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Coastal Ecosystems at the Science-Policy Interface

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FACULTY OF SCIENCE | LUND UNIVERSITY

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II Defining the Boundaries of Climate Change Expertise: Science-policy interaction in the Structured Expert Dialogue.

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Coastal Ecosystems at the Science-Policy Interface

Terese Thoni

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Abstract:

Climate change is a growing threat to mankind. The message from the scientific community is clear: we need to act fast and profoundly. The political response has, however, been slow. The likelyhood that we will be able to meet our political climate goals only by reducing emissions is slim. Meanwhile is the interest around ways to capture carbon dioxide that has already been emitted on the rise. In addition to technical solutions currently being tested, ecosystems can be used in a similar vein. Most attention has been on forests. In this thesis I look at a less well-known way to mitigate climate change, namely to utilise the ability of coastal ecosystems, such as mangrove forests, salt marshes and seagrass meadows, to sequester and store carbon, or to protect existing ecosystems to avoid emissions. The political interest in this so called "Blue Carbon" has increased over the past decade, and it is now governed through, inter alia, national carbon inventories and carbon markets. More specifically, in this thesis I explore the "making of" Blue Carbon – how the carbon associated with coastal ecosystems is made knowable and governable in the context of climate change mitigation at the global level. Informed by social and environmental science, I draw on a range of methods, including participatory observations at the United Nations climate change negotiations, interviews with experts, and qualitative document analysis, to present new perspectives on Blue Carbon and how it is governed.

To understand the making of Blue Carbon it is, I argue, necessary to situate it in relation to broader processes within and related to climate science and policy. I identify three logics of the climate regime – the global, scientific and neoliberal logics – that I find useful for this purpose. I describe how these logics are articulated and reproduced in material, institutional, and discursive dimensions of the climate regime. I find that science, and more precisely a specific type of science, plays a particularly important role in the making of Blue Carbon, and in the context of climate policy generally. In the context of coastal ecosystems, science is needed to know the size of carbon stocks, which in turn is the foundation for creating policy mechanisms. I show that the making of Blue Carbon is indeed rendering coastal ecosystems governable in the context of climate change, which in turn opens the door for new governance mechanisms and funding sources. However, my study also reveals the complexities around measuring carbon in these ecosystems, and the challenges associated with collapsing something as dynamic as an ecosystem into a standardised protocol. This in turn raises questions regarding the possibility to address important uncertainties embedded in the making of Blue Carbon, not least given that these ecosystems are also vulnerable to the effects of climate change. There is a risk that an exaggerated focus on carbon services makes other values invisible, which could lead to a devaluation of these important ecosystems. There is also a risk of creating competition between ecosystems, with negative consequences for their management and wellbeing. I argue that these risks merit further consideration. A broader, more diverse, and more inclusive approach to knowledge-making in this context could be a first step, not least to be able to bring forward alternative ways of governing coastal ecosystems, or make more of the alternatives that already exist, depending on the desired outcome.

Key words: climate change, coastal ecosystems, Blue Carbon, science-policy interface, UNFCCC

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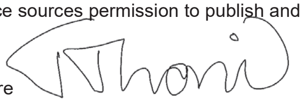
Signature 

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Contributions

I	TT and JEL contributed equally to the design, data collection, analysis, and writing of the article.
II	TT and JEL contributed equally to the design, data collection, analysis, and writing of the article.
III	TT developed the design of the paper, collected data, analysed the data and took the lead on the writing of the paper. SH analysed data on Soil Organic Carbon-methods. MR provided input regarding design, structure and framing of the paper. All authors revised the paper.
IV	TT designed the study, collected and analysed the material, and wrote the paper.

TT: Terese Thoni

JEL: Jasmine E. Livingston

SH: Sofia Hydbom

MR: Markku Rummukainen

Figures and Tables

Abbreviations

ANT	Actor-Network Theory
AR	Assessment Report
BAU	Business-As-Usual
BC	Blue Carbon
BCI	Blue Carbon Initiative
CBC	Coastal Blue Carbon
CBD	Convention on Biological Diversity
CDM	Clean Development Mechanism
CDR	Carbon Dioxide Removal
CfRN	Coalition for Rainforest Nations
CI	Conservation International
CO_2/CO_2e	carbon dioxide/equivalent
COP	Conference of the Parties
CSR	Corporate Social Responsibility
EbA	Ecosystem-based Adaptation
ENB	Earth Negotiation Bulletin
ES	Ecosystem Services
ET	Emissions Trading
ETS	Emissions Trading Scheme
FAO	Food and Agriculture Organization of the United Nations
GCM	General Circulation Model
GDP	Gross Domestic Product
GLF	Global Landscapes Forum
GWP	Global Warming Potential
ICCI	International Cryosphere Climate Initiative
INDC	Intended Nationally Determined Contributions
IOC-UNESCO	Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
JI	Joint Implementation
KP	Kyoto Protocol
LTGG	Long Term Global Goal
LULUCF	Land-Use Land-Use Change and Forestry
MPA	Marine Protected Area
NAMA	Nationally Appropriate Mitigation Action
NAPA	National Adaptation Programme of Action
NDC	Nationally Determined Contribution
NGO	Non-Governmental Organisation
NOAA	National Oceanic and Atmospheric Administration (of the United States)

PA	Paris Agreement
PES	Payments for Ecosystem Services
Ramsar Convention	Convention On Wetlands of International Importance
RCM	Regional Climate Model
REDD+	Reducing Emissions from Deforestation and forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
RSO	Research and Systematic Observation
SB	Subsidiary Body (also negotiations of the subsidiary bodies under the UNFCCC, which usually take place two times each year)
SBSTA	Subsidiary Body for Scientific and Technological Advice
SED	Structured Expert Dialogue
SPM	Summary for Policymakers
SPREP	Secretariat of the Pacific Regional Environment Programme
STS	Science and Technology Studies
TEEB	The Economics of Ecosystems and Biodiversity
TNC	The Nature Conservancy
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNGA	United Nations General Assembly
VCS	Verified Carbon Standards
Wetlands Supplement	2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands
WMO	World Meteorological Organization

Populärvetenskaplig sammanfattning

Klimatkrisen framstår mer och mer som det största hot människan någonsin ställts inför. Även om det politiska svaret kan beskrivas som avvaktande, pågår arbete för att på olika sätt minska klimatförändringarnas effekter, och hantera de risker vi kommer att ställas inför. Världssamfundet är enigt. Den globala medeltemperaturen bör inte öka med mer än 2 grader, och helst inte mer än 1,5 grader, jämfört med förindustriella nivåer. Riskerna med att överskrida 2-graders uppvärmning anses helt enkelt vara för stora. Problemet är att vi redan har släppt ut så stora mängder växthusgaser att det målet kommer att bli mycket svårt att nå enbart genom att vi minskar våra utsläpp, eftersom vi då hade behövt minska utsläppen radikalt och mycket snart. Det ser alltså ut som att vi, på ett eller annat sätt, även kommer att behöva ta hand om en del av de utsläpp som vi redan har orsakat. Det kanske mest uppmärksammade svaret på det här problemet handlar om att genom tekniska innovationer fånga in koldioxid som sedan lagras någonstans där den förhoppningsvis kommer att stanna kvar under en lång tid framöver, till exempel långt ner under jordens yta, eller på havets botten. Dessa innovationer har dock inte testats storskaligt och det är därför svårt att avgöra om de verkligen är ett alternativ för framtiden. Ett annat uppmärksammat svar handlar om massplantering av träd. Plantering av träd har samhället lång erfarenhet av, men med en ökande världspopulation och därmed ett ökat behov av mark för matproduktion, råder det delade uppfattningar kring hur stor potential den här åtgärden har.

I den här avhandlingen tittar jag närmare på en mer okänd åtgärd, nämligen att använda sig av kustnära ekosystem, så som mangroveskogar, sjögräs och kustnära våtmarker för att fånga och lagra kol – antingen genom att plantera eller återställa dessa ekosystem för att fånga in koldioxid, eller genom att skydda existerande system. Kustnära ekosystem är nämligen hotade av mänsklig aktivitet, inte minst klimatförändringarna. Genom att skydda befintliga ekosystem förhindrar vi att det kol som de redan har bundits, frigörs. Kol som fångas, lagras och/eller skyddas i kustnära ekosystem för klimatets skull kallas för ”blått kol”.

Att använda kustnära ekosystem för att mildra negativa klimateffekter har diskuterats internationellt de senaste tio åren. Från att ha varit en marginaliserad fråga har nu många länder skrivit in skydd eller förstärkning av blått kol i sina nationella klimatstrategier. Länder som USA, Australien och Förenade Arabemiraten ligger i framkant. Det pågår även satsningar på marknadsåtgärder –

både på den privata (”fria”) marknaden och den reglerade (statligt styrda). Redan idag går det att på den privata marknaden klimatkompensera utsläpp genom satsningar på mangroveprojekt.

Människan har alltid levt i och av naturen, och vi har länge styrt och reglerat naturen på olika sätt. Kustnära ekosystem är inte heller dem nya som politiska objekt, men de är alltså relativt nya i klimatpolitiken. Tidigare styrdes de politiskt främst genom olika typer av skydd av marina områden, eller sammankopplade med de varor som de producerar, så som fisk och timmer. Många människor bor och lever vid och av våra kustområden, och de är värdefulla på många sätt. Det är lätt därför att tilltalas av idén att kunna skydda eller förstärka dessa viktiga ekosystem, och samtidigt göra något som är bra för klimatet. För marknadsaktörer finns det även inkomstmöjligheter.

Min undersökning visar att introduktionen av kustnära ekosystem till klimatpolitiken öppnade dörrarna till nya politiska redskap och åtgärder, och ny finansiering, som potentiellt skulle kunna leda till minskad påverkan på klimatet och skydd av ekosystem och biologisk mångfald. En viktig faktor för att förstå introduktionen av kustnära ekosystem till klimatpolitiken är den roll som vetenskapen har spelat – inte minst gällande möjligheten att mäta kol i de här ekosystemen. För att kunna hantera dessa ekosystem som klimatpolitiska objekt behöver de vara mätbara och jämförbara på sätt som klimatpolitiken och/eller marknaden förstår. För att i sin tur förstå den roll som vetenskapen har spelat har jag förutom att studera kustnära ekosystem, även studerat vetenskapens roll i klimatpolitiken mer generellt. De övergripande resultaten visar att vetenskapen ständigt behöver profilera sig gentemot politiken. Vetenskapens roll i det här sammanhanget är ofta att informera politiken, men samtidigt får inte relationen bli för tät för då förlorar vetenskapen trovärdighet. Den här balansgången är svår och krokig, och mer komplex än idén om en tydlig gräns mellan politik och vetenskap gör sken av. Den här komplexiteten är inte i sig problematisk, men riskerar att bli det om politiska diskussioner osynliggörs. Huvudslutsatsen jag drar av mina studier är att den här risken potentiellt hade kunnat minskas genom en mer inkluderande process med fler aktörer och olika typer av kunskap, istället för att begränsa debatten till en mellan en viss typ av vetenskap och beslutsfattande. Det hade dessutom kunnat minska bördan för vetenskapen, och öka det demokratiska inflytandet i processen.

