. It is essential to highlight that figure 31 was taken from the main reports and not from the technical appendixes, which shows a more significant concern in communicating the limitations of the devices beyond experts in statistics.

6.2 Setting or reinforcing standards?

Based on existing literature (Merry, Davis, and Kingsbury 2015), an initial hypothesis in this dissertation was that through QDs, research centres were setting standards and co-producing the issues they quantified. However, this approach has been challenged across this thesis: I have demonstrated how QDs are framed by existing theoretical understandings and standards within the sociotechnical infrastructures they operate. In this sense, QDs are co-produced (Jasanoff 2004) by larger narratives and theories when researchers commit to particular databases, theories and conceptual approaches. Therefore, these devices mobilise particular worldviews through discourses highlighting the importance of *following the data*, equated to science and facts.

Within research groups, the notion of data-driven decisions (instead of theory-oriented) caused divisions. Some people at ViEWS indicated their concern about the proposal of basing their forecasts purely on machine learning rather than on existing conflict theories. At the same time, programmers working at ViEWS claimed that at this stage of the project, the algorithms are incapable of providing actual forecasts given the lack of theoretical frames. Brown was one of these:

Think of it as weather, we have a model of weather. To me "modelling", as a scientist, is taking reality, simplifying reality to a still working mechanism, that eliminates all the noise, and simplifies it to something practical, running it, and then adding the uncertainty; we don't have that for conflict! We don't have a "this + this + this + this, under circumstances this and this, will lead to conflict". We have theories, we have many models that say: "[noises implying steps of a procedure] maybe increase the risk of [noises implying steps of a procedure] increase the risk of [noises implying steps of a procedure] decrease the risk of. But we don't have a grand unified theory, or even a set of models that will clearly state how this would properly work. We are still I think where weather forecasting was in the 1930s. We know that there is some signal, that we know, we hear the signal, but how to extract the signal from the noise properly, what the limitations of the signals are, and how to extrapolate the signal further; that's what we are trying to build, that's what we are trying to understand (Brown 2018).

Brown shows how even those who would be more likely to trust the power of algorithms admit that their predictions are bounded by what theories have stated. Given the acknowledgement by DPCR members of the theoretical limitations to predict

the emergence of new conflicts, they recognise that at this stage, ViEWS is limited to only forecasting the continuation of existing disputes. In this sense, the claim that QDs can set standards was disputed. Rather than establishing their standards, these devices are already framed by existing understandings of the world, selected by those producing them.

QDs are framed by existing theories and what others have defined as necessary enough to be quantified. Since most QDs projects do not collect the data themselves, they depend on third-party organisations that have already produced it. This data dependency not only frames what QDs can measure but also the way things are quantified. As it has been widely proved in criminal recidivism prediction, machine learning algorithms are not neutral technologies; their results are based on previous police behaviours (Joh 2017; Završnik 2019). Facebook has been accused by Global Witness (2021) of reinforcing sexist labour stereotypes through its algorithms. This includes showing jobs in mechanics to men and jobs in nurseries to women disproportionately. In this sense, the datasets used for QDs will carry their own biases, which could frame the decision-making of policymakers. Once again, the ViEWS team did not have a consensual position about the possible biases these tools could reinforce. While some argued that algorithms could reduce the preference of individuals for specific countries, during informal conversations others argued that the way data for conflict is collected tends to be biased by who collected it and labelled a particular group with either negative (e.g. "terrorists") or positive labels (e.g. "resistance"). Given that labelling is a normative process, how QDs use existing tags will carry the norms that others have already used.

The multiple systems within sociotechnical infrastructures (Edwards 2003) operate at different temporalities. That is why it was possible to observe how the periodicity in which QDs are updated requires the arrangement of these multiple systems. This dissertation has analysed how even when research centres secure essential aspects like funding and the right technical tools, the publications of new editions respond to two elements: the characteristics of their potential users and the provision of updated datasets. While the EPI could be produced every year, this would make no sense for its producers since data is not released that fast. Hence, changes from one year to the other are meaningless. In the case of ViEWS, while their primary

dataset – UCDP, is updated monthly, their target audience (security policymakers) has outlined the scope of the forecasts by requiring at least 36 months to make decisions. The discussion around a *data lag* and the consequences this could have for the predictions made was part of my interviews with researchers. For Brown, as long as the lag occurs in what he referred to as *slow moving factors*⁴² the need to communicate existing lag across datasets is not a critical issue:

Delay maybe, as long as the data is slow moving factors, I don't think that it would have any substantial impact on the forecasts. Which is one of the problems, right? In order to predict onset, we would need triggers, and triggers are short in time, so in order to get triggers we would need to be able to extract other type of data that is constantly updated. Maybe it happened into news sources and extract certain events globally or their impact. So on slow moving factors I don't think it would have a substantial impact on the predictions (Brown 2019).

This influence by institutional designs was also observed not only in how the EPI is assembled but even how it has transformed through time. Pietro, one of the EPI senior researchers was clear about it when talking how the former Environmental Sustainability Index (ESI) became the EPI:

I though ESI, was great, but it didn't capture the outcome measures and the performance measure that were the most relevant for decision making. If you look at the DPSIR⁴³ framework, if you're familiar with that, it had too many driving forces, it probably had too many responses, there were also a lot of pressure indicators, which we still include some. I finally went through the EPI, and I had it in my computer for one of my lectures. I always had this impression that we had mainly state measures, and maybe some impact measures. But the reality was that we had a lot of driving force measures in our, and still in the EPI, but in that.... I wouldn't say driving force but pressing measures, we still have a lot of pressure measure in the EPI like industry and things like that. But it's

⁴² Based on informal conversations, *slow moving factors* could refer to water streams where changes do not occur within months or even one year to another but across years.

⁴³ DPSIR, also known as the causal framework, describes the interactions between society and the environment. The acronym stands for Driving Forces (socioeconomic sectors fulfilling human needs), Pressures (human activities exerting pressure on the environment), States (intended or unintended changes in the ecosystem), Impacts (changes on the welfare of humans) and Responses (actions taken to compensate, ameliorate or adapt to changes in the environment) (European Environment Agency N/D; EPA N/D).

generally restricted to the pressure, state and impact area (Pietro 2019).

Pietro's account shows that transition from ESI to EPI focused on moving the state of the environment towards how human activities transform the environment. This highlights that the EPI will measuring existing frameworks. As discussed, the indicators through which the index is produced were selected based on what western environmental ministries consider their duties. Hence, the EPI will export a western worldview of environmental protection if countries in the Global South decide to improve their policies based on their metrics. Meaning that the researchers building these devices are not setting standards, but this is done by other elements within the sociotechnical infrastructure. In this sense, it is possible to argue that standard setting is a co-production process where multiple systems within a sociotechnical infrastructure intervene.

In sum, rather than thinking of researchers using QDs to set standards and theoretical understandings through quantification, it is clear that they are shaped by the infrastructures to which they are connected (Edwards 2003:186). This shaping is not unidirectional; those making QDs also influence the speed at which data is produced or how environmental ministries tackle particular issues. The trust that has been constructed in numbers (Porter 2020b; Stone 2020), allows the exportation of institutional designs and worldviews by providing a sense of detachment from their places of production.

6.3 Epistemic Justice and the Limits of Replicability

Part of the authority QDs aim to achieve rests on the possibility of replicability. The discourse of replicability does not assume that making these tools is simple, and anyone can use them but shows that their results stick to unbiased realities rather than human decisions. However, it is possible to confirm that replicability as a way to allow falsifiability (Popper 2002), is a limited aim. Instead, the construction of QDs should ensure what I refer to as *conscious understanding*. The notion of *conscious understanding*, grounded in reducing existing epistemic injustices, should be divided

into two branches. First, scientists from *datafied* (Cukier and Mayer-Schoenberger 2013; Dourish and Gómez Cruz 2018; Micheli et al. 2020) communities should be ensured access to the bare minimum elements of the sociotechnical infrastructure (i.e. education and technology) required for the replicability *in situ* of the devices. This was claimed as impossible right now by a ViEWS' researcher who mentioned that the technology needed to replicate the device, was not available in most African countries.

Second, to avoid the *hermeneutical injustices* (Fricker 2013:1319) where lay members of a community are denied the possibility to make sense of their *datafied* selves, there is a need to make clear, in non-technical language, the implications of the tools for them (Visvanathan 1997:33). Conscious understanding seemed complicated to achieve even for those making these devices. Brown, one of the researchers working in ViEWS even argued that forecasting is such a black-box they may not fully understand how the results are developed:

I think, in general terms absolutely, we don't need to know the exact details of how the forecast are created, like threshold values or beta coefficients or things like that. I think, that's probably less important to know specifically, but what we do need is some form of variable importance measures and some indication of directions and relationships and how exact those need to be. I mean, the most exact the better but it's also very difficult to develop because of the black-box, so I think we need tools to see a simplified of what happens inside the box, we need a filter to get some information about signals that variables get without having to look at the entire web of links (Brown 2018).