De möjligheter som klimatpolitiken har öppnat upp för kustnära ekosystem som politiska objekt åtföljs av ett antal risker. Huvudriskerna har att göra med att ett fokus på kustnära ekosystems potential som kolsänka, och (monetär) värdering av dessa ekosystem utifrån hur bra de är på att fånga och lagra kol riskerar att osynliggöra andra, minst lika viktiga, värden. Till exempel går ett fokus på kol inte nödvändigtvis hand i hand med skydd av biologisk mångfald – om huvudfokus är att fånga kol, vad är det som säger att vi inte prioriterar monokulturer med den art som är bäst på att fånga kol, och inte mångfald? De mätmetoder av blått kol som finns är dessutom osäkra, inte minst som en oundviklig konsekvens av att ekosystem är dynamiska och inte med lätthet passar in i standardiserade mätprotokoll. Att minska dessa osäkerheter är svårt eftersom undersökningarna är resurskrävande. Det gör att det finns en överhängande risk att mätningarna överskattar eller underskattar kolfördelarna. Om vi skapar ett system där värdet av ett ekosystem mäts i kol, betyder en underskattning av ekosystemets värde i kol, en undervärdering av hela ekosystemets värde. En överskattning å andra sidan riskerar att göra att vi tror att vi har utrymme att släppa ut mer växthusgaser än vad vi egentligen har. Problematiken ökar av att kustnära ekosystem är känsliga för klimatförändringar. I värsta fall riskerar vi att skapa ett system som systematiskt överskattar kustnära ekosystems kolfördelar, vilket i sin tur leder till ökade utsläpp.

Det råder ingen tvekan kring att kustnära ekosystem är ovärderliga. Däremot är det inte säkert att det bästa sättet att skydda dem är genom att fokusera på deras roll i kolcykeln. Det finns dock alternativ. Förutom de åtgärder som redan nämnts återfinns satsningar på kustnära ekosystem även inom klimatanpassningssektorn. Kustnära ekosystem skyddar kusten på många sätt. Genom att lägga fokus där istället stannar frågan inom klimatpolitiken, men åtgärderna värderas inte baserat på osäkra mätningar av kol. De fördelar för klimatet som bevarande och (åter)plantering av kustnära ekosystem medför får vi ta del av ändå, men de konkurrerar inte med andra åtgärder för att mildra klimatförändringarnas effekter. I ett bredare perspektiv är det viktigt att inte blanda ihop åtgärder för att mildra klimateffekter, och slutgiltiga lösningar på hela klimatfrågan. Hur mycket sjögräs eller hur många träd vi än planterar kommer vi inte kunna lösa klimatfrågan utan att också hantera utsläppskällorna.

1. Climate Blues

> The time is long gone when we could afford delay.
>
> Each day brings further evidence of the mounting existential threat of climate change to the planet.
>
> Every day that we fail to act is a day that we step a little closer towards a fate that none of us wants – a fate that will resonate through generations in the damage done to humankind and to life on Earth.
>
> Our fate is in our hands.
>
> Let us finally commit – together – to rise to the challenge before it is too late.
>
> *António Guterres, Secretary-General of the United Nations, High-Level Event on Climate Change, September 2018*

Climate change has been called the defining issue of our time (Guterres, 2018), and the greatest threat to future generations (Obama, 2015). In Paris in 2015, nations recognised "[…] the need for an effective and progressive response to the urgent threat of climate change" (United Nations, 2015). This response includes "[h]olding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels" (Ibid., Article 2). Meanwhile, the Intergovernmental Panel on Climate Change (IPCC) tells us that the likelihood that we will meet our political goals are slim if we do not find a way to not only bring greenhouse gas emissions down to zero, but to also remove large amounts of carbon dioxide from the atmosphere - we need "negative emissions" (Fuss et al., 2014; IPCC, 2018).

The response is spelled Carbon Dioxide Removal (CDR), either engineered techniques such as pumping carbon dioxide into geological formations, or natural such as reforestation. CDR is part of all of the IPCC's 1.5 °C-pathways with no or limited overshoot (exceeding 1.5 °C temporarily) (IPCC, 2018). Climate engineering has transformed from being met with suspicion to being considered an acceptable future (Gupta & Möller, 2018). The acceptance of climate engineering however does not come from experience. In fact, it is yet to be tested on a larger scale (Fuss et al., 2014). If climate engineering techniques are unavailable, the other part of CDR – the use of natural sinks, needs to be even more strengthened (UNFCCC, 2015). In this context, references are most commonly made to land-based sinks in the agricultural and forestry sectors (Dooley & Gupta, 2017; IPCC, 2018; UNFCCC, 2015). There may, however, be another more or less untapped carbon sink to add to the CDR-strategy. Coastal ecosystems, including mangroves, seagrasses and salt marshes, sequester carbon and store it in biomass and sediments. Hence, protecting and restoring these ecosystems make us less dependent on complex, technical, untested, large-scale climate engineering solutions (e.g. Kuwae et al., 2016; Nellemann et al., 2009). These ecosystems are already doing the job for us if we only let them, the argument goes. However, if we destroy them, which we are currently doing, the carbon stored is released back to the atmosphere (e.g. Pendleton et al., 2012). This carbon "the carbon stored, sequestered and released from coastal marine ecosystems such as mangroves, salt marshes and seagrasses" is called *(Coastal) Blue Carbon* (Herr et al., 2012). Protecting our Blue Carbon is important for our climate, and as an added bonus, we can enjoy many other benefits people obtain from ecosystems (Nellemann et al., 2009). Protecting and restoring coastal ecosystems is "[…] a "triple win" for climate mitigation, climate adaptation, and habitat conservation efforts because coastal blue carbon ecosystems provide all three of these important benefits simultaneously" (Sutton-Grier & Moore, 2016, p. 274).

In this thesis, I twist and turn the premise of Blue Carbon. I deconstruct it and I look at the processes enabling it. This in turn leads me to investigate the contexts, materials, and ideas that Blue Carbon is embedded in. Blue Carbon was, and still is, framed as a technical and scientific issue, and scientists have played an active and important role in bringing Blue Carbon to the agenda, and making it knowable in a way that can be understood by policy. Hence, Blue Carbon did not develop in isolation and I have therefore complemented research about Blue Carbon, with studies focussing on science-policy interaction. Studying the making of Blue Carbon, I argue, also provides insights into the co-production of science and policy.

That said, while the relationship between science and policy comes across as particularly interesting in the case of Blue Carbon, it is not the only piece of the puzzle. If there is one thing I think the case of Blue Carbon shows, then it is that complexities matter. Hence, understanding the making of Blue Carbon is not as easy as understanding how topics understood as scientific or technical, Blue Carbon being one such topic, are made governable. Science is not the only relevant "actor" to follow, and "scientisation" not the only interesting process to look at.

As will become apparent in the subsequent sections, the field of science-policy studies is a broad and densely populated one. As a field, it is interested in many other scholarly fields, and in particular topics that are complex. Climate change is one of them, sometimes called a "super wicked problem" (Levin et al., 2012). Blue Carbon, in turn, is defined within the umbrella of climate change governance. I have made most use of, although not been restricted to, the science-policy literature within the subfield of climate change. Moreover, my methodological approach, as developed further in Section 4, has been to trace, and follow, the Blue Carbon-issue where it goes, and that has been a journey not restricted to the realms of science or the science-policy interface. Therefore, while I think and hope that insights from this thesis can be used to better understand the role of science in policy in general, Blue Carbon is at the heart of this thesis. By that, I refer both to its thematic focus as well as to its main contribution. As for the latter, Blue Carbon is a new topic on the political agenda. It is in a formative stage and there is still time to change its focus, if deemed necessary. Through unearthing processes around Blue Carbon, I hope to contribute to the debate regarding how to (best) protect or manage our coastal marine ecosystems, and the implications of different choices. Hence, I hope to contribute both empirically as well as normatively to this emerging field. The latter not by providing – constructing – policy advice, but rather through the act of deconstruction – to reconsider taken for granted facts, turn stones left unturned and, in extension, possibly open new doors.

Aim and Research Questions

The overarching aim of this thesis is to contribute to research on Blue Carbon, a field that has thus far been dominated by the natural sciences. Informed by social and environmental science, I provide new perspectives on this issue, its advantages and disadvantages, and thereby hope to contribute to finding sustainable and plausible approaches to the conservation, protection and restoration of coastal ecosystems. More specifically, the aim is to investigate how coastal ecosystems became Blue Carbon-ecosystems – how they were made knowable, governable and what world(s) this process in turn enacts. Making coastal ecosystems governable as carbon has developed with making forests and other ecosystems governable as carbon, and rendering "nature" governable in general. Against this backdrop I argue that Blue Carbon is an interesting topic to investigate not only because of its role as carbon sink, but also for what it says about the relationship between human and nature, and whether or not such a division is meaningful.

Empirically, this thesis contributes with information regarding the processes used to make Blue Carbon an object amenable to policy interference. As argued above, the role of science and the interaction between science and policy are key parts of the making of Blue Carbon. To better understand this process, I also look at two science-policy interfaces within the climate regime – the IPCC and its internal work on its future, and the UNFCCC Structured Expert Dialogue. In addition to helping describe the issue of Blue Carbon, examining these two sites add empirical findings to the diverse literature of science-policy interaction. The aspiration is that my analyses and case studies can be used to discuss, deconstruct and investigate the role of science in policy also in other contexts. That said I do not wish to belittle the importance of context. In fact, one of my main findings is that context matters a great deal.

Theoretically, I draw specifically on two overlapping bodies of work. The first one is “new materialism”, sometimes referred to as “relational materialism”, or “neo materialism”. How non-humans, like ecosystems, are rendered governable are common themes within this strand of theoretical thinking. This thesis brings the case of Blue Carbon under scrutiny by the tools and approaches proposed within new materialism, and thereby contributes to this growing body of literature.

The second, overlapping, body of literature looks at the interaction between science, policy and society and comes from the field of Science and Technology Studies (STS). Some would place new materialism under the umbrella of STS, which is why I refer to them as overlapping. There are, however, some differences that I discuss further in Section 3. What matters here is that together these two bodies of work cover two entangled themes – notions of the material and the relational more broadly, and the relationship between science and policy.

The most important theoretical contribution stemming from this thesis is, I believe, to bring new materialism in conversation with environmental science. I argue that these fields have a lot in common, and together bring forward concepts that are useful in order to understand the making of Blue Carbon from many angles.

To answer my overarching research question regarding how costal ecosystems became Blue Carbon-ecosystems and how this development can be understood - this study focuses on contexts and processes. Contexts differ in terms of their geography and their constitution. Processes carry, by definition, a temporal dimension. They are dynamic, consisting of series of actions and thus do not represent a single moment in time. This sensitivity to contextual and temporal dimensions, and their entanglement, informs the specific research questions this thesis explores.

> RQ1: What characterises the material, institutional and discursive settings in which the idea of Blue Carbon was articulated?

Responding to this question puts the making of Blue Carbon in a wider perspective - how it became thinkable, and how this relates to the broader issue of making nature governable. Furthermore, an important theme for this thesis is the key practices involved in rendering coastal ecosystems governable. The following three questions engage more directly with the making of Blue Carbon, and possible implications. I ask:

> RQ2: How are coastal wetlands made governable as a response to, or effect of, the logics of the climate regime?

RQ3: What role has the co-production of science and policy played in the making of Blue Carbon?

RQ4: What realities do Blue Carbon enact, in terms of social values made visible and invisible?

Answering these questions involves looking into what processes and objects in the environment are considered important and what tools and technologies are used to investigate them, how scientific knowledge is translated to policy, and what policy options are deemed acceptable. While RQs 1-3 focus on the past and the present, RQ4 focusses on the future. Understanding the making of Blue Carbon involves, I argue, thinking about what values the making of Blue Carbon makes visible, and what it makes invisible. It involves thinking about how Blue Carbon with its methods and its apparatus generates meaning and makes certain realities possible.

As I will discuss in more depth in the following sections, an underlying understanding of this thesis is that the world is a dynamic, changing place, not stable, which also means that even the things, indeed even "realities" that we take for granted *might be otherwise* (Law 2004, p. 66). That is not necessarily the same as positing that they *should* be otherwise, but rather that we should be open to the idea that there may be other possibilities worth exploring.

Environmental Science Contribution

This is a thesis in Environmental Science. Environmental Science is commonly understood as an interdisciplinary discipline that studies the environment, and ways to solve environmental problems. It is thus an optimistic field – environmental problems can be solved. The idea that it *might be otherwise* (Law, 2004) is also optimistic in the sense that it opens up for other possibilities. However, mainstream environmental science tends to start by trying to understand the problem and then finding a pragmatic solution to it *within* the same setting. Thinking about how it could be otherwise requires us to look beyond the immediate setting. This may sound straightforward, but imagining settings that do not exist today, require, I believe, theoretical tools that can help us bring forward new stories and imaginaries about the world we live in. These questions become rather abstract when talked about in a general sense, so I will exemplify what this could mean using the case of Blue Carbon.

As I will discuss more in detail in subsequent sections, making Blue Carbon governable is tied to a neoliberal understanding of how to manage "nature". However, is it not this logic that also got us into a situation of accelerating climate change and mass species extinction? Will we be able to use the same means to take us out of this situation that got us here in the first place? If so, are there any amendments or precautions we should consider? This is just one example and, for the sake of the argument, presented in its most simplistic terms. My point is that asking critical questions and thinking about how realities could be otherwise are, or at least should be, at the heart of environmental science as a field. If we want to find the best possible solutions to environmental problems, then we should also consider all possible solutions, including those that question the foundations of our society (cf. Pielke Jr., 2018, for a similar argumentation).

To be able to understand the making of Blue Carbon, I needed to attend to the ecological functions and processes of Blue Carbon-ecosystems, their role in the carbon cycle and how we acquire knowledge about this, as well as how this knowledge is converted and transformed into policy. I also needed to foreground questions about the nature of the climate regime, its functions and processes, how scientific knowledge is used and how something as complex as an ecosystem is made to fit the structures of the climate regime. Having studied both environmental science and critical social sciences, I came to the conclusion that none of these fields in isolation offered tools that would help me enter these complex systems, understand their interconnectedness, and at the same time not overlook their specific natures. However, bringing environmental science and critical social sciences into conversation offers, I suggest, a fruitful way forward. Critical social sciences offer concepts to deconstruct taken for granted "truths" – in this case about how to make "nature" governable and the dichotomy between nature and society (see also Blok, 2014; Demeritt, 2002; Robertson, 2012), as well as the relationship and the dichotomy between science and policy. Critical social sciences also offer conceptualisations around societal structures and power relations, including, and perhaps of particular interest to environmental scientists, on the question of who gets to speak on behalf of "nature". When put in conversation with environmental science, questions regarding how to make nature governable can be problematised by looking at the "nature of nature" (e.g. Nogués-Bravo et al., 2016; Whatmore, 2002). "Nature" or the "environment" may not have a voice in the same way we do, but it has "agency", or the ability to "strike back" (e.g. Hinchliffe, 2008; Plumwood, 2009; cf. Latour, 2000). In the case of Blue Carbon this could, for instance, be thought of in terms of sea level rise due to anthropogenic climate change, forcing mangroves to retreat where possible, or die back, which in turn would adversely affect us through the release of carbon that we had already accounted for, loss of adaptive capacity, and loss of resources such as fish and fuel.

Recent developments in the critical social sciences draw towards the idea of a "flat ontology" – an understanding of reality that does not presume that humans possess more power than artefacts or nature, or a "more-than-human ontology" that dismisses the dichotomy between nature and society (e.g. Kuby, 2019; Mol, 2002; Whatmore, 2006). These ideas are considered almost radical within the social sciences, however, the natural sciences are no strangers to the idea of a blurred line between what is human and what is non-human, or that nature has "agency" – it is just expressed differently. Hence, similarly to how (critical) social sciences can bring tools to think about how society, structure and power affect the environment, environmental science and natural sciences broadly can help social sciences understand agency and the behaviour of nature relevant to questions regarding society, structure and power. How nature is rendered governable is a question that has foremost been dealt with in the critical social sciences. I suggest that not only is this issue of interest for environmental science, but one where environmental science can make a significant contribution.

Overview

This thesis consists of five parts – this "kappa", and four papers. In the kappa, I summarise the findings in the papers, put them in a broader context and engage with them in relation to the societal and scholarly debates about science-policy interaction, as well as how climate change is made governable. My papers, in turn, can be divided in two parts. Paper I and II deal with the relationship between science and policy in the context of climate change in general. They also provide insights regarding the material, institutional and discursive settings that Blue Carbon arises from and operates within (RQ1 and RQ2 primarily). This includes covering the co-production of science and policy (RQ3). Paper III and IV deal with the making of Blue Carbon more directly but they also provide insights regarding the climate regime, and the relationship between science and policy (i.e. RQ1-4 but in different ways).

Paper I engages with the discussion regarding the ideal distance between science and policy. It does so by applying a typology of science-policy interaction to the case of the internal review of the future of the Intergovernmental Panel on Climate Change (IPCC). The main finding in this paper is that the debate regarding the distance between science and policy is one that extends beyond these two spheres. Focusing on this divide creates more division. A more constructive way of overcoming ontological differences on the relationship between science and policy is to break down the question to more manageable pieces.

Paper II investigates one particular science-policy interface, namely the Structured Expert Dialogue (SED) of the UNFCCC. It studies how boundaries are drawn between experts and non-experts in this context, between science and non-science and science and policy, and discusses the implications of this "boundary work". It finds that while the drawing of boundaries and defining of roles are necessary parts of any science-policy interaction, these processes are formed by external structures and are limited to the actors already involved in the process. Future iterations of the SED or similar activities should pay better attention to this and thereby make sure that the all types of relevant expertise and knowledges are included in the process.

Paper III dives into the making of policy-relevant science, by summarising, comparing and discussing different methods of measuring Blue Carbon in soils and sediments, and their implications for both science and policy. It finds that even the most robust scientific methods may produce volatile results that are not as easily translatable to policy as often suggested. It brings calls for robustness and comparability into question by showing that it may not be realistic to ask for both, and requests a more pragmatic and diversified approach adaptable to questions asked and the purpose of Blue Carbon-studies.

Finally, **Paper IV** studies how coastal ecosystems became Blue Carbon-ecosystems and thereby rendered governable within the climate regime. It describes how the issue went from being discussed by only a handful of experts and representatives from conservation organisations, to being discussed at the UN climate change negotiations, included in countries' national inventories, and entering climate markets. While it discusses the role of science and expertise, it stresses the co-productive nature of the making of science for policy, and the entanglement of processes and actors. It shows that while the making of Blue Carbon renders coastal ecosystems governable as carbon, values other than carbon are made less visible. This may have unwanted consequences, especially as the carbon benefits that the rationale behind Blue Carbon-strategies builds on are difficult to estimate, and long-term effects uncertain.

This **Kappa** consists of 6 sections. This overview concludes the first section, the introduction, which explained Blue Carbon's position in the context of climate science and policy, and introduced this thesis' research puzzle and contributions. Section 2 describes "the big picture" - the wider settings of Blue Carbon and their material, institutional and discursive dimensions. In Section 3 I turn to the importance of contrasting the big picture painting with micro-scale studies. I draw specifically on notions of relationality and conceptualisations of the material. In Section 4 I describe my methodological choices in more detail and present methods and material used. In Section 5 I bring forward important findings in my papers as well as findings that emerged from the collection of studies and questions asked during the years that I have worked on this thesis, to discuss how we can understand the making of Blue Carbon. In the concluding section, Section 6, I summarise and look forward and outwards.

2. The Big Picture

> Purity is not what science is made of: behind the force, the wings of angels are still invisibly flapping.
>
> *Bruno Latour, 2014 "Agency at the time of the Anthropocene"*

This thesis aims at understanding the making of Blue Carbon, and discussing its implications. However, Blue Carbon is not something that exists on its own. Blue Carbon is an idea emerging from and operating within certain settings. While its political and institutional forms can be different, it always revolves around climate change mitigation through the use of coastal ecosystems in different ways (conservation, restoration and plantation).

Climate change mitigation in turn deals with how to best address the biggest challenge mankind has ever faced. No matter what theoretical concepts we place in our tool-box, the task is daunting. Therefore, this chapter should not be seen as an attempt to try to describe all important aspects of climate change mitigation. My focus here is rather to foreground the, as I call them, *logics* of the climate regime – fundamental ideas regarding how climate change can and should be governed. These are, I propose: the global, scientific and neoliberal logics. Blue Carbon, as climate change mitigation, can, I suggest, be thought of as an effect of, and part of, these logics.

A logic is an argument, a position, a rationale. However, logics, as discussed in this section, also get materialised in, for instance, tools, institutions, protocols, and conventions. According to the Cambridge Dictionary, a logic is "a particular way of thinking, especially one that is reasonable and based on good judgment"[1]. This definition draws attention to the stability of a logic. This stability, as examplified below, comes from, I propose, a) being taken more or less for granted – logics are logical, and b) being self-reinforcing. A logic is, however, and for the same reasons, also dynamic, and they enact socio-technical worlds. In making this distinction, and in choosing to use the concept of logic rather than, for instance, "background", I want to, in line with new materialism, avoid describing Blue Carbon as a stable,

[1] <https://dictionary.cambridge.org/dictionary/english/logic>

inactive object in a stable, inactive context, and instead draw attention to relationality and processes (see e.g. Latour, 1991, also Section 4 more generally). This means that I think of Blue Carbon as an effect of these logics, as well as a part of them. I talk about *logic* in singular when referring to one of the three logics outlined below, and in plural when talking about two or more. This is simply for reasons of linguistic clarity. Just like Blue Carbon did not develop in isolation[2], these logics are connected with other issues as well, and they can be broken down into smaller parts.

I start my analysis with international climate change science and policy – the place where the debate around Blue Carbon took off. For each logic I first describe how they are expressed and materialised in the climate regime, before turning to questions regarding what they do, their effects, informed by scholarly literature primarily from the field of Science and Technology Studies (STS). I argue that these logics have in common that they in turn operate on a "logic of extraction" (Kuntz, 2015)[3] that removes information from its context and makes it general. The logic of extraction renders climate change mitigation governable at the international level. The price of this is a loss of accessibility and inclusion, an issue I return to in the subsequent sections.

A Global Logic

This section starts with a short history of global climate science and international policy. I give examples of where in the climate regime and how the global logic is expressed and materialised.

There is of course also climate research looking at local climate effects, and there is local climate policy[4]. The purpose of this section, however, is to outline one of the

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[2] Does anything ever develop in isolation? According to new materialism, the answer is no. For instance, Actor-Network Theory (ANT, see Sections 3 and 4) holds that everything is the sum of its *associations* – its connections and relationships in the broadest sense of the words. While ANT is interested in *actor-networks*, environmental science is interested in *webs*. In either case, isolating objects or phenomena is only every relevant for analysis, if at all.

[3] Developed from Aaron Kuntz's book "The Responsible Methodologist" (see also Section 4). Even though the topics are different, I find that it is a helpful concept to think about the development of climate change as a governance object as well.