Brown's claims are staggering as it leaves us with little faith towards ensuring a *conscious understanding* towards how these devices are being produced. He seemed to downplay the importance of understanding every step that the algorithms go through by claiming that what matters is to understand the results, not the process. Without a conscious understanding of the rationale behind decisions and the technology needed, QDs may only reinforce dependency processes. Given that most QDs are developed in the Global North, those nations in the South could be limited to only copy and pasting instructions to replicate these tools without the possibility of fully understanding them. I want to be clear about what could determine the likelihood of reflexive replicability: it is not a matter of a superior understanding of science but a

combination of QDs being done through mundane non-transferable procedures and existing epistemic injustices experienced in a historical underrepresentation in scientific institutions (Grasswick 2017). This underrepresentation of individuals from wider communities in the production of QDs limits possible critical discourses by enhancing weak assumptions (Longino 2002) during their production. The clearest example of this was my experience with the EPI when deciding what counts as a country from a unilateral position and without actual knowledge of each place. Programming has shown to be dependent on standardised techniques as much as tacit knowledge (Plantin 2018). Still, it was possible to observe how while QDs are promoted as devices *anyone* could replicate, in practice, a lack of access to the technical devices makes this unachievable. In this sense, while similar results might be achieved, the possibility of arriving at the exact same results understanding the rationale behind every step has been acknowledged as impossible.

Figure 32 exemplifies how the reproduction of devices dependent on creative processes, such as QDs, will force us to take long leaps between how something is theoretically achieved and the need for implicit knowledge to jump from straight lines to an actual result. Ironically, seagulls and QDs seem to share the characteristic of having "Accidental Wisdom."

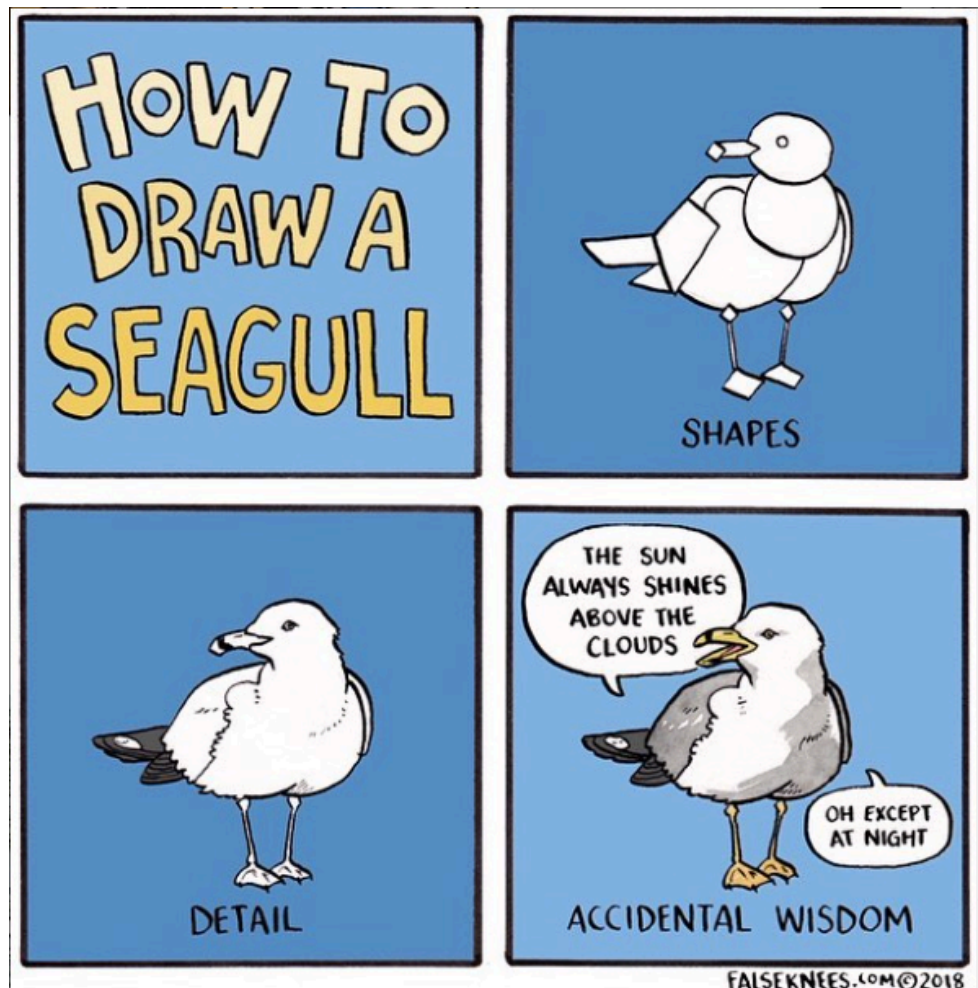


Figure 32 How to Draw a Seagull (Falseknees 2018).

Following an approach from the Sociology of Scientific Knowledge I demonstrated that the notion of objectivity is sought not only by one person but by a group. While peer review was mentioned as essential by both teams, is not where verification ends. The process that unfolds after new knowledge is published was more valuable. At that moment, new critiques seemed to arrive, which kept testing the objectivity of the proposed observations, making it a "community's practice of science.". While the "removal" of biases has been sought through a peer-verification of processes and results. The notion of replicability assumes that scientific knowledge is true regardless of its location; therefore, by following the same processes as the original experiment, any interested person should, in principle, arrive at the exact same results. This position is similar to Popper's (2002) notion of *falsifiability*, according to which, science demarcates from pseudo-science by asserting over refutations and tests against proposed statements. Hence, the power of science depends on the

capacity to 'survive' to processes of *testability*, including the replication of empirical claims (2002:72). However, this dissertation has proven that existing sociotechnical global gaps reinforce limitations to the idea of replicability.

The notion of *experimenter's regress* (Collins 1985) suggests that replication as a discourse of truth is, at least, limited. This paradox was presented when given the tacit knowledge required for experimentation, once an algorithm is replicated, there is no certainty whether the same degree of expertise has been applied. This can create a loop where the third process of replicability would be needed to prove the validity of the previous two and so on *ad infinitum*. I argued that machine learning algorithms should be understood as a *ship in a bottle*. Given the technical expertise and tacit knowledge required to produce algorithms, their programming codes will remain mostly untouched once they provide the expected results. The only modifications conducted are updates in small sections while the overall code stays intact. These ships tend to be seen as valid knowledge without opening them up; until a scientific controversy appears (Kuhn 2012).

6.4 Quantitative devices as sociotechnical systems

This thesis recognises the usefulness of quantitative devices as tools that provide a general outlook of multiple types of phenomena. In this sense, the discussions in the previous chapters do not aim to eliminate or discredit the use of QDs but to highlight that these devices are not developed in isolation of social processes. At this stage of the dissertation, it is crucial to bring back the earlier claims that QDs represent sociotechnical systems (Edwards 2010, 2003) embedded in infrastructures (Star and Ruhleder 1996). Given that the scope of this research was focused on QDs as systems embedded within infrastructures, rather than entire infrastructures, this discussion has been possible through a process of *system* and *infrastructural inversion* (Bowker 1994) using the characteristics signalled by Star and Ruhleder as a framework, and incorporating the sociotechnical elements (Felt and Öchsner 2018:1429) analysed through the empirical chapters.

Embeddedness: QDs are part of a more extensive infrastructure of processes of quantification

The notion of infrastructures embedded within structures allowed me to visualise sociotechnical systems within existing structures. In simple words, through my fieldwork, I discovered the existing narratives and imaginaries in which QDs are embedded. The EPI is a device that continues a neoliberal endeavour that seeks to design policies from a managerial approach (Kaplan et al. 1992) pursuing to allocate scarce resources, maximise investments and reduce the role of governments in regulatory frameworks. Data becomes crucial since it allows complex problems, such as the interrelation between environmental elements (i.e. air quality, deforestation), to be simplified as unrelated silos ready to be *managed* by environmental ministries; designed under scarcity constraints. While ViEWS has its origins in projects developed for the World Bank to evaluate the costs of war (Collier et al. 2003), my analysis focused on its embeddedness within a Swedish imaginary. I demonstrated how while ViEWS had been developed independently from other projects in the country, it can be positioned within a national civic epistemology (Jasanoff 2012a) of using QDs as geopolitical tools. It is important to add that at this stage is not possible to evaluate the success of these devices in framing global development policy.

A second element that confirms QDs as sociotechnical systems within sociotechnical infrastructures is how external aspects limit these devices' construction. This was observed in how QDs can only measure what other organisations have deemed important enough to be *datafied* (Dourish and Gómez Cruz 2018; Micheli et al. 2020; Redden 2018). In this regard, this dissertation showed how rather than assuming that QDs, such as rankings and indicators (Sauder and Espeland 2009), set the *is* and the *ought* (Jasanoff 2010:248) other systems frame their production and performativity within the infrastructure to which they belong.