[4] The IPCC is also going in the direction towards more context specific information. For instance, during its internal review, covered in **Paper II**, it became clear that most governments want more regionally specific information. The IPCC is currently preparing its Sixth Assessment Report, which will include more regional information than before <https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/>. Still, the IPCC is mandated to serve the international community and the information it presents is adapted accordingly.

underlying logics of the climate regime, namely that climate change is a global problem, and to discuss what this global logic does. That is not the same as saying that climate change is not also a local issue, or that it should not be treated as such. Environmental issues in general are commonly seen as transboundary. As an example, pollutants can be transported by air, water, or by organisms, magnified upwards in the food chain, beyond national borders. That said, what is counted as a global versus a local environmental problem is not given – it is socially constituted and may be temporal and context specific (Lidskog & Sundqvist, 2011). For instance, water quality is usually seen as a local problem and climate change a global, but water quality issues are not always only local and climate change has local effects and implications (ibid).

Examples of a Global Logic

Climate change science has a long history. The Earth's so called "greenhouse effect" was described already in 1824 (Fourier, 1827). By the end of the 19^{th} century, the link to human activity was established (Arrhenius, 1896), although at the time man-made climate change was hypothesised as a positive development for mankind.

It was not, however, until the 19^{th} century that the word "climate" started being used for the global system – before this the word *climate* was mainly used to describe local or regional weather (Allan, 2017). Much of the foundations of today's climate research grew out of military interest in the climate system. The end of World War Two with the nuclear bombings in Hiroshima and Nagasaki followed by tests of bombs helped create an understanding of transboundary air pollution and the implications of a shared atmosphere (Lidskog & Sundqvist, 2011). During the Cold War, patterns of radioactive waste, better understanding of ocean circulation to inform submarine navigation, and the Arctic as a potential future battlefield are examples of interlinkages between military interests and climate science (Allan, 2017).

In a paper published in 1957, oceanographer Roger Revelle and chemist Hans Suess published findings that showed that the oceans are not able to absorb all carbon dioxide emissions, as commonly believed at the time, and suggested that if industrial development continues, carbon dioxide emissions will become significant (Revelle & Suess, 1957).

In 1975, Wallace Broecker coined the term "global warming" (Broecker, 1975). In the 1980's, advances in satellite and computer technology made it possible to model climatic processes, presented as General Circulation Models (GCMs), which enabled scientists to understand the climate system in new ways (Edwards, 2010).

The 1980's was also the time of growing attention around international environmental and climate policy, leading up to the establishment of the United

Nations Framework Convention on Climate Change. One important event was the "International conference of the Assessment of the role of carbon dioxide and of other greenhouse gases in climate variations and associated impacts", called the Villach Conference in 1985 (WMO, UNEP & ICSU, 1986). One of the outcomes of the conference was an expert group on climate policy, followed by the establishment of the Advisory Group on Greenhouse Gases in 1986 – an early attempt to organize expert advice for climate policy (Agrawala, 1999). Two years later, the Intergovernmental Panel on Climate Change (IPCC) was formed, endorsed by the UN General Assembly Resolution 43/53 "Protection of global climate for present and future generations of mankind". The resolution states that UNGA is "Convinced that climate change affects humanity as a whole and should be confronted within a global framework" (UN General Assembly, 1988).

The IPCC is an intergovernmental body open to all member states of the United Nations and the World Meteorological Organization (WMO). The interplay between the scientific and political elements takes place on various scales, from that of international politics to the writing of a report (e.g. Hughes, 2015; Livingston et al., 2018). In 1990, the IPCC's first Assessment Report (AR) was released. Since then, five[5] have been published and the sixth is currently being produced. In its first report, the IPCC concluded that the temperature of the Earth has risen due to anthropogenic emissions of greenhouse gases and that the warming is likely to continue (Houghton et al., 1990).

The most important international policy response to climate change - the United Nations Framework Convention on Climate Change (UNFCCC) - was born out of the United Nations Earth Summit in 1992 in Rio de Janeiro. The ultimate objective of the Convention was and still is the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (United Nations, 1992). The first Conference of the Parties-session (COP) took place in 1995 in Berlin (UNFCCC, 1995). In 1997, the first binding targets (for developed, so called Annex-1, countries) through the Kyoto Protocol were agreed upon, although it took another eight years before the agreement came into force.

Even though the ultimate objective of the UNFCCC has not changed, the institutional arrangements have. The perhaps most obvious such change is the shift from a division between developed and developing countries (Annex-1 and non-Annex 1 countries) - the Kyoto Protocol, to an agreement without such strong

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[5] First Assessment Report (FAR), Second (SAR), Third (TAR), Fourth Assessment Report (AR4), Fifth (AR5) and the upcoming, sixth (AR6).

division[6] – the 2015 Paris Agreement (PA) (United Nations, 2015). In this sense, the UNFCCC has become more global, more encompassing. At the same time, the PA also meant a shift from a top-down approach with specified targets and timelines, to a bottom-up design, with "Nationally Determined Contributions" (NDCs) (for a comprehensive elaboration on this shift see e.g. Lövbrand & Bäckstrand, 2015).

Effects of a Global Logic

The account above serves as a short history of global climate science and international policy, and points out expressions and materialisations of the global logic. The remainder of this account turns the attention to how we can think about this logic and its effects.

An underlying idea of how I approach Blue Carbon specifically, but climate change generally that guides the analysis in this section and onwards, as well as **Paper IV**, is to think of Blue Carbon as well as Climate Change as objects of global governance, following Allan's (2017) model of the making of global governance objects (see also Corry, 2014). Or, in the case of Blue Carbon - an object of global governance in the making. According to Allan (2017, p. 136), "[r]eferring to these entities as objects helps to highlight that they are hybrid entities, not disembodied ideas or norms, which have both a knowledge and a physical or practical component". This approach, I find, both facilitates analysis and fits well with the material-semiotic approach that I will turn to in the next chapter.

According to Allan, to become a global governance object, an issue needs to be delineated from other issues – *designated*. It also needs to be *translated* "into a portable, global object" (Allan, 2017, p. 137). Portable in this context means that even though it needs to be stable enough to be recognised as an object, it needs to be flexible enough to be understood and related to across countries and cultures. To enable this translation, "modes of abstraction" can be used to "…remove elements of context to isolate specific properties" (ibid. p. 138). This extraction of information fits well with the description of how other scholars have explained the making of climate change as a global issue. For instance, Lövbrand, Stripple, and Wiman (2009) argue that a number of rationalities and technologies – such as satellites and global monitoring systems - have enabled us to understand the earth as a single and controllable system. This development in turn has enabled policy responses built on meticulous counting of carbon at all levels – from the global to the individual (Lövbrand & Stripple, 2011). One of these underlying rationalities, that is perhaps particularly important in the context of Blue Carbon, is the idea of a

[6] Still recognising that different countries have "common but differentiated responsibilities", but also "respective capabilities".

global "carbon sink" (see e.g. Ehrenstein, 2018; Lövbrand, 2009; Lövbrand & Stripple, 2006), made up of the biosphere and the oceans.

Hulme highlights how the practices of climate change science have focussed on gathering global data, which in turn has shaped our understanding of the matter: "global kinds of knowledge yield global kinds of meaning-making and policy-making. They erase cultural differentiation and heterogeneity" (Hulme, 2010, p. 563). Erasing cultural differences and losing the local perspective means that only a certain type of knowledge is recognised, and we miss out on the opportunity to learn from the local levels how they tackle this issue. Climate change science therefore, Hulme (2010) argues, needs to rethink the benefits of globalised knowledge and consensus-seeking, to the advantage of a more inclusive process and more context specific and local types of knowledge. A more inclusive process is also more in line with our democratic values and could spur more action on climate change, as policy-makers ultimately need the support from the people (Lidskog & Sundqvist, 2015; Murray, 2012). Indeed, for environmental science and policy it is otherwise common to argue that those affected by an issue should be heard and invited to the knowledge making around it (Berg & Lidskog, 2018a). Perhaps because climate change affects all of us, this way of thinking is not something that stands out when it comes to climate change generally. For instance, the IPCC only assesses and communicates specific types of information (Ford et al., 2016; Pearce et al., 2018). Moreover, even though the IPCC as a body does not carry out scientific research, the process of summarising and assessing the available climate science for policy, primarily the UNFCCC-negotiations, means that it is involved in creating a certain kind of climate change knowledge – global, technical and focussed on carbon (Edwards, 2010; Hulme, 2010; Jasanoff, 2010).

According to Allan (2017, p. 141), the role of science and expertise is particularly important in making global governance objects as scientists and experts "control and reproduce modes of abstraction throughout transnational, interdisciplinary communities of practice". In terms of translation, models and numbers are particularly useful tools as their languages can easily be understood internationally (ibid. 142). As outlined above, technological advances such as computer modelling and satellite data, stimulated climate science and enabled us to understand climate change in new ways, not least through GCMs. While models can inform decision-making on climate change, Jasanoff cautions that "[…] models may engender a false confidence that all of what needs to be known is contained within the inner workings of the model itself" (Jasanoff, 2015, p. 41; see also Thompson & Smith, 2019). Hence, models capture certain types of information, but make other types of information invisible. Similarly, metrics – quantitative data generated in order to assess a process - enact our world in specific ways through their ways of making visible certain phenomena (Beer, 2016). They also tend to reinforce themselves (ibid.). In climate science, models are used in various ways. Climate models, simply speaking, are numerical representations of the world's climate system, fed with different types of data and run on different assumptions made. For instance, models used to project future climates are initiated running on observational data, before continuing with experimental/theoretical analysis (Knutti, 2008). The performance of models – how accurate they have been compared to observational data - is later on checked against observations (ibid), the underlying assumption being that models that can accurately model the past have a better shot at projecting the future. Underlying assumptions in the model in turn can make a big difference for the results (Stainforth et al., 2005), and policy options considered. Moreover, while uncertainties in scenario development are transparently presented, ambiguities receive less attention (Enserink et al., 2013). Certain types of data are also easier to use, and certain types of scenarios easier to analyse. For instance, when projecting climate change, abrupt changes, such as so called "tipping points", are challenging to include, although efforts to make climate models better at predicting abrupt changes are ongoing (Klus et al., 2019).

To interpret the results of climate models, trends are visualised at the expense of variability and outliers (e.g. Enserink et al., 2013; Pielke Jr., 2018). Essentially, Edwards (2010) explains, our climate is not something we can study using experiments only – the scientific method otherwise considered most robust - because the climate system is too complex (see also Parkhurst, 2017). Therefore, we need models. There are different types of models and they use different types of data. In Edwards words "making data global" is the process of making "coherent global data images" from "highly heterogeneous, time-varying observations" (p. XV, introduction).

Moreover, GCMs run on low resolution and relatively large grid sizes, as high resolution would require more data capacity than currently exists (Rummukainen, 2010). To be able to look at a specific area or process in higher resolution, Regional Climate Models is a downscaling technique that complements GCMs (Rummukainen, 2016). RCMs is a growing field and both GCMs and RCMs have increased their resolutions (ibid.). RCMs still, however, build on GCMs as just explained, and no matter how high the resolution, a model is and always will be a simplification of reality or it would not be a model. Therefore, regardless of how good the models are, there are limits to what models can do - something that model developers are aware of, but perhaps not always policy-makers or the general public (Thompson & Smith, 2019). The question here is therefore not primarily how to make better models, but what type of information is lost through modelling. Alternatively, thinking of climate models as "modes of abstraction", it becomes clear that science plays an important role in the making of climate change as a global issue (Allan, 2017), and turns attention to who is affected by this simplification, if and how it matters, and what type of information that could complement information from models.

The examples above, I find, illustrate how making climate change mitigation global operates on a logic of extraction, which might produce a democratic deficit. More specifically, a core issue seems to be that this process is not opened up to deliberation. Indeed, in International Relations-studies, the making of a governance object is often not even considered – analysis tends to start with agenda setting (Allan, 2017). Or, as Berg and Lidskog put it: “If a narrow (scientific) framing of an environmental issue is taken for granted, one of the most fundamental aspects of environmental policy – the object of policymaking, the environmental problem – is not included in the deliberations.” (Berg & Lidskog, 2018a, p. 12). Therefore, increasing deliberative capacity of global governance and democratisation of science often go hand in hand (Berg & Lidskog, 2018a; 2018b, see also Craig, 2014 and the literature on citizen science). In other words – given the important role of science in the making of global governance objects, one way of decreasing the democratic deficit would be to make the underlying science more inclusive. An alternative or complement could be to make the process of brokering scientific information to policy more inclusive – in the case of climate change that would mean making the IPCC process more inclusive (see the literature on IPBES for a more in depth discussion on the attempts of making the biodiversity regime more inclusive, e.g. Beck et al., 2014; Montana, 2017).

Another, more direct option also discussed in the scholarly literature but thus far only to a limited extend implemented, is to make global environmental governance more inclusive. There are elaborate suggestions for how this could be done more specifically in the literature, for instance approaches that foster “deliberate democracy”, more direct citizen involvement, and cosmopolitan governance models (Bäckstrand, 2011; Dryzek, 2006; Hajer, 1995; Vanderheiden, 2008). International governance is inevitably further away from the people and thus the issue of democratic deficit even more pronounced than on the national or local level, which in the end can lead to implementation problems if the people do not support the decisions made (Baber & Bartlett, 2011). The possibility of holding governments to account for violating or failing to implement international regulation is also limited, and treaties, like the UNFCCC, have more in common with contracts than laws (ibid.)[7]. In the case of climate change, the intergenerational problem is also more pronounced than for many other issue areas, as climate change will affect the generations today that are not allowed to vote or not yet born more than the electorate (Vanderheiden, 2008).

[7] That said, there are some mechanisms that can be used to put pressure on governments, such as trade-embargos, as well as more general, adverse, diplomatic consequences.

A Scientific Logic

This section looks at the role of science in climate change mitigation, and understandings of climate change as a scientific issue. The purpose here is not to argue that climate change is not a scientific issue (or a neoliberal, or a global one), but to discuss what this logic does to our understanding of climate change. To do so, however, I find it necessary to also look at questions around what science is, and what its role is and should be in relation to (climate) policy.

To start with, however, a few words of clarification. When I talk about science, I refer to a type of knowledge that is understood as separated from other types of knowledge, such as life experiences, indigenous knowledge or religious knowledge. However, instead of deciding on a fixed definition of science, I recognise that what science means differs between situations and depending on who you ask. Some, for instance, would think of science only as the physical sciences, other have a broader definition. What is important to the discussion below is that the discussion rests on the assumption that there is not one definition of science and not one right answer to what it should be.

Examples of a Scientific Logic

As mentioned above, important steps for global climate science and policy were the creations of the IPCC in 1988 and the UNFCCC in 1992. Even though the IPCC is often considered to represent "science" and the UNFCCC "policy", both institutions have parts that have more or less to do with science and/or policy (see e.g. Bulkeley & Newell, 2010). It is a simplification to talk about these bodies as singular entities as they are, of course, made up of smaller entities in turn, and people within these. To be precise, "the UNFCCC" is an international climate treaty – a document. Contrarily, "the IPCC" is "a panel of 195 member governments", in its own words (IPCC, 2019). The Panel meets annually and these meetings are attended by representatives of the member states. When the IPCC is talked about as "the science" of climate change, it is its products that are referred to, written by scientists that are not employed by the IPCC. This may seem like unimportant details, but I find it worthwhile to start by paying attention to complexities hiding within these seemingly singular entities, as misconceptions regarding what in particular the IPCC is, is something that climate change sceptics and deniers often use as an argument to discredit the entire body of climate change science altogether. Science has always played an important role in international climate policy – to inform policy, but also used to create controversy (e.g. van der Hel & Biermann, 2017). As phrased by Bulkeley and Newell (2010, p. 27): "[s]cience has been a key battleground in the debate about climate change: the severity of the threat, the nature of the causal mechanisms and probably impacts and associated costs of taking action".

The UNFCCC article 21 articulates that the executive secretary of the UNFCCC "[…] will cooperate closely with the Intergovernmental Panel on Climate Change to ensure that the Panel can respond to the need for objective scientific and technical advice" – linking the IPCC to the UNFCCC already at the inception of the UNFCCC. Looking at the early days of the IPCC, science and policy were intertwined too. For instance, around the time of its foundation in 1988, the IPCC was mandated to lay the foundations of a climate convention, what later became the UNFCCC. Having fulfilled this mandate, the IPCC was caught off political tasks and instead mandated to provide decision-makers, primarily the UNFCCC with information (Beck, 2015). At a later stage, the IPCC was split into three different Working Groups, with tasks that are to a varying degree intertwined with policy responses. Together, however, the role of the IPCC is to:

> […] assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation. IPCC reports should be neutral with respect to policy, although they may need to deal objectively with scientific, technical and socio-economic factors relevant to the application of particular policies (IPCC, 2013, paragraph 2).

The balancing act between delivering information relevant to policy, at the same time as staying neutral, is further discussed in **Paper I.** Looking at the two organisations' time-frames and operations, the IPCC's Assessment Reports have thus far been released with about six years apart, while the governments meet to negotiate under the UNFCCC once a year, making some worry that the IPCC's long cycles would slow down progress in the UNFCCC (Lanchbery & Victor, 1995). The next years will, however, see a coordination of the release of IPCC-reports with the upcoming UNFCCC Global Stocktake (Sundqvist et al., 2018). The past years have also seen an increase in shorter reports on limited subjects that are quicker to prepare. One example is the Special Report on 1.5 degrees warming (SR15), requested by COP 21 in Paris in 2015 (IPCC, 2018).

Another example of linking climate science and policy can be found in the internal structure of the UNFCCC. The UNFCCC has two subsidiary, permanent bodies. One deals with implementation and is consequently called the Subsidiary Body for Implementation (SBI), the other one is called the Subsidiary Body for Scientific and Technological Advice (SBSTA). As a permanent body of the UNFCCC, SBSTA was established through the text of the convention (Article 9). Its aim is "[…] to provide the Conference of the Parties and, as appropriate, its other subsidiary bodies with timely information and advice on scientific and technological matters relating to the Convention" (United Nations, 1992). It was also early on described as a link between scientific assessments and policy (UNFCCC 1995, decision 6/CP.1). One way it functions as a link is by requesting reports from the IPCC to inform the negotiations[8]. SBSTA can also request reports from other bodies, and invite experts to the negotiations.

An example of this could be the Structured Expert Dialogue (SED), featured in **Paper II** of this thesis, and mandated to assist the 2013-2015 Review. The Review was in turn mandated to review the Long Term Global Goal (LTGG) of the UNFCCC (2-degrees C warming at that time), as a joint undertaking between the SBSTA and the SBI. The review, and the SED as a part of this, has been described as a key to the updated LTGG of the PA (well below 2 degrees C "pursuing efforts" to limit warming to 1.5 degrees) (UNFCCC, 2018). The LTGG in turn is often understood as a response to the UNFCCC ultimate objective – namely to avoid dangerous anthropogenic climate change. What *dangerous* climate change is, however, usually understood as a normative question and therefore one for policy, not science (e.g. Gupta & van Asselt, 2006; Oppenheimer, 2005). The 2-degree target has been seen as an operationalisation of the LTGG, but the SED concluded that 2-degrees C warming should not be seen as a "safe guardrail" but an upper limit (UNFCCC, 2015). The 2-degrees target had been discussed in different policy circles at least since the 1970's, but it was at COP 15 in Copenhagen in 2009 it became the centre of the negotiations (Jäger & Jäger, 2011). This political target spurred research around what a 2-degree warmer world would look like. When the negotiations instead needed information on warming below 2 degrees, it became clear that this was a research gap, and the SED was launched. Six months after the release of the SED-report, the negotiations in Paris ended with a careful lowering of the LTGG, and a request to the IPCC for a report that looked specifically at the difference between 1.5 and 2 degree warming (**Paper II**). This is one example of how science and policy evolve together, and depend on one another.

The UNFCCC in general encourages input from the scientific sphere. Many decisions are informed by the "best available science" (see e.g. decision 2/CP.17, §160f in UNFCCC 2012b). The sources that are deemed appropriate to inform the negotiations are regulated and ranked, with IPCC-reports on top of the hierarchy (ibid.), sometimes called the "gold standard" (UNFCCC, 2015, p. 177). In this line, the preamble of the UNFCCC reads: "[r]ecognizing that steps required to understand and address climate change will be environmentally, socially and economically most effective if they are based on relevant scientific, technical and economic considerations and continually re-evaluated in the light of new findings in these areas" (United Nations, 1992), with a nod to the Brundtland-report and its definition of sustainable development, as discussed in the next section. However, even though the role of science is important, the precautionary principle of the

[8] As an independent body, the IPCC decides how it responds to requests. That said, almost the same states that are members of the UNFCCC are also members of the IPCC.

UNFCCC (Article 3) also says that if there is a lack of science that should not be used as an argument to not take action, and at the same time "taking into account that policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost".

To sum up, there are several ways that the (importance of the) role of science is recognised in the architecture of the climate regime – from the mandate of the IPCC, to the SED, the text of the Convention, and requests for reports and expertise. Hence, in this context, the role of science is understood in relation to policy. The next section looks closer at this relationship, how it can be understood, and its effects.

Effects of a Scientific Logic

To understand the many and differing opinions regarding the role of science in climate policy, I suggest that we first need to look at the role of science in policy and society in general and how it is portrayed in the scholarly literature. The understanding about what science "is" and what its relationship to policy should be, is a topic that has been and still is discussed both in the literature and in society.

Around the time of the Second World War, it became apparent that science could be used as a tool in warfare (e.g. Roosevelt, 1944). Climate science as explained above, was interesting to the military and consequently also received funding from the military sector. The dominant view on science around this time was that science and policy should be kept separate in order for science to keep its independence. Scientists should be "disinterested" in policy (Bush, 1945; Stone, 2002), and driven by curiosity (Pielke Jr, 2004). However, to keep science completely separated from policy is difficult, not least when it comes to funding (Stone, 2002). An important model in the science-policy literature that tries to address this dilemma is the so called "linear model of knowledge transfer". The core idea of this model is that knowledge should be produced in one place and used in another, to make sure that the scientific community can produce unbiased and sound information that can be used to inform decision-making (Jäger, 1998). Only by keeping science separate from policy can science "speak truth to power" (Price, 1981), leaving the decision-making and value-laden questions to policy and keeping science objective legitimises science (Murray, 2012).

In the 1980's, private funding for research overtook public funding in the United States (Lave et al., 2010). This in turn had implications for the organisation of scientific work, such as more emphasis on research and less on teaching, reluctance to share equipment and an industry around patents for scientific work (ibid).

How far science and policy can and should be kept apart is disputed. For instance, while some argue for complete independence for science and separation of science and policy, other argue that some issues, like environmental degradation, are so complex that policy needs advice from science. For science to be able to give good advice, science cannot be too far away from policy (Haas, 1992). Science needs to know what information is relevant to policy, to be able to provide policy-relevant science. However, merely producing relevant information is not enough, some scholars argue. Science has to be translated so that it can be used by policy (Fazey et al. 2013; Stone 2002). The challenge is to find a balance between the wish from policy-makers to receive clear advice, and researchers' tendency to focus on conveying uncertainties (Hage et al. 2010; Pregernig 2014). In other words, the "gap" between the "two communities" of science and policy needs to be bridged (Merton, 1945; Rich, 1991, see also Sundqvist et al 2018).