Transparency: QDs are produced through taken-for-granted infrastructures

The presentation of QDs to their audiences (Goffman 1973) as devices whose scientific legitimacy rests on the capacity of being replicated showed us that infrastructures are assumed as given by their creators. However, as I demonstrated,

in private some of those creating the devices alerted the ethical risks of existing unequal access to technical capabilities. This includes Herbert's recognition that the technology needed for the development of ViEWS is absent in most of the countries they are forecasting (Herbert 2019). Therefore, while the construction of new iterations of QDs does not require rebuilding new infrastructures, in practice building them outside of the first place of origin presents its challenges. Edwards (2010:8) warned that the proper operation of sociotechnical systems depends on reliable services and is widely accessible by certain communities. This research has shown that some of those producing QDs ignore existing gaps between those who can access the sociotechnical elements required to *consciously* replicate their tool and those who cannot. It is important to highlight that the existence of these technological limitations was to broadly share, as it was proven through multiple quotes. Visvanathan (2005) and Danaher (2016) have demanded the need to provide non-technical explanations to communities affected by scientific and data projects. However, those producing these two QDs limited their responsibility to give instructions regardless of whether these are either understood or even technically accessible. For example, Jose Arcadio mentioned in terms of replicability, ViEWS was limited to share the data online since individuals could *always* rent a supercomputer. It is essential to highlight how the EPI team seemed more open to explicitly communicating certain limitations than in the case of ViEWS.

Reach or Scope: The creation of QDs may be embedded within existing power relations

Given the lack of fieldwork in peripheral communities, this aspect of a sociotechnical infrastructure allowed me to speculate around the power of QDs in global development. Seen through Foucauldian lenses (1982:220), and based on an analysis of public speeches by individuals from the Global South during the UN Security Council, I was able to speculate that some countries may willingly try to achieve the futures presented to them even if the construction of such scenarios cannot be consciously understood. While there was a clear reproach at the UNSC towards the Global North, those working at ViEWS and the EPI assumed that their

relations with global institutions like the World Bank or the UN could help them to influence actions in the Global South.

Learned as part of membership: Those wanting to produce QDs require specific training in particular statistical methods and how to operate a particular technology.

The participant observation during the construction of QDs allowed me to know the profiles of those building the devices. As illustrated, the membership of the group that creates these devices is limited by formal and informal practices of entrance. In most cases, there is a need to be part of the institutions that host the QDs. This is significant given that the first point of entry is not set by the projects themselves but, in this case, universities. On the one hand, EPI research assistants were exclusively recruited among students that have taken a specific course delivered by a senior researcher. On the other hand, almost every single researcher at DPCR has studied at least one degree in the department. By recruiting members whose academic careers started at the same place, the chances of everyone sharing the same ontological and epistemic understandings towards conflict and environmental studies increases. At the same time, as argued earlier, this weakens the variety of voices and worldviews (Longino 2002).

Membership requirements show the existence of institutional doors that limit the participation of a more comprehensive array of communities (Erickson 2016) which could reinforce existing epistemic injustices where only particular worldviews are represented. Institutions play a key role in where these devices are produced. Universities, with the size of endowment as Yale and Uppsala, seemed to be unique places with the sociotechnical capacity for the production of a QD. This was highlighted by both teams when I asked why their devices were built in Uppsala University and Yale respectively:

I think it's mainly because of the resources of this department, you know UCDP of course but also all the experts that we have. It's a large group of experts that is very unique in the world, absolutely, if you look at other departments that are sort of related, of related or focused on conflict studies or peace studies, for that matter, you'll see that the staff is way smaller (Catalan 2019).

I think there's very few places that would have a chance of putting a team of expertise as diverse as ours. I think that between Dan and people here and Marc and Alex and the CIESIN group, you really have a lot of expertise in a wide range of areas, direct expertise, and I think they really make good effort at partnering with other groups that bring similar expertise in similar areas. I think we are doing as good a job in the data analysis front that anyone is likely to do, I think that it's probably unusual that you get someone like me involved in a project like this. I think that the project as existed circa 2004 doing thing with Excel spreadsheets is far more likely to be the case at most places (Alfonso 2019).

Both Catalan (ViEWS) and Alfonso (EPI) recognise that the capacity of their institutions to gather together a wide arrange of experts in all the areas covered by both their devices is crucial. In this sense, while the notion of membership excludes, it also implies that there is a need for some diversity to be included. This allows me to argue that while there is a wide technical diversity, needed for the proper construction of a device, the limitation remains in how those technicians approach an issue.

It is important to highlight that the creation of QDs is not limited to these two case studies. As I reviewed, the production of quantitative devices has increased in all possible policy realms, including education (Bogdandy and Goldmann 2012), sustainability (Bell and Morse 2018) and policing (Joh 2017). Given the wide scope of issues quantified through the EPI and ViEWS, it is possible to drag generalisations about how QDs are produced through informal practices rarely shared to the public.

Links with conventions of practice: QDs are designed to respond to conventions of the communities their producers interact with.

I argued that QDs can only measure what other organisations within their sociotechnical infrastructure have already datafied; however, this is not the only framing that governs their construction. Throughout the analysis of both empirical chapters, it was possible to observe how the design and timing of QDs respond to the structure of the ministries they aim to influence. This was explicitly observed in how ViEWS is produced with enough time for their target audience to incorporate the

device into the decision-making process. ViEWS' producers had to mobilise the sociotechnical system of the Uppsala Conflict Data Programme (UCDP) into their conventions of practice to receive data 'on time'. In the case of the EPI, while the device could be produced every year, it had to be adapted into the conventions of data production, where environmental datasets are updated at least every two years. Not only that, but the design of the EPI responds to an adaptation to the responsibilities of 'western environmental ministries' and policy frameworks like DPSIR originally developed by the OECD.

Embodiment of standards: for QDs to become connected with other elements, they require to contain standardised elements of different infrastructures.

The pursuit of standardised procedures was an objective that, in both cases, studies showed resistance from programmers. According to Star and Ruhleder (1996), for infrastructures to become transparent (unnoticed) elements of everyday life, they must embody specific standards of other infrastructures. This was observed in how QDs do not define what they measure but incorporate existing epistemic understandings. The clearest example of this was the construction of datasets using the codes developed by the International Standard Organisation (ISO) to refer to countries. However, as Plantin (2021) has argued, there is a resistance to standardised practices among programmers and data managers. The calls by programmers, who equalised their work as personal as poetry, show that while senior managers pushed to ensure the longevity of the devices, those dealing more closely with data assume standardisation as an unachievable goal. This shows that the embodiment of standards is only limited to certain aspects. Even in the case of the ISO codes, it was possible to observe how this shows complications as recognising what counts as a country.

Built on an installed base: The production of QDs is possible due to the longstanding development of processes and technologies that make quantification possible.

This dissertation demonstrated that the inclusion or exclusion of particular metrics within QDs is often related to how governmental ministries are organised.

While algorithms might be more efficient than humans when dealing with large amounts of data (Bishop and Trout 2002); their results and work are bound to what humans have previously defined. Therefore, while the imaginaries built through metrics could be constrained by times, humans still redefine how these tools reinforce particular hopes, expectations, or impositions, not only algorithms or devices. By stating that technology is political in the broadest sense, I do not intend to disqualify it but to argue that technology as a social element can open political debates (Barry 1991:9). This research recognises that the adherence of QDs to particular world views should open the door for a more comprehensive discussion of their politics.

The EPI and ViEWS have been constructed within existing epistemic, ontological and political structures. I refer to how the construction of QDs was shown to be delimited by existing imaginaries (Jasanoff and Kim 2015), epistemic and ontological understandings of the world, and technical capabilities. As analysed, the EPI and ViEWS responds to how environmental ministries and peace and security councils have been designed and operated. Still, some of the existing infrastructures represent challenges for some of the objectives of the devices. The clearest example was the confrontation within ViEWS around following existing theoretical understanding of conflict or allowing machine learning algorithms to drive the production of forecasts. Hence, while QDs are built on existing structures, these will be proofed to represent limits on the design of the devices.

The limit of what can be included into QDs was also highlighted by how rather than a transfer of power from the state to supranational entities, when looked closely, states remain apprehensive to their capacity of guiding the collection, one of the main tools to govern (Foucault et al. 2007:354), statistics. This is not to say that NSAs, like the PISA index or what ViEWS and the EPI expect to become, do not collect data but rather underline that most demographic data is state-sponsored. This dependency towards nation-states to provide data has also prevented data collection that the state could consider "sensitive". In avoiding collecting data, states can be seen as actively ignoring an issue, as Downs (1957) calls "rational ignorance". Another possibility for the lack of data, which emphasises the inequality around data collection and usage, (not mutually exclusive from the previous) is the lack of sociotechnical infrastructures for its collection.

It becomes visible upon breakdown: the production of QDs is not possible everywhere when we find communities incapable of reproducing these devices.

The *truck factor* (Avelino et al. 2016) analogy represents the moment in which the QDs become visible. While from the outside, the construction of QDs could be perceived as a device that is “just” routinely updated, their producers are aware of the importance of tacit knowledge (Collins 2010) among their members. There is an understanding that certain members within the group carry knowledge that has not been transmitted to other team members by practice or that cannot be transferred through technical appendixes. Hence, their smooth pipelines become visible when they lose team members or when new iterations are restarted. This was *dramatically* exemplified by Brown when he mentioned how if Frederick was to be ran over by a car, even though part of the everyday work could continue, there will be information lost forever. Not only the embeddedness of standardised practices is seen as the possible solution against dependency towards tacit knowledge, but some researchers also suggested the use of software capable of tracking all the changes done while coding to provide a more robust understanding of the decisions made while programming. However, as analysed, many decisions are still taken beyond the computer or the programming screen that would remain unrecorded.

Researchers showed their concerns towards opening 'too much' the limitations and natural uncertainty of their work due to their fear of losing credibility. This was even more visible during my time at Uppsala when researchers often shared their disquiets towards how statistics are understood by policymakers and the lay public. In their eyes, a common lack of understanding towards statistical uncertainty often put in doubt the claims that researchers can make through QDs given the incapacity to provide fully certain insights. It is crucial to highlight that this uncertainty is not only a limitation of statistics, but of the data that is used too. Aureliano, a DCPR member highlighted how the data about conflicts used for ViEWS is uncertain due to the complications of collecting data in the middle of armed conflicts:

We deliver what we call "candidate event data", so is the violent events that we have been able to observe and code or classify from

the previous month. We call them Candidate Events because there is a reevaluation of the events at the end of the year and the beginning of the next year. The reason for that, or one reason for that, is that new information sometimes becomes available overtime. News have this nice quality the they correct errors, so sometimes there it comes news organisations, Reuters or AP and they send out a correction that some previous wire was incorrect in some respect. That's why we call them preliminary, and also there are often times at the end of the year or at the beginning of the new year were a lot of reports published by NGOs and the UN, like Human Rights Watch or Amnesty International, organisations like that, they tend to publish on a yearly basis so at the begging of the year they will publish things that will provide additional information that will allow us to better specify; maybe we don't know where something happens but this information is valuable in some report, or the numbers are vague in the newswire but exact on the report. There are all kinds of corrections that are made as new information becomes available (Aureliano, 2019) .

It is important to remember that ViEWS reached an agreement with the Uppsala Conflict Data Programme to ensure that datasets were updated on a monthly basis. However, Aureliano's claims let us see that forecasts are being produced with unconfirmed events. In other words, ViEWS is providing forecasts bases on data that often changes. This is problematic not only because it highlights how uncertain the predictions are, but also in terms of epistemic injustice (Kidd, Medina, and Pohlhaus Jr. 2017). Since it is clear that there are communities being quantified without access to the sociotechnical elements required to consciously inspect QDs, the flawed predictions being presented will rarely be challenged. If these communities were to follow the models given to them, these could provide insights that do not represent an issue accurately.

This visibility was also evident when we consider the design of QDs from a centric perspective where peripheries are ignored. As I demonstrated, the indicators through which these devices are constructed disregard the authority and involvement of local communities. This was visible even in the case of ViEWS, where forecasts are provided at a very granular level but where indicators use national-level data. The case of the UK represents another clear example of this issue, where the EPI provides country-level scores to matters solved in devolved nations. This approach assumes not only that all problems can be solved by central governments instead of recognising the role that local communities should play.

6.5 The creation of worlds

The empirical chapters of this dissertation showed that QDs are required to be produced alongside narratives that, if followed, promise a better future (Moore 1966). As it was argued during the literature review, and empirically demonstrated, an essential aspect of the study of expectations was to understand how different institutions build and procure that their futures occur (P. Martin, Brown, and Kraft 2008; Bronk 2009). The expectation towards these fictions (Beckert 2013:220) or *futures as understood at present time*, symbolises the interests and understandings of those creating them rather than possibilities built through communal processes. While researchers tended to downgrade the final impact their claims could have, they also mentioned being actively involved with organisations like the UN and the World Bank to push for their devices to become a part of the decision making at influential organisations. These encounters reinforce the connection of QDs' producers within a larger sociotechnical system (Edwards 2010) required for the implementation of the proposed future where at least organisations, political interests, technological elements and global governance interact.

When the focus was set on how the data is managed and circulated, it was possible to observe that QDs represent the merging of social and environmental conditions that were datafied (Dourish and Gómez Cruz 2018; Micheli et al. 2020; Redden 2018; Sadowski 2019) under multiple temporal and space conditions. Hence, this thesis aimed to provide a novel insight into the study of quantification, rather than focusing on the way QDs have transformed policymaking, it proposed to study the everyday life of those making these devices as a way to understand what happens while these tools are produced. This interest in understanding the mundanity of knowledge production was reinforced in multiple occasions through the claims of the researchers I worked with:

When I first got into the whole issue of using remote sensing for both tree monitoring, because I was interested in the use for treaty/conventions, and indicators there were a lot of discussions around Big Brother, who's processing the data? I don't hear those concerns as often anymore, but I'm not maybe floating in the circles of people who are major sceptics or saying we should question how

those data are produce. Every remote sensing scientists, every modeller does have a worldview, is a human process, that's what you are studying, is sociology. I don't know what goes on in the minds of hydrological modellers or the people who do the Global Burden of Disease study which are generally, you know, centred around the environmental international health metrics institute. I don't know how their worldview may influence what they produce. But if you're savvy enough, mathematically and statistically, you can in theory follow what they did. I'm not saying I am, actually when we first started doing some of the environmental risk exposure metrics, I did have the time to really dive into their deep materials, but they were thick and very complicated. I'm sure there's tons of assumptions and other things going into there (Pietro 2019).

As I showed through the empirical chapters, researchers tended to highlight the importance of studying who is dealing with data? how is this done? what is being left outside? These were claims raised by the researchers themselves who, just as Pietro, recognised that there are several processes left outside of how QDs and their narratives are produced.

The discussion about the importance of tacit knowledge and the dependency of QDs on sociotechnical infrastructures could be summed up in the way their measurements should be observed. Through this dissertation I have claimed that the results provided through QDs should be understood as developing completely new time and space realities. An ecological fallacy (Firebaugh 2001) arises when national environmental policy scores are developed, ignoring that the conditions of one country will affect others. Instead, it is assumed that the data from multiple years can be merged and provide an overview of the conditions of the environment at the national level. I referred to this as *in vitro environments* to signal that environmental QDs represent exercises where researchers can manipulate the size and pace of ecosystems at pleasure (Knorr Cetina 1995:145). The clearest example of this *manipulation* of the complex environmental interdependency was the treatment of environmental issues as silos.

These *in vitro environments* are the result not only of the combination of multi-temporal datasets but also of the sociotechnical imaginaries in which they are embedded. These new realities are the result of a combination of multi-temporal data sets, as in the case of ViEWS, but also of narratives of idyllic futures. In the case of

both the EPI and ViEWS, it was analysed how the combination of more than a dozen of indicators, with data from different years, will result in the publication of reports that aim to show the situation of the world. However, after having analysed and corroborated how data is produced by multiple individuals, under different circumstances (see: Plantin 2018; Leonelli 2014), at different times, it is possible to argue that in practice, these devices are creating worlds by treating the multiple indicators that make the device as silos rather than recognising the interrelation between all metrics. In other words, researchers aim to influence policymakers not with the status of the world, at any given moment, but through a multi-temporal and spatial collage of the environment. The notion of *in vitro* also highlights that researchers have the possibility of developing scenarios and QDs in complete isolation of the issues they measure.

A final way in which the development of *in vitro* environments was proven was in how the quantification of the environment relies on simplifying complex ecosystems into easy-to-read metrics. As proven, QDs will often reward nationalistic approaches towards environmental protection rather than recognising the interrelation between planetary ecosystems. As shown, most metrics ignore the multiple national governance arrangements at which issues are tackled. In other words, QDs tend to assume that policy issues are solved by single central governments, which ignore pluri-national countries or multiple degrees of local governance. In this sense, the quantification of an issue promotes the elimination of local contexts (C.A. Miller 2016) and the emergence of seemingly shared global issues. This quantification can take multiple shapes (e.g. marketisation or statistics) that will often result in limited representations in the form of indicators. As with qualitative representations, quantitative indicators will also be linked to how their producers understand the world. Given that the production of indicators depends on the theoretical understandings about the issue being quantified, when selecting which theories explain better that issue, researchers are presenting the world on their own terms. When these indicators are brought together, researchers can create devices and carry expected shared beliefs through different statistical methods. This is a signal of how the development of QDs is done by choosing variables that fit the narrative of the device even if that implies ignoring the way policy issues are being tackled in reality.