The two approaches outlined above suggest different practices in science-policy interaction – one that separation is needed and that more research will lead to better policy, the other that science and policy need to be brought closer together through better communication. However, both argue that knowledge can be objective, and both suggest that science and policy can indeed be separated, even though those in support of the second position more easily run into demarcation issues, as it is less clear where the boundary between science and policy is drawn (Spruijt et al., 2014).

Table 1: Summary of science-policy theory on the distance between science and policy.

The distance between science and policy should be:	Far	Close
Insufficient policy action can be explained by:	Lack of science	Lack of science communication
Legitimacy of science stems from:	Complete independence	Ability to provide objective policy advice
View on role of science in society:	To increase our knowledge of the world. This may be used to inform policy, but scientists should stay "disinterested"	To inform policy; robust decision-making

The role of science as defined in the context of the climate regime is dominantly along the lines of keeping science separated but close enough for science to inform policy. I have already given some examples of this – for instance the mandate of the IPCC to produce "policy-relevant", yet neutral information (see also Beck, 2011). The same type of thinking can be seen in the official writings of the UNFCCC, where "the best available" science should inform policy, but not dictate it, or the SED as a specific case where the predefined roles of experts versus negotiators were constantly blurred and the information exchange not a one-way process (see **Paper II**). Against this backdrop, the rest of this section will be spent looking at how we can better understand what this logic, this understanding of what science is and should do, does to our understanding of climate change, using literature primarily from Science and Technology Studies that criticises the idea that science and policy can be separated in the first place.

To start with however, I would like to clarify that the remainder of this section is not an attempt to try to undermine climate change science. Instead, I try to show that the dominating understanding of what science is in this context is a specific one, which in turn enables specific practices, and disables other practices. More specifically, I am concerned with the way "neutral" science is seen as the key informant to climate policy, without problematising its perceived objectiveness or the limits to this type of information if and when this affects the possibility for other types of knowledge to get involved (see also Funtowicz & Ravetz, 1993; Jasanoff, 1987; **Paper I**). The main critique is, however, not directed to the use of the linear model as such but rather the way that this model and the idea that science is neutral closes the possibility for scrutiny of the internal processes of the scientific enterprise (Jasanoff, 2008). As Jasanoff (2008, p. 2) explains:

> In an enlightened society, few would question that acquiring information and knowledge prior to taking action is better than acting without relevant information. To that extent, we are all subscribers to the linear model, regardless of the nature of the politics we engage in.

Hence, the use of the linear model is not an issue in itself. What is problematic is the simplistic image of science as neutral and homogeneous that the model enacts and that ignores that "the very process of collecting and codifying information is value-laden and should not be insulated from democratic accountability" (ibid). Information can thus never be neutral. This anti-essentialist's position critiques the idea of objective science and that "it is possible to reflect the world without presuppositions, without intruding philosophical and theoretical assumptions into one's work", instead arguing that presuppositionlessness is "both politically undesirable and philosophically impossible" (Agger, 1991, p. 106).

A key concept to understanding how the idea that scientific information is neutral is "impossible" is *co-production*, which stands in sharp contrast to the idea of a clear separation between science and policy. The concept of co-production draws attention to how the boundary between science and policy is not fixed, but continuously negotiated in the interaction between science and policy (Jasanoff, 1987; Lidskog & Sundqvist, 2015; Wehrens, 2014). As a result, "[…] science – the use of science as well as the production of scientific data – is always contingent in relation to the social order" (Lidskog & Sundqvist 2002, p. 95). This also means that science is never neutral, as it can never be separated for policy or society. As a consequence, adhering to the idea of the linear model in the context of climate change means closing down a process that is inherently political to scrutiny, by saying that it is not political. In addition, by default the linear model excludes knowledge types that might be valuable to policy (cf. Lahsen, 2005; Nursey-Bray et al., 2014). This creates a democratic deficit.

Hence, the question here is not so much if we should have the linear model or another model, but what the linear model enacts and what other models could tell us. As Sundqvist et al (2018) put it, there is a constant battle between the processes of separating science and policy, and integrating them. They argue that we actually need both processes, and instead of trying to see which side wins, we should accommodate both (see also **Paper I**). For now though, the debate continues. How can we understand why we never seem to agree, why this debate is seemingly never-ending, and thereby also better understand what the dominant narratives around science and its role do? In the literature, a recurring theme is to look at vested interests that take advantage of the way that the relationship between science and policy is understood. For instance, as described by (Bulkeley & Newell, 2010, p. 27):

> Scientific knowledge is used by all actors in climate governance to advance and defend their position and to confer legitimacy upon it. It is the perception of science as above politics that makes it attractive to actors who believe it provides them with a trump card over the claims of others. However, decisions about whose knowledge counts, who wields authority and how knowledge is presented and framed are deeply political processes that imply the exercise of power.

In other words, science and policy cannot be completely separated, but because the authority of science in this context is bound up with the understanding of science as neutral, and some stand to gain from what the science is saying, the "traditional" image of science as objective stays. According to this argument, the authority of science is bound up with it being understood as separated from policy (as per Bush, 1945 see also **Paper II**). However, as science is never neutral, never objective, the view of science as precisely that is an easy victim to critics too (e.g. De Pryck & Gemenne, 2017).

However, not only policy-makers use the demarcation between science and policy to their advantage. Scientists and experts are involved in this practice too, for instance as recognised in the concept of boundary work (Gieryn, 1983). If experts are unable to show that they and their expertise are different to other types of knowledge, what becomes of the expert? (**Paper II**)

In addition to boundary work between expertise and non-expertise, there is also a hierarchy among types of expertise and between disciplines, which has changed over time. The Ancient Greeks, for instance, considered philosophers to be best equipped at making decisions. In the climate regime of today, the natural sciences dominate and of the social sciences, economics dominates (Corbera et al., 2015; Ford et al., 2011; Pearce et al., 2018), while the humanities have been largely left aside (Hulme, 2011).

Moreover, there is not just one "climate science" as it is underpinned by different ontological and epistemological understandings, carried out according to different traditions - there is a multiplicity to climate science (Livingston et al., 2018). For instance, one is observations about what is happening in nature, another is projections into the future (see also Jasanoff, 2015). That said, climate science, because of the one thing that holds the field together – studying climate change and its implications – fits the description of post-normal science, or that "facts are uncertain, values in dispute, stakes high and decisions urgent" (Funtowicz & Ravetz, 1993, p. 744). Hence, climate science(s) is different from what one can call "traditional" or "normal" sciences and climate science constantly needs to relate to this. Climate science needs to separate itself from non-science, but it also needs to deal with uncertainty, and the high political interest and importance. The mandate of the IPCC – to be "policy relevant" but not "policy prescriptive" tries to balance on the one hand the independence of science and on the other the close relationship between science and policy (IPCC, 2013, **Paper I**).

IPCC does not conduct its own research, but it produces knowledge about the climate through assessing and summarising the existing climate science. The result, the knowledge produced, is supposed to inform policy making. In comparison, Jasanoff (1990) calls science produced for policy making "regulatory science", which differs from basic science and applied science (see also Lövbrand, 2009). Basic research has and still is in some contexts seen as the most legitimate type of research because it is detached from policy (Pielke Jr., 2012), although legitimacy for the other types of research can be valued in other ways depending on context (for instance ability to provide policy-advice) (Gieryn, 1983; **Paper II**).

In addition to hierarchies between different disciplines and different types of research, the literature on science-policy interaction also discusses hierarchies between evidence/research results. So called evidence-based policy is inspired by medical practice where evidence – preferably randomised trials, inform medical care (Parkhurst, 2017, cf. "speaking truth to policy" Haas, 2004; Price, 1981). The idea has been transported into political decision-making. In medical care, the goal of an intervention is usually agreed and singular – improving the patient's health. Political decision-making, however, is usually different as the goals are often neither clear nor agreed on (Parkhurst, 2017). The implication, according to Parkhurst (2017), is that evidence-based policy may suffer from two types of bias – technical and issue bias. The first one includes biases that are invalid from a scientific point of view, such as cherry-picking or flaws in models. While the first type can be addressed, the second one, issue bias, is, according to Parkhurst, more problematic because it may create a democratic deficit. This comes from making invisible the politics involved, by pointing to and letting the evidence decide, as if evidence were neutral (see e.g. Elgert, 2010). It is not, Parkhurst argues, because it biases the debate in specific ways and should therefore be openly addressed, not disguised under the banner of "evidence". Moreover, the preferred types of evidence in medical care – randomised trials - are not necessarily the most informative ones for policy-making (ibid.). The evidence preferred in the climate regime is quantitative, numerical, information as this type of information can be best understood in this context, given the tools and methods used (see **Paper IV**, for a more in depth discussion). This makes this type of information more visible, and other types of information – qualitative – less visible. This is another example of hierarchies between knowledge/information, and another example of the logic of extraction making visible certain types of information. The concept of *black-boxing* can be used to think about these effects. As Jasanoff explains, "black-boxing knowledge claims is equivalent to reducing or erasing the uncertainties around them", and one way of doing this is "[…] to express results in numerical form. The precision of numbers conveys an aura of definiteness, belying the inevitable choices and judgements involved in translating complex phenomena into mathematical terms" (Jasanoff 2015, p. 40).

In terms of inquiry, black-boxing means focusing on the input and output of science, not its internal structure or processes (Latour, 1999). According to Callon (1986), if we want to understand the role of science in society, then we need to study the mechanisms that run the scientific enterprise, not just its impacts. This suggests opening the black box of science, for the black box conceals both the actual content and the context of the scientific enterprise, as well as the inherent contradiction in this divide (see e.g. Latour, 2000). In other words, we need to better understand the efforts made to close the black box of science, and focus on "science in the making" as opposed to "ready-made science" (Latour, 1987). Understanding the making of Blue Carbon, for instance, gives us a possibility to disrupt this development – should we believe that to be necessary - before it has been "made", before all contestation is settled, before no one questions it or even comes to the idea of questioning it because there is no controversy, no debate, nothing more to question. That said, objects "must be seen as the shaping of many associated and heterogeneous elements. They will be as durable as these associations, neither more nor less" (Callon, 1986, p. 23)

A Neoliberal Logic

The section starts with an overview of where in the climate regime we can find expressions of a neoliberal logic, before turning to how we can understand the development of a neoliberal logic in the climate regime, and possible effects.

Neoliberalism here refers to ideas around governance based on economic liberalism with a free market and minimal state involvement (so called laissez-faire economics). Important ideas include privatisation, deregulation and free trade (e.g. Gareau, 2011 for an overview of neoliberalism and "green" neoliberalism). Neoliberals typically propose market-based solutions to a range of issues (Lave et al., 2010). The private sector plays an important role. The scholarly literature on neoliberalism is in turn interested in a range of political issues. For this section I draw on the literature on, and critique of, environmental neoliberalism. Environmental neoliberalism has been defined as: "[…] contemporary stages of regime development in which market-based principles come to eclipse or negate those of precautionary and equity-based concerns" (Ciplet & Roberts, 2017, p. 150). Liberal environmentalism on the other hand has been described as accepting:

> […] the liberalization of trade and finance as consistent with, and even necessary for, international environmental protection. It promotes market and other economic mechanisms (such as tradeable pollution permit schemes or the privatization of commons) over "command-and-control" methods (standards, bans, quotas, and so on) as the preferred method of environmental management (Bernstein, 2002, p. 7).