In sum, this dissertation has demonstrated that the central storytelling within QDs is the production of "desired futures" (Leach, Scoones, and Stirling 2010:4) which can be achieved by reducing the uncertainty offered by the metrics. As we have seen through this dissertation, part of the success of statistics and the market has relied on their capacity to detach as much as possible singularities; therefore, focusing on the generalisations of its measurements.

7 Conclusions: Contesting and reclaiming futures

"En tiempos de crisis climática, el futuro es un territorio a defender"

["In times of climate crisis the future is a territory to defend"]

(Futuros Indigenas 2021)

This dissertation has initiated an inversion (Bowker 1994) of the sociotechnical infrastructure (Edwards 2010) that embodies quantification. In particular, through ethnographic research I analysed the everyday life at research centres quantifying the environment. I defined QDs as those devices aimed at representing a given issue and whose production depends primarily on statistical methods. The empirical discussion and analysis around the production of QDs was possible with data collected at the Violence Early Warning System (ViEWS) and the Environmental Performance Index (EPI). These two case studies allowed me to refute Merry, Davis and Kingsbury's (2015) views of composite indexes that assume that through these devices theories and standards (Bowker and Star 1999) are built. Instead, I argued that by being recognised as elements of larger sociotechnical infrastructures, QDs already incorporate standards and theories in their construction. In other words, through these devices standards and theories are not created but they are circulated. The recognition that this dissertation has 'started' an infrastructural inversion, allows me to identify the limitations of my work while also opening the door for future research. In this final chapter I will provide a conclusion of the multiple questions opened through this dissertation.

One of the first questions raised during the design of this research was how and when QDs are defined by their producers as stabilised. Under the framework provided by the Social Shaping of Technology (SST), stabilisation was understood as the settlement of disputes and negotiations over particular theories or technical designs (Sørensen and Williams 2002). The empirical discussions showed a constant set of negotiations at multiple levels. Within ViEWS the clearest example was the debate around the role that theoretical understandings of conflict should play during the construction of QDs. This ongoing discussion did not allow me to see its closure,

but it signalled an existing contestation against an over quantification of social processes. By digging into the history of the EPI, it was possible to observe that quantitative methodologies have been given a greater relevance over theoretical understandings of the environment. The pursuit of a data-driven world, as described by the EPI founders Daniel Esty and Jay Emerson (2018), showed a resolved discussion on the role of theoretical understandings during the construction of the EPI. However, the dependence that both devices have towards other organisations to obtain the datasets required for the devices, showed that even when quantitative data seemed to have been preferred, the construction of devices is limited to what those other organisations have deemed as valuable enough as to be quantified. Hence, there is a requirement to analyse the conditions and rationale behind every dataset (Leonelli 2014). A meta-analysis of each dataset could allow us to understand the conditions under which they were built and the rationale of doing it. This claim situates QDs within a sociotechnical infrastructure where the dependence to other systems requires us to follow the thread of how data is produced. It is possible to conclude that in both case studies while theoretical understandings of environmental issues and conflict still frame what it is included in the models, there is an ongoing tendency towards providing more freedom to algorithms and quantitative methodologies. This move was evidenced through the internal disputes towards the aim of both teams: to build metrics based on existing theoretical understandings or develop machine learning algorithms.

Before starting my fieldwork, I was aware that QDs were produced with datasets and quantitative methodologies. However, it was during my participant observation when I noticed that researchers were talking in particular ways about *data*. Asking the researchers what they meant by data allowed me to understand that for them data is only a quantitative element and that it also has multiple representations. These perceptions towards data were analysed through quotes like the one by Alfonso (2019) in page 93 who claimed how for him: "Well, I would say that data, fundamentally, are almost entirely numeric, sometimes text but even that could be coded as numeric [...]" or Gerineldo (2019) who was quoted in page 94 " [...] To me, a data point is just a number [...]. However, as Deborah Stone (2020) reminds us something constantly repeated throughout this dissertation: numbers have been used

to dispossess facts from their origins, from its stories. This was seen on how when discussing about what these researchers saw in data, their answers were different. For instance, one of the most staggering interviews I conducted was with a ViEWS' member who shared how difficult it had been to create the datasets about Uganda. For her, every *number* within an excel sheet represented someone who had died during the genocide and not just a 'data point'. Still, the elimination of faces, stories and struggles through quantification is often justified by those producing QDs to provide emotionally detached accounts of an issue. As Porter (1995:77) has argued, "it is not by accident that numbers have been the preferred vehicle for investigating factory workers, prostitutes, cholera victims, the insane, and the unemployed." The case studies I just analysed and discussed, are quantifying the victims of environmental-related issues without paying attention to their stories.

The conflicting understandings of *what are data?* were present throughout my research, always questioning what are the stories that QDs ignore. Even more, those who defend the usefulness of de-contextualisation, as a way to abandon personal biases, also presented themselves as *generalists* to refer how their work is focused on processing data of any issue rather than looking for the specificities of the topics (i.e. environment, health or education). This dissertation expands on what Plantin (2018, 2021) has shown around data cleaners and managers. Even when these individuals want to be shown as hermeneutically disengaged with their data, as a strategy to portray objective practices, internally there are tensions about the lack of reflections around the process of datafication (Sadowski 2019; Redden 2018; Dourish and Gómez Cruz 2018). This expansion of Plantin's work was possible through my interviews and informal conversations with members of both projects, where multiple voices questioned their position of being able to datafied contexts they are unfamiliar with at a distance (Law 1986). Brown (ViEWS) was very clear about this:

As a quantitative researcher in a data-driven research, is so abstract, it's just numbers in a data frame for me, and I'm doing fieldwork and things like that. Then sometimes you realise like, wow! this is people going into a village and murdering a bunch of children, and then that hits you and you get a bit stunned for a while and then you go back to programming again. It feels so incredibly strange that what I do when I sit on a Friday or a Wednesday evening at 11:30

with a bag of candies and programming, can have an effect on like politics somewhere very very far away, and can affect (Brown 2019).

I dare to include Brown's claims at this stage of the dissertation since it works as a perfect conclusion of what is behind data and the way programmers engage in their everyday work and give significance to what data are. One of the proposed research questions was to analyse what are the aims of those building QDs. Researchers at ViEWS and the EPI did not demonstrate to have single aims; rather multiple interests collide among the teams. The first type of aims was methodological. In both case studies it was possible to observe that the objective was to prove that statistics could 'save us from human errors'. Hence, the aim was to demonstrate that their own methodologies could provide useful results. In this sense, an ethnographic work should distinguish the heterogeneity among team members. In both case studies at least two groups were observed: programmers and analysts. These two groups very often will overlap functions with each other but also, they would have different tasks within the group. Each group will seek different objectives, while technicians will be more concerned about providing strong methodological tools, analysts will often be concerned mostly with inserting the narratives of the device into their sociotechnical infrastructure.

Brown's realisation of how his everyday work could have an impact thousands of kilometres away also highlights the power imbalances between those making QDs and those potentially affected. While he sits having some candies, communities in Africa could be affected if his work is used to inform policymakers. Eating while working is no issue, however, it highlights the very different circumstances under which those measuring, and communities affected by conflict live.

My interests on the everyday life of those making QDs extended to the micropolitics (Nast and Pile 1998; Irwin 2001) of the construction of QDs. This thesis demonstrated the importance of tacit knowledge (Collins 2010) during the construction of QDs. As it was discussed with QDs' producers, while technical appendixes are promoted as having enough procedural information to reproduce the devices, it was also recognised by some of them that no reflexive understanding was possible this way. Borrowing from Vis Visvanathan (2005) I referred to *reflexive replicability* to refer

to the requirement that those creating QDs have towards ensuring that anyone interested in replicating their device has access to a clear understanding of the decisions, procedures and assumptions that were taken. As argued by some of those at ViEWS, this is not an easy goal, but they referred a preference to provide limited metrics capable of being fully understood by everyone, rather than complex algorithms whose operation they struggle to understand. As I discussed, reflexive replicability is not only a technical argument, but a debate on the epistemic injustices (Fricker 2007; Kidd, Medina, and Pohlhaus Jr. 2017; Pohlhaus Jr. 2017) that can be perpetuated through these devices. It is important to acknowledge that while during my fieldwork I had interesting discussions about the imbalances between who can measure and who is measured, it was not until the analysis of my data that I arrived at the concept of *epistemic injustice*.

Throughout this dissertation, I theorised through a Foucauldian conception of power, understanding it as a mode of action aimed at modifying other free subjects. In this sense, power can be exercised "only over free subjects, and only insofar as they are free" (Foucault 1982:220). In the case of this research, through the empirical chapters, I discussed how power is expected to be exercised through QDs when the future of particular communities is defined by the imaginaries of others (Fukuda-Parr and McNeill 2019:7). It is essential to recognise that power is not evil; instead, if understood as a strategic game where positions can be reversed, it can become a mechanism for liberation (Foucault 1988:18-19). Therefore, metrics could move from being tools of the powerful to empower (Tichenor et al. 2020:6) those in struggle.

The main finding of this dissertation is that researchers producing QDs do not co-produce policy, but that these devices are already embedded within a sociotechnical infrastructure (Edwards 2003) of quantification that frames its design and construction. Therefore, QDs operate within existing boundaries of what other institutions have deemed as valuable. This is not to say that these devices have no impact, Espeland and Sauder have demonstrated extensively the influence can have (see: Espeland and Sauder 2007; Sauder and Espeland 2009), but to argue that the hermeneutics of these devices are (pre)conceived by other actors too. Examples of this were analysed throughout the empirical chapters. In the case of ViEWS, it was evident that being produced in a country (Sweden) that has defined its very nature

through the production of policy tools as a way to influence global policy making, would allow the tool to be received with greater openness by global organisations. This represents an example of what I described earlier as *hermeneutical injustice* (Fricker 2013), where there is not only an overrepresentation of QDs built under western understandings, but these also carry greater credibility. Even more, the production of ViEWS and the EPI represents an example of a *distributive epistemic injustice* (2013:1318). One important aspect that make the production of these QDs feasible is the association between their producers and other sociotechnical infrastructures. These includes supercomputers and greater access to influence global institutions (i.e. the World Bank). In this sense, while ViEWS can be seen as being independently built by some researchers at Uppsala, there was also a recognition that their timeframes depended on how those institutions being targeted as potential audience operate.

In the case of the EPI, multiple elements of epistemic injustices can be found. Following the claims by some of my interviewees and personal experiences during my fieldwork, I argued that part of the authority the EPI is based on being built at a prestigious university such as Yale. This was referenced to during the EPI chapter with a former EPI researcher claiming that "because we are not an Ivy-League, most of the times we need to work twice the amount to be heard". This, represented an example of *hermeneutical injustice* (Fricker 2013) where the same researcher had experience a differentiated attitude towards their work.

One of the objectives of this dissertation was to analyse how futures are developed and presented through QDs. This dissertation has found that QDs do not only measure an issue; better futures are promised through them. These devices propose utopias (Moore 1966) of how the future could look like if we approached current issues through their metrics, and dystopias to those who dare to ignore them. This implies that those producing these tools constantly sought to define what constitutes the standard of acceptable practices of what they measure (Merry, Davis, and Kingsbury 2015) by inserting their devices within larger narratives. The use of QDs to produce desired futures was illuminated by the concept of *present futures* (Walter and Wansleben 2020). This notion claims that through metrics, the future has already been framed into possible outcomes. The EPI for instance included like

" Metrics have ground-breaking potential to propel us toward a sustainable future – but only if the work embraces data-driven policymaking, built on a foundation of careful measurement of environmental trends and progress" (Wendling et al. 2020:1)

Claims like this do not only over relay on a future driven by data, but they consider the present as a moment of dismay that can only be saved if specific steps are taken. This statement that I make does not imply a denial of the multiple problems humanity faces neither a compliancy with the "neoliberal optimism industry" (Shirazi and Johnson 2018).

Scenarios are required to be mobilised to be fulfilled. This was seen as possible through imaginaries and narratives that, like economic models, defined possible scenarios which operate in social worlds with demarcated standards, interests and evolving infrastructures (Cardon 2020:40). Capitalism seemed to play a key role in promoting the use of scenarios as achievable outcomes. As such, the future was presented through fiction expectations (Beckert 2013:325) where for a possible goal to be achieved the creativity available in the economic dynamics of capitalism are required. These *fictional expectations* assume that regardless of the incalculability of outcomes, the present imaginaries of future situations orientate the decision making. It is essential to clarify that, "fictions" are imaginaries of future states of the world available at present time (2013:220). This implies that even if the future is "unforeseeable", expectations play a role in creating "imagined futures states of the world". The clearest example to illustrate these discussions of how the future is constructed now is the idea of economic growth, which was rooted in both case studies, where the expectation of growing at a predicted rate will mobilise the required neoliberal infrastructures to achieve the prophesied "sustainable" future. In the case of QDs I have demonstrated how the quantitative aspects are surrounded by narratives where suggested changes in the current state of affairs are promoted as the only possible solution to ensure longlisting economic growth.

In the case of the environment, ecosystems were proven to be valued based on the assemblages between their constitutive elements, markets and other economic entities (Fredriksen 2017:49). An example of this is the measurement of reforestation projects intended to operate as a carbon offsetting mechanism. Ehrenstein and

Muniesa (2013) demonstrate how, given the time trees need to grow, the value of these projects is often based on imaginaries of the 'what might be'. The *value* of trees is dependent on how much carbon they can sequester. By this, trees are observed through capitalist lenses within sociotechnical imaginaries of climate change. Rather than establishing an intrinsic value, market approaches will reinforce existing categorisation processes defined by dominant epistemic communities. Hence, market-based valuations are not the only performative processes, but the entire ensemble through which these are done.

Forecasts were seen as devices that could be used to legitimise extractive activities by constructing visions of an abundant future and as arguments to avoid a disastrous future (Kojola 2020). These visions are grounded on "emotional meanings of the past and the future" (2020:27). Given that the leading discourse towards the consequences of climate change is grounded on an apocalyptic view where risk and securitisation are interwoven (Methmann and Rothe 2012). This included speeches of "unprecedented rainfalls" (Albeck-Ripka 2019) and "atypical temperatures" (McGrath 2021) reinforced by the existence of uncertainty (Ravetz 2016:98-100) that only science and technology can prevent. Given that the effects of climate change are to a great extent unknown or highly volatile, the future is no longer a definite linear event but one full of uncertainty (Kunreuther et al. 2014). This is just how environmental conflict has been defined by ViEWS, tens of socioeconomic, environmental and historic variables in continuous interaction. Thus the future that was once a linear known ready to be lived; requires science to forecast what can happen and what to do to prevent it.

The analysis of the discourses expressed at the UN Security Council meeting showed how communities are often bound through the expectations and imaginaries of possible futures. Hence, the study of the expectations of those communities was partially done by analysing how different institutions and their interests portray the future. It is the articulation of imagination and materialities that could allow expectations to be achieved (P. Martin, Brown, and Kraft 2008:32). On the one hand, imagination can allow actors to move beyond inherited thought patterns and categories, enabling individuals to develop futures beyond conditioned pasts (Bronk 2009:201). On the other hand, macrostructures play a key role in developing

expectations towards the future. Therefore, it is essential to recognise existing power dynamics to understand *who* can imagine. In this sense, this sociological study incorporated how routine practices contributed, together with cultural, institutional and relational groundings, to create particular future projections (Mische 2009:702). This discussion was essential for my dissertation since it made clear that I needed to incorporate the role of imagination and sociotechnical structures to analyse how imaginaries are presented through QDs. Since fictions acknowledge the existence of uncertainty, their incorporation as possible futures depend on being convincing more than being accurate. This was shown when researchers argued that the communication of statistical uncertainty could backfire them, highlighting the value of a convincing narrative.

Understanding that stories and tales often represent the vision of those in power, the account of current success against climate change and environmental issues should be analysed carefully. An example of this are big campaigns against plastic pollution. While in developed countries there has been a vast campaign against the use of single-use plastics, and a celebration over the increase of recycling processes, in practice most of the plastic generated in the European Union is exported to developing nations (5 Gyres N/D; McVeigh 2021). The technology required to burn plastics is almost always imported by developing nations through loans paid to the Global North. In other occasions, plastics are simply burned in open pits, associated with negative local health and environmental impacts (Pandey et al. 2021). This transforms the narrative of environmental protection into one that can allow an accumulation by dispossession (Harvey 2003) in the form of debt. In this sense, it has been argued that the movement against plastics has reinforced colonialism. While wealthy nations celebrate improvements in plastic recycling, developing nations receive plastic waste and go into debt to burn it. This will not only deteriorate their health (Liboiron 2018) but see them as pollutant nations too. The way plastic pollution is being dealt with represents a narrative in which success stories hide new forms of colonialism and trigger hypocritical discourses (World Bank 2021) of cooperation and developing nations incapable of dealing with pollution. Still, the silo encapsulation of environmental issues will transform colonial actions of exploitation into narratives of

success in the Global North by providing better scores on air quality, while keep shaming the South for a lack of action against pollution.

The construction of QDs is framed by multiple systems within the sociotechnical infrastructure of quantification. To start with, the construction of the EPI being based on Kaplan and Norton's (1992) approach towards minimising the number of indicators, signalled a preference towards a 'simple' managerial approach. As it was analysed, the metrics that are included within the EPI respond to how Western environmental ministries have been arranged. I also analysed the existing dependency towards data providers. Only that which has considered as relevant enough as to be *datafied* (Dourish and Gómez Cruz 2018), will be measured. In both, ViEWS and the EPI, it was observed how those producing QDs are not static, and they can also mobilise data providers to either produce new data or modify their timings as in the case of the Uppsala Conflict Data Programme (UCDP). It would be naïve to argue that any institution can mobilise the systems within the sociotechnical infrastructure of quantification. As it was proved during this dissertation, senior researchers have current or former affiliations with international institutions including the World Bank, the UN and the World Economic Forum. These affiliations increase the possibility of being invited to present their devices to these institutions and eventually being used.