Compared to liberal environmentalism, neoliberal environmentalism is:

> […] a more fully implemented stage of liberalism, with the expansion of the market, economic rationality and private gain as increasingly identified as the primary goals and sole mechanisms for the protection of public and environmental goods (Ciplet & Roberts, 2017, p. 150).

The difference between liberal and neoliberal environmentalism is blurry and for the discussion below not so important, but I want to point out that there are conceptual differences between the two and that, in general, neoliberal environmentalism is seen as more "extreme" in terms of private ownership, market-based solutions and so on. Consequently, some of the critique against neoliberal environmentalism may not apply to liberal environmentalism.

Examples of a Neoliberal Logic

The UNFCCC, founded in 1992, is built around the idea of "common but differentiated responsibility" (United Nations, 1992) – linking to the global logic and multilateralism. In the spirit of the United Nations, decision-making is consensus-based. Many scholars (Ciplet & Roberts, 2017; Gupta, 2010; Paterson, 2011), as discussed below, have argued that neoliberalism has become more and more important defining factor in the context of the UNFCCC, but already in the original text of the UNFCCC, ideas in line with the logic of neoliberalism can be found. For instance, the importance of economic growth/development is stressed at least eight times (United Nations, 1992). In addition, neoliberalism typically holds that economic growth will lead to a better world and human progress – growth is justified with development (D'Alisa et al., 2015). The UNFCCC was adopted at the UN “World Summit” in 1992. This was after the release of the Brundtland-report “Our Common Future” in 1987, which coined the term “sustainable development”, making economic growth an important part of a sustainable future and economic, social and ecological development equally important (see e.g. Tulloch & Neilson, 2014). The report subscribes economic growth as a reason behind environmental damage, and at the same time stresses the need for economic growth – not least in the context of developing countries and combatting poverty (Brundtland, 1987). A solution is a different type of growth, using new, energy-efficient and thereby also cost-efficient, technology (Brundtland, 1987, e.g. 5:67). Year 1992 was also only two and three years respectively after the perhaps most prominent front figures of neoliberalism, namely Prime Minister Thatcher and President Reagan, left office. Even though Thatcher said that There Is No Alternative (TINA) to neoliberalism, there are and were back then too, counter narratives. In this context, it is perhaps worth mentioning the report *The Limits to Growth* by the Club of Rome (Meadows et al., 1972), which received attention at the 1972 World Summit in Stockholm, and the contemporary degrowth debate (e.g. D'Alisa et al., 2015).

The first commitment to manage emissions under the UNFCCC was the Kyoto Protocol (KP) from 1997[9], which is now at the final stages of its second commitment period (UNFCCC, 2017). The KP is constructed around a grouping of nations as developed (Annex-I) or developing (non-Annex I)[10], recognising the historical burden of developed countries as well as their advantaged position to reduce emissions. The KP, overall, represents a compliance-based protocol around a top-down structure of states. That said, there are some important neoliberal elements built into the KP as well, and a general development towards more reliance on market-based approaches in international climate policy (Gupta, 2010). This is perhaps most evident in the KP’s *flexible mechanisms* – its market-based mechanisms, including Joint Implementation (JI), Clean Development Mechanism (CDM) and Emissions Trading (ET) (UNFCCC, 2019a). JI and CDM are project-based market-mechanisms that enable developed countries to make investments in developing countries (CDM) or other developed countries (JI), and account for them in their national accounting. Emission reduction units are earned from projects by showing that these projects have contributed to lower emissions than “business-as-usual” (BAU). For CDM and JI to work, calculations “[…] based on good

[9] Entered into force in 2005 when the conditions to do so were met (55 signatories, contributing with 55% of emissions. The first commitment period ran from 2005 to 2012, the second one from 2013 to 2020.

[10] More specifically Annex-I countries are members of the Organisation for Economic Co-operation and Development (OECD), while Annex-II countries excludes so called “economies in transition” - states that belonged to the Soviet Union. Non-Annex 1 countries are countries that are not members of the OECD.

information, for example of past emissions, and accurate measurement of the emissions once the project is implemented" is deemed pivotal (UNFCCC, 2019b).

ET is different as, instead of operating against BAU, it operates against a kind of reverse logic that starts from how much emissions are allowed according to an agreed "cap". These "allowances" are then allocated/sold to the parties involved in the trading and these parties are in turn free to trade their allowances with other parties, subject to regulation (e.g. Betsill & Matthew, 2011; UNFCCC, 2019b). On a general note, key words for these mechanisms that go hand in hand with neoliberalism are flexibility – as the name suggests, meaning that every country has a number of options and tools to use to reduce emissions, and efficiency (Paterson, 2011), more specifically *cost-efficiency* as the UNFCCC webpage says (UNFCCC, 2019a). Regarding the latter, the argument is that it is most cost-effective to reduce emissions where it is the cheapest to do so (Paterson, 2011), an argument that also fits well with the idea of climate change as a global issue – it does not matter where emissions are reduced.

Simply speaking, carbon markets can be "voluntary" (private) or regulated (state controlled). The markets under the UNFCCC are regulated – private actors are allowed, but states ultimately set the terms. Regulated markets have been described as in line with liberal environmentalism, and thus less radical than neoliberalism (Ciplet & Roberts, 2017). The European Union emissions trading scheme (ETS) is an example of a regional, regulated market. Here, state control includes for instance that the EU-states together decide how many units that are allowed at the start of a trading period and the rate of reduction of units (Borghesi & Montini, 2016)[11].

In addition to regulated markets there are also voluntary carbon markets, which is the closest we have come to a free market in the context of climate change. The voluntary carbon market can also be thought of as "financing beyond boundaries" (Gold Standard, 2019), which hints at the overarching idea of a free market – no state involvement. Another difference to the regulated market is that the voluntary carbon market also has a secondary market – or stock market (e.g. Hamrick & Gallant, 2017; Jiajia & Junjie, 2018). While the ultimate goal of the primary market is emission reductions, the goal of the secondary market is to trade carbon. This means that there is no inherent incentive to reduce emissions, as this would eventually make the market abundant.

Under the Kyoto Protocol, the use of market-mechanisms is allowed, but the degree has been regulated. It has not been allowed to offset all emissions in another country, and do nothing nationally (UNFCCC, 2019c). It is at this moment in time still unclear what effects the Paris Agreement (PA) will have on the development of

[11] The idea is that there is a number of emission units to trade in the beginning, but these numbers are reduced – the "cap" is lowered – which leads to reductions in emissions.

climate change market-based mechanisms. It may increase demand as the issue is becoming more and more pressing and the PA allows for market based mechanisms, but with all countries now expected to contribute to emission reduction, some developing countries may be unwilling to be hosts of other countries' climate projects as they may want to account for the reductions themselves (Hamrick & Gallant, 2017).

In the context of climate change, the focus of market-mechanisms is on carbon particularly and these markets are also called carbon markets – making carbon a new "commodity" (UNFCCC, 2019a). However, in the context of Blue Carbon there are other relevant market-based mechanisms, most prominently Payments for Ecosystem Services (PES) (Locatelli et al., 2014). In PES-schemes, valuation is not restricted to carbon (but can be) – the value of any ecosystem service can be included, provided that it is possible to calculate the value of the service and that it is not traded on other markets (such as fish - a commodity and ecosystem service already traded globally). There are ecosystem services that do not have a direct market value, such as cultural and aesthetic ecosystem services – the fact that we feel good in nature, find it beautiful and/or have particular cultural roots to specific ecosystems or places (MEA, 2005). Proxy values can be used to calculate estimated values in some cases. For instance comparing the value of apartments facing a park, versus apartments in the same area not facing that same park could give an indication of how much extra we are willing to pay to see "nature" from our windows. There is an entire scholarly field and business around these types of evaluations, and a lot of literature (e.g. McGrath et al., 2018; Porras et al., 2013; Schroter et al., 2018).

Another neoliberal element of the KP is that non-state agents can also join these mechanisms, albeit "[…] under the authority and responsibility of governments" (UNFCCC, 2019a). A general trend following the logic of neoliberalism, however, is to step away from this multilateralism to instead move in the direction of bilateral agreements between two states, or between smaller groups, "climate clubs" (cf. e.g. Blaxekjær & Nielsen, 2015; Bäckstrand, 2011; Ciplet & Roberts, 2017). An early example of this could be seen at COP 15 in Copenhagen in 2009 where a smaller group of countries negotiated behind closed doors, side-lining the consensus-based approach (Ciplet & Roberts, 2017).

COP 15 also marked the beginning of the turn to a pledge-and-review system – in line with the United States' demands for flexibility, and against the European Union's request for binding targets à la KP (Bäckstrand & Elgström, 2013) – that the negotiations in Paris in 2015 (COP 21) ultimately ended with. There are important differences between the KP and the PA. While the KP operates around a top-down – multilaterally controlled - model of agreed and legally binding goals, the PA offers a voluntary bottom-up – nationally controlled - model, using review systems to keep track of progress (Ciplet & Roberts, 2017). That said, as this section has pointed to, and as elaborated by van Asselt and Zelli (2018), the changes did not come overnight, and even though there are differences between the agreements, there are also similarities. For instance, market-based mechanisms and offsetting are allowed in both the KP and the PA, in the former called "flexible mechanisms" and the latter "cooperative implementation" (United Nations, 2015). It is, as before, up to every country to decide if they use this option or not. Moreover, even though the KP is generally considered top-down governance, states themselves agreed on the goals and put forward the targets, making it more of a "hybrid" between top-down and bottom-up approaches (van Asselt & Zelli, 2018, p. 31).

The development of the UNFCCC towards more flexibility and less multilateralism came with an increased search for diversified solutions suitable for different types of countries, along with an increased complexity (Gupta, 2010, see also Bulkeley & Newell, 2010). With this we also see a continued development towards decentralisation and polycentric governance – the same problem, in this case climate change, being governed by several authorities (van Asselt & Zelli, 2018). The increased involvement of the private sector has also increased private investment, but at the same time moved power and control away from governments and made a larger share of investments voluntary (Ciplet & Roberts, 2017).

To sum up, this subsection has pointed to some developments of the climate regime that seem to go hand in hand with the logic of neoliberalism: decreased multilateralism, more actors including the private sector, flexibility and voluntary engagement instead of binding targets, and an increased use of market-mechanisms. These developments overlap and have in common that they reduce government involvement in international climate policy, as discussed below. That said, it is also important to note that even as it stands today, the UNFCCC cannot be described as entirely neoliberal. There are, for instance, references to the "Rights of Mother Earth" in the preamble (Ciplet & Roberts, 2017; United Nations, 2015), a notion quite far away from the rational language of neoliberalism. Moreover, the turn to neoliberalism has not been without resistance. For instance, the development against multilateralism in favour of smaller negotiations outside the UNFCCC has been met by resistance from developing countries on the basis of equity. "For states such as the Least Developed Countries, multilateral regimes are often the only contexts to meaningfully express opposition to unequal policies, and to make demands for environmental and social justice" (Ciplet & Roberts, 2017, p. 151). According to Paterson (2011), resistance to a neoliberal system can be seen in the absence of a truly global, free, carbon market. Moreover, the fact that CDM allows for a very limited inclusion of forestry can be seen as resistance against fully embracing the values of neoliberalism and the free market (Paterson, 2011). That said, we now have a market-based mechanism on forests in the UNFCCC – Reducing Emissions from Deforestation and Forest Degradation (REDD+), and even though it took long to negotiate and had to include a number of "safeguards" before the decision could be hammered through, it could be seen as another development in line with the logic of neoliberalism (cf. Dehm, 2016; Scheba & Scheba, 2017).