The futures proposed through QDs are not developed in isolation, but they are required to be mobilised by other elements of the infrastructure. However, without the possibility of what I referred previously as a *conscious understanding* of how these futures are produced beyond their original laboratories, an issue of disparity between those who can forecast, and the communities being used as simple case studies arises. In other words, those being *datafied* (Dourish and Gómez Cruz 2018; Micheli et al. 2020; Redden 2018; Sadowski 2019) are unlikely to hold accountable the producers of tool that could impact them directly. This could give rise to the continuation of hermeneutical injustices (Fricker 2013:1319) where narratives of futures are developed without the participation of those being affected. This dissertation calls for an increase in the democratisation of science by increasing the participation of local communities in developing the scientific projects that will affect them (Visvanathan 2005). In this sense, this thesis calls for an more critical thinking towards QDs as technologies required to be investigated within their sociotechnical

imaginaries (Jasanoff and Kim 2015) and sociotechnical systems (Edwards 2010) to move from data-driven policies— where the focus was shown to be on demonstrating the power of quantitative methodologies— to prosperity driven metrics, where quantification is at the service of improving the conditions of human and non-human beings.

As part of the recognition that QDs belong to a sociotechnical infrastructure of quantification, this dissertation calls not only for the description of the multiple sociotechnical systems that make it possible, but for an inclusion of more elements. Hence, an extension of this research will seek to move towards the way local communities make sense and engage with QDs. This interest is grounded on what Ibrahim mentioned during her speech at the UN Security Council, on the lack of engagement between global decision makers and local communities. While this thesis did not embark in directly collecting data from communities that could be affected by decisions based on QDs, existing empirical evidence (see: UNSC 2018) suggests the existence of a gap between how the Global South and the Global North imagine the future. This proposed future research would investigate how QDs can incorporate multiple cosmologies (Vasconcelos 1967) as a way of securing that the futures proposed through these devices reduce current hermeneutic marginalisation where these devices do not allow disempowered communities to make sense of their own realities (Vasconcelos 1967).

If those being "benefited" by QDs cannot reconstruct the proposed futures, forecasts will become devices through which unopposed imaginaries are delivered. As a contested arena, nature is also space of resistance (Pohlhaus Jr. 2017:13). This resistance may come from various fronts, including those affected by the forecasts and groups making the devices. At the beginning of this chapter, the epigraph from the *Futuros Indigenas* [Indigenous Futures] network manifesto signals how the pretended future being built for the disempowered by those who have conducted exterminations, ecocides, and genocides will find their resistance (Futuros Indigenas 2021). The discourses around responses to the climatic emergency are built within dynamics that pretend to expand and reinforce current power relations (Yearley 1996). In this sense, the idea of climate change as a common problem has historically been

that of broken promises from the North to the South (Roberts et al. 2006). Technology transfers have perhaps been the most common unfulfilled promise.

Another future direction from this research can be sought on the notion of multi temporal devices. As I argued, QDs end up building multi-temporal and spatial collages from the world rather than representations. I want to continue investigating the multi temporality of QDs within their own sociotechnical infrastructures and how these multiple times could be better communicated.

To start with some concluding thoughts not on my empirical discussions but on my ethnographical experience I will recall something that happened during the first week of my fieldwork. Perhaps understanding ethnographic methods through its colonial past, one of the ViEWS members mentioned during the weekly *fika* how they were just to "become a tribe ready to be studied and analysed". While indeed I studied two communities of scientists in the way they produce particular types of scientific knowledge, this was far from being a static position studying people from a corner in their room. As it was discussed across this dissertation, the opportunity that I had of working with statisticians, programmers, environmental scientists and conflict researchers pushed me to learn from these communities while using them as translators of the scientific worlds they belonged to. In this sense, one day I could be reading about soil sciences, the next one about water chemistry and finish the week having to learn how to programme in R. Far from complaining, it is a reminder of the multiple social worlds that interwoven for the creation of QDs. In this sense, having to learn about the production of these devices implied not learning one single jargon but to follow how these are reinterpreted. The multitude of indicators usually incorporated into QDs to provide single number results imply that the expertise of those producing these tools is not on the issues they measure but on the statistical capacities required for their production. Hence, rather than understanding QDs as either environmental, conflict, health or education tools they should be seen within the field of statistics aiming to use other scientific fields to expand their methodologies.

In sum, this thesis aimed to demonstrate the importance of conducting ethnographic work at research centres to understand how power relations embodied within the quantification of everything are challenged and reinforced during everyday performances. I hope that through my thesis the reader can have a broader

understanding of QDs beyond data and institutions. Instead, I demonstrated that by belonging to sociotechnical infrastructures, rankings and forecasts should be evaluated through its minutia, asking about the origin of data, why some assumptions were taken, or whose expected futures they are trying to fulfil.

Inspired by Carlos Fuentes (1958:285): our destinies can be diverse, but if we are to make it ours, we should have the possibility of knowing the good and the bad. If communities are to have their own expectations, they should have the tools to imagine their futures. If communities are to have their own expectations, they should have access to the tools to imagine their own futures. Rather than pushing for a single common future, we should work towards multiple futures that can provide sustainable and fair developments for everyone within their own cosmologies.

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Appendix I – Overview Interviews⁴⁴

Interviewee	Position	Interview Location	Interview Type	Duration hh:mm	Year
Alfonso	Senior Member	Office	Semi-Structured	00:42:	2019
Alvaro	Senior Member	Office	Semi-Structured	00:49	2018
Aureliano	Senior Member	Office	Semi-Structured	01:33	2018
Brown	Junior Member	Café	Semi-Structured	01:18	2018
Brown	Junior Member	Café	Semi-Structured	01:09	2019
Catalan	Junior Member	Café	Semi-Structured	01:30	2018
Fernanda	Junior Member	Office	Semi-Structured	01:14	2018
Fernanda	Junior Member	Office	Semi-Structured	01:46	2019
Gerineldo	Junior Member	Office	Semi-Structured	01:22	2019
Herbert	Junior Member	Café	Semi-Structured	01:26	2018
Herbert	Junior Member	Café	Semi-Structured	01:29	2019
Jose Arcadio	Senior Member	Office	Semi-Structured	01:11	2019
Jose Arcadio	Senior Member	Office	Semi-Structured	01:14	2019
Mauricio	Junior Member	Café	Semi-Structured	01:28	2018
Melquiades	Senior Member	Office	Semi-Structured	01:13	2019
Nicanor	Senior Member	Office	Semi-Structured	01:14	2019
Pietro	Senior Member	Office	Semi-Structured	01:08	2019
Pilar	Senior Member	Office	Semi-Structured	00:49	2019
Prudencio	Senior Member	Office	Semi-Structured	00:48	2018
Rebeca	Senior Member	Office	Semi-Structured	01:28	2019
Remedios	Junior Member	Office	Semi-Structured	01:08	2019
Rodrigo	Senior Member	Office	Semi-Structured	00:18	2019
Ursula	Senior Member	Office	Semi-Structured	00:52	2018

⁴⁴ The specific date and location of all interviews has been excluded to secure the anonymity of the interviewees.

Appendix II Guiding Questionnaire for Semi-structured Interviews

Questionnaire

1. What is your name?
2. What role do you play for ViEWS?
3. How did you come up with the idea of creating ViEWS?
4. Why did you decide to start working for ViEWS?
5. Do you think qualitative research can be biased?
6. Do you think quantitative research can be biased?
 - o When could these biases occur?
7. For you, models and indicators are institutional or personal projects?
8. What are the limitations of ViEWS?
9. Isn't ViEWS losing some very detailed perspective of the terrain? For instance, just by using ViEWS could governments prevent conflicts?
10. Is this the only way that exists to forecast conflict?
11. When building a model, do you also define a problem and possible solutions?
12. Could people at a national level prevent conflict with your model?
13. Do models mean power?
14. Is the power of models overrated?
15. I have found some issues during my stay here, I have felt sometimes that some people are not "experts" in political science but yes in programming. How could a non-expert in a field could suggest solutions?
16. How can programmers work with more qualitative research?
17. Who do you work for? Who's your target audience?
18. How is the Climate-ViEWS part of the overall project?
19. Is the interest focused on climate or in conflict?
20. Who are you trying to speak to?
21. If money was not a limitation, would you have built your research in the same way?
22. What do you think about this research?

Appendix III Information Sheet and Consent Form



THE UNIVERSITY of EDINBURGH
School of Social and
Political Science

Information Sheet: *Opening the black box of indicators: An STS approach to the construction of environmental knowledge*

Researcher: José Antonio Ballesteros Figueroa

Contact Details¹:

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About this project

This research aims to analyse how everyday life within organisations together with formal events affect the production of tools measuring environmental and conflict issues. As a process of scientific rigour, and a practice of transparency, some of these institutions will provide access to the methodologies, data sets and sources that were used for the construction of environmental indicators. However, little is known about the effect that daily life events within the organisations that could be considered 'mundane' (and by definition without relevance), together with formal events like seminars and workshops have in the production of environmental performance tools. From an epistemic point of view, this research employs the concept of *micropolitics* developed by Heidi Nast and Steve Pile (1998) who argue that it is in the day-to-day work of the organisations that knowledge may be outlined for specific purposes.

The research design of this project considers analysing two case studies; both pertaining to leading institutions creating innovative indicators. Considering the approach that the Department of

¹ From February 1st 2019 - June 30 2019, contact address are:

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Peace and Conflict Research (DPCR) has in producing data and other tools to guide policy makers in environmental and conflict issues, the department has been on the focus of this research since early stages. This interest has been strengthened through one of its most recent projects, the Violence Early Warning System (ViEWS). Together with DPCR, the Yale Center for Environmental Law and Policy (YCELP) constitutes the other case study through the Environmental Performance index (EPI). EPI is one of the most established indicators measuring and ranking countries in relation to how they perform in environmental protections at the national level. Both case studies represent institutions that have managed to establish their authority in their respective scientific and academic communities.

The methodology proposed to analyse the production of knowledge at both institutions is an ethnography, which according to Signe Howell (2017), has as final aim to bring human notions of the self into account. This final product becomes a case that, when placed along similar studies, some generalities might emerge (Ingold, 2017). The data collection process includes document analysis, interviews and participant observations. In the case of YCELP, a participant observation implies that as a researcher I will spend five months at the center analysing how is it that the everyday life at the organisation affects the knowledge that it is produced. Because these observations imply participation as a way to learn with the community about its practices, it has been proposed that Antonio will collaborate as Visiting Assistant Researcher (VAR) for the preparation of the 2020 Environmental Performance Index.

Who is responsible for the data collected in this study?

Antonio Ballesteros is a PhD candidate at the University of Edinburgh; he will be responsible for the data collected during the study. Fieldwork notes, interviews and transcripts from every actor are available by request after being edited to secure anonymity of all participants. Additional documents, such as photographs, videos and memoirs will be also collected if they are provided by research participants. Access to transcripts will be limited to Antonio Ballesteros and will be encrypted. In all cases, anonymity will be granted to anyone involved in the research.

Any content, or direct quotations from the observations, that are made available through academic publications or other academic outlets will be anonymized and an alias will be attached so that participants cannot be directly identified, and care will be taken to ensure that other information in the observations that could identify participants is not revealed.

My relationship with YCELP

I reckon researchers have a busy schedule; hence, YCELP and EPI staff and research assistants (RA) can expect the least possible interference with their work. Requested interviews will be at the minimum and made at the convenience of both staff and RAs.

What do I expect from YCELP?

As described in the previous section, as a way to validate my observations other data collection methods will be used. Interviews with some members of the department will be conducted. These interviews can have a double purpose; the first one is to obtain information from key actors that have been identified during the observations. The second aim is to clarify assumptions made by the researcher and avoid wrong interpretations. Because of this, it is expected from people involved in YCELP-EPI a position of openness in relation being interviewed.

What can YCELP-EPI expect from me?

I am a social scientist with training in qualitative and quantitative methods. I hold a degree in Political Science and a Masters by Research (University of Edinburgh) in Science and Technology Studies. I have also attended Summer Schools focused on environmental issues (IDS-Sussex University,2018), social mobility (CEEY,2014) and Social Market Economy (Konrad Adenauer Stiftung,2012) . Because of this, YCELP can expect a researcher willing to widely collaborate on the different streams within EPI.

About Science, Technology and Innovation Studies at Edinburgh

The Science, Technology and Innovation Studies (STIS) research group at The University of Edinburgh has its origins more than fifty years ago when a group of scholars funded the Science Studies Unit. Its objective was to analyse the construction of scientific knowledge considering historical, geographical, and disciplinary settings. Since then, the 'Edinburgh School' in the sociology of scientific knowledge has been recognised as the research centre where Science and Technology Studies originated. Currently, STIS is a centre producing interdisciplinary research and public policy advice on a wide range of themes including, Environmental Science, Technology and Sustainability.

What are the risks involved in this study?

Your contribution will be anonymized, to the various degrees described on this information sheet. There are few risks involved in this study given the non-confidential, public nature of the behaviour studied and the voluntary nature of participation.

What are the benefits of taking part in this study?

The research will provide both the environmental community and academia with insights on the Sociology of Scientific Knowledge (SSK) that offers an account of the processes that allow the production of knowledge. Internally, after the conclusion of this research, YCELP-EPI will benefit by understanding how daily practices and interactions together with organised events influence what is produced. Antonio will provide insights that will allow ViEWS to understand how the knowledge produced might be affected by everyday mundane actions and not only by “insulated” methodologies. For YCELP-EPI, this research could help to understand if the social conditions at the department stimulate or inhibit the production of scientific knowledge

Possible calendar

Calendar of activities at DCPR

Month	Activities to be done
February 2019	Arrival at the Department of Peace and Conflict. If agreed, Antonio will be introduced into the ViEWS project and the people working on it.
From arrival until January 2019	Working on the tasks assigned by ViEWS
January 2019	Conclusion of my stay at DPCR . This is when I will carry most of my formal interviews.
September 2019	Send first transcriptions of interviews to interviewees for approval

Summary

I do not anticipate that there are any risks associated with your participation, but you have the right to withdraw from the research at any time.

Thank you for agreeing to be part of this research project described on the ‘Information Sheet’ that has been provided to you. Ethical procedures for academic research undertaken from UK institutions require that participants explicitly agree to be part of it and to acknowledge how their information will be used. This consent form is necessary for us to ensure that you understand the purpose of your involvement and that you agree to the conditions of your participation. Would you therefore please read the accompanying information sheet and then sign this form to certify that you approve the following:

- Antonio will produce fieldnotes where he keeps his reflections. Fieldnotes are kept in an Nvivo file encrypted and protected by a password. Access to this file is limited to Antonio and his supervisors as part of the analysis process.
- Before any publication, claim or final analysis interviews will be conducted as a process of clarification. You will be sent the transcript of the interview and given the opportunity to correct any factual errors.

- Any summary interview content, or direct quotations from the interview, that are made available through academic publications or other academic outlets will be anonymized so that you cannot be identified, and care will be taken to ensure that other information in the interview that could identify yourself is not revealed.
- While the statements will be the result of interviews, participant observations and document analysis, the written ethnography will not be linked to individuals but will be the result of generalised similarities between different statements made by individuals.
- Any variation of the conditions above will only occur with your further explicit approval

Participant's name _____ Date _____

Participant's signature _____

For more information

This research has been reviewed and approved by the School of Social and Political Science. If you have any further questions or concerns about this study, please contact the researcher. In case of any concerns about the way this research is being conducted, you may also want to contact his supervisors.

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Appendix IV Coding Tree

- **Expectations**
- Belief
- Expectations
- Imaginaries
- Politics of nature
- Power
- Shared Futures
- Storytelling
- Technique
- Uncertainty
- **Data**
- Contesting data
- Lag
- Theory
- Assumptions
- data collection
- Data vs humans
- data missingness
- Good data - Reliable data
- Multiple uses of data
- Authority
- Accountability
- Effects of indicators
- emulation
- External perception
- Longevity
- Management
- Transparency
- Science Governance
- assemblage
- limitations.
- Objectivity
- The use of science
- Replicability
- Technical
- Reaching (Measuring)
- Representations of the world
- Knowledge Justice
- citizen science
- infrastructure inequalities
- Mandate
- Tacit Knowledge
- Creativity
- Everyday fixes
- Frustration
- Hunch
- Imagination
- Pragmatism
- Standardisation
- Tools' production
- Quantitative Tools
- Alliances
- boat in the bottle
- competition
- Innovation
- institutional or a personal project
- self-critique
- scales
- Trust in the tools
- Miscellaneous

- Academic vs policy
- Assessment
- Capitalism
- Comparison
- Cooperation
- Demand
- Dependency
- Discourse
- Ethics of forecasting models
- Expectations
- Expertise
- Experts
- Field relationships
- Funds
- Hunting data
- Independence of science
- Internal perception of the Ethnography
- Internal perceptions
- knowledge justice,
- Lack of data
- Lay audience
- limitations.
- Linear development of technology
- Local
- Machine learning
- Methodology
- Modelling everything
- Other uses
- Personality
- Placing the data
- Policy
- Private Sector
- Programming language
- Public understanding
- Recommendation
- Remote sensing
- Responsibility of doing it
- Scepticism
- Shared futures
- Space and Social order
- Success
- Technique
- Trust in data
- Use of indicators
- What is data
- What is ViEWS
- Working as a community