Effects of a Neoliberal Logic

How can we better understand the shift towards neoliberalism in the UNFCCC since its inception? To start with, this development is in line with a more general turn to the neoliberalisation of nature (Bakker, 2007; Castree, 2008). This includes a preference for market-based mechanisms to address environmental issues, and a more dominating focus on what goods and services "nature" provide us with, rather than nature's intrinsic value (Bakker, 2005; Robertson, 2006). We also see a growing number of market-mechanisms for a growing number of "ecosystem services" - carbon sequestration and storage by Blue Carbon-ecosystems being a recent addition. At its most basic, the argument for putting a price on different ecosystem services is that it will help us see how important these services are to us, be able to compare them, and ultimately protect them (Robertson, 2012). In a large international and inter- and transdisciplinary effort *The Economics Of Ecosystems and Biodiversity* (TEEB) – the volume on wetlands, the same sentiment is communicated in the following way: "Monetary valuation can significantly help demonstrate the importance of wetlands to society and the economy and thereby help argue for their protection, wise use and restoration" (Russi et al., 2013, p. 19). "Nature" and its resources has of course always been used and valued by humans. However, the neoliberalisation of nature comes with a distancing from nature – externalising nature (e.g. Morgan, 2018), underpinned by a rational that we are connected with nature primarily because we need resources and goods from nature - not because we are always and already inseparable from it (cf. Alaimo, 2010).

In brief, taking climate change as an example, market-based mechanisms are based on a trust in the market's ability to decide where and how it is most efficient to, in this case, reduce emissions. This logic ties neatly with the view on climate change as a global issue as the latter holds that it does not matter where emissions are reduced as long as they are reduced (Paterson, 2011). The market, not politicians, is thus able to lead the way – the metaphor of the "invisible hand" of the market visualises this idea. Market-based mechanisms are seen as rational, transparent and neutral (cf. e.g. Randalls, 2011; Robertson, 2006). If there is a problem with the market, the market can also find a solution (Lave et al., 2010). The concept of the "free market" is usually understood as a market without any government interference – the only forces at play are demand and supply. That is, however, disregarding the distribution of power in the world as interfering with the market. In the context of climate change, the carbon market is both partial and political, not free (Randalls, 2011). It is partial because no carbon market includes all carbon there is – first, there are uncertainties in the measurements, and second some “types” of carbon emissions (such as from international aviation) are excluded. What sources and sinks to include or exclude are highly political choices (ibid.). This, in turn, brings attention to the type of information used to make these decisions. For instance, as Paterson (2011) argues, a factor that helps explain the expansion of neoliberalism in the UNFCCC is the science-policy interface. Examples include the unit Global Warming Potential (GWP) coined by the IPCC that enabled flexibility regarding actions to take, and its sibling the carbon dioxide equivalent, CO_2e, used for instance in carbon trading and allowing comparison between greenhouse gases (ibid.).

Following this logic, numbers come across as particularly important – climate models as numerical representations of our world, carbon accounting to keep track of our carbon budget, how large our sinks and sources are, and a price on carbon to enable market-based mechanisms, just to give some examples. As Randalls (2011, p. 129) puts it: “Statistics, in this case in the form of number of CO_2-emissions, transform realities into comparable numbers that allow a form of economic activity to be created that measures, values and rewards the movement of these numbers”. Expert knowledge is needed to calculate carbon in the precise way that is needed for market-mechanisms (Paterson, 2011). The importance of quantitative studies and calculations is reflected also in the scholarly disciplines represented in the IPCC, with the natural sciences dominating, economics being the dominating social science field, and the humanities marginalised (Bjurström & Polk, 2011a; Corbera et al., 2015). Other signs of the importance of the field of economics can be seen in, for instance, the resonance at the time (and e.g. at COP 15) around the Stern Review, commissioned by the British government, which found that climate change could lead to twenty percent reduction in Gross domestic product (GDP) globally if mitigation actions are not undertaken. However, mitigating the worst effects of climate change would only cost one percent of GDP (Stern, 2007). While these “calculative approaches”, according to Randalls (2011, p. 129), “have offered opportunities for climate policymaking and while the ethical debates within them are clearly important, they can obscure fundamental and contested questions about what the good life is and how it is generated through practice” (Randalls, 2011, cf. Jasanoff, 2015 on models). Against this backdrop, we may ask what solutions to climate change, or indeed what futures, these “calculative approaches” offer. According to Morgan (2018) here too, science and policy are intertwined, creating a narrative around the “techno-finance fix” of environmental problems, geoengineering of the climate being an extreme case. The techno-finance fix is a “dialectical relationship operating under the conditions of global capital” and a powerful narrative as it suggests that we can keep the financial system of growth, thanks to technological, short-term “fixes”, in turn underpinned by financial instruments like carbon markets that also fund technological breakthroughs (ibid.:

9). The techno-finance fix depoliticises climate change by leaving climate governance in the hands of the market and in science. In this way, neoliberalism makes visible some practices and invisible others. For instance, putting a price on Blue Carbon makes it visible in a capitalist, market-run, system (cf. Robertson, 2006, on ecosystems generally). At the same time, this process makes the politics less visible and its management further away from governments and further away from the people. The logic of neoliberalism and the increased use of market-mechanisms makes governance "[…] insulated from normative interventions which extend beyond the well-defined institutional bounds of market-oriented consideration (Ciplet & Roberts, 2017, p. 150; see also Kallis et al., 2015).

In a way, neoliberalism both physically and discursively excludes government from governance. For instance, the narrative around sustainable development "[…] depoliticizes genuine political antagonisms about the kind of future one wants to inhabit; it renders environmental problems technical, promising win-win solutions and the (impossible) goal of perpetuating development without harming the environment" (Kallis et al., 2015, p. 9). This process, in turn, reduces "politics" to "[…] the search for technocratic solutions to pre-framed problems instead of a genuinely antagonistic struggle between alternative visions" (ibid). Hence, the logic of neoliberalism makes politics less visible. The issue, in this case climate change, is still highly political but the politics are hidden, which in turn reduces the possibility for the people to interfere, and increases the democratic deficit. At the extreme end of the spectrum of neoliberal approaches is "commodification", defined as the:

> […] creation of an economic good through the application of mechanisms intended to appropriate and standardize a class of goods or services, enabling these goods or services to be sold at a price determined through market exchange (Bakker, 2005, p. 544).

Bumpus (2011) suggests that the processes of individuation – categorising and singling out an entity from its supporting context – and spatial abstraction - treating an entity in one place as essentially the same as any apparently similar thing located elsewhere – can help us understand the effects of commodification. An example of this is when companies buy biodiversity credits in support of a specific species or area, to offset environmental degradation they have caused elsewhere. Here, the species in question are taken out of their contexts, and the individuality of ecosystems is washed away as this logic suggests that one degraded area can be compensated by the protection of another area (Robertson, 2006). In the context of climate change, if it does not matter where emission reductions are made – adhering to the global logic – the most rational strategy is to reduce emissions where it is cheapest to do so (Ervine, 2014; Lansing, 2012). The only way that this logic holds is when one only focusses on the carbon budget. If all implications of carbon mitigation actions and strategies are taken into consideration, it becomes clear that it *does* matter where and how mitigation actions is done. For instance, there is morally and politically a difference between cutting one tonne of carbon dioxide emissions from the richest one percent of the population, compared to the poorest one percent. There is also morally, politically, economically and ecologically a difference between reducing one tonne of carbon dioxide emissions through more efficient use of energy in the steel industry, or from banning harvest of mangrove forests. And there is morally, politically, economically and ecologically a difference between pumping down one tonne of carbon dioxide into an old natural gas extraction spot, and capturing the same amount of carbon through planting seagrass meadows.

Summary Logics

In this section, I outlined the three, as I argue, logics of the climate regime – the global, scientific and neoliberal. These logics are underpinned by specific views on how climate change should be governed, institutionalised in the architecture of the climate regime. For each logic, I first described where they have been expressed and materialised in the climate change, before turning to their effects – as seen, for instance, in the making of Blue Carbon. For instance, I described how the global logic can be found in changes to the concept of "climate" and research interest, the concept of global warming, a growing interest in international environmental policy generally, and the inceptions of the IPCC and the UNFCCC specifically, with their respective mandates clearly pointing to an understanding of climate change as global. I then argued that for climate change to be governed as global, it had to be governable, a process involving demarcation, the generation of global types of knowledge, and transferrable units and concepts like the global carbon sink and the carbon dioxide equivalent. I outlined (global) climate models as a specific example, and argued that even though climate models can provide us with a lot of information, there are limits to how climate change can be understood through models. This type of data is also complex, which enhances the role of experts. Moreover, global types of information makes local and contextual information less visible. Expressions and materialisations of the scientific logic in the climate regime can, I argued, be seen in, for instance, the original text of the UNFCCC, the relationship between the UNFCCC and the IPCC, science-policy interfaces like the SBSTA generally or the SED specifically, and the entanglement of science and policy in the LTGG of Convention.

The scientific logic is tied up with what science is understood to be, and its role in policy and society. This role is, however, contested. In the context of the climate regime, the role of science is commonly understood as informant to policy, but still separated from policy. This is a balancing act that requires actors of science to perform boundary work to maintain authority. This in turn has arguably created a range of hierarchies between different types of knowledge, disciplines, evidence and more.

Representations of a neoliberal logic in the climate regime can be seen in the linkage to the concept of sustainable development and the idea that economic growth is both a cause and a solution to environmental degradation, just used differently. In the UNFCCC specifically, the most obvious expressions of a neoliberal logic is the use of, and belief in, different types of market-based mechanisms. Some of these mechanisms also more clearly than others give the private sector more influence. There has been a general tendency towards less multilateralism. The growing interest in a neoliberal logic of climate change mitigation, can be understood against ideas regarding the neoliberalisation of the governance of nature generally. This builds on the idea that environmental problems stems from environmental services and goods not being valued. Market-based mechanisms put a value on nature. Once in place, markets work on supply-and-demand and are thereby able to govern the goods, in this case carbon, efficiently. This in turn reduces the influence of states to some degree depending on type of mechanism. Making carbon tradable, and thereby governable, means, however, loosing context specific information. It does not matter where emissions are reduced, which connects well with the global logic. Another commonality between the logics is that numbers, quantifiable information, is important. Quantitative information can be transparently compared and understood in many contexts. I argued that these logics, taken together, in turn operate on a logic of extraction that makes information more general and less contextual, or situated. They also have in common that they in different ways depoliticise climate change mitigation, which may lead to a democratic deficit. The global logic makes local knowledge redundant, knowledge that may be more relatable to communities. Global policy is also less accessible than local policy. Global, scientific, information is in many ways less accessible to the people and society broadly. The neoliberal logic with its redistribution of power to markets and the private sector, away from elected representatives, is another example of loss of accessibility.

3. Bringing Differences Back

> The soil allows us to attach ourselves; the world allows detachment. Attachment allows us to get away from the illusion of the Great Outside; detachment allows us to escape the illusion of borders. Such is the balancing act to be refined.
>
> *Bruno Latour, 2018 "Down to Earth"*

In the previous section, I outlined three logics that I argue are particularly important to understand the making of Blue Carbon. To continue this exploration, we could go even further back in time and even further away geographically. We could look at the history of the UNFCCC in more detail and try to understand where it comes from, or we could situate the climate regime in an even broader context – socially, politically, historically (e.g. following Agrawala, 1999; Andresen & Agrawala, 2002; Gupta, 2010). If we understand Blue Carbon, at least partly, as an effect of the global, scientific and neoliberal logics, then a next step could be to investigate what these logics in turn are effects of. However, as argued in Section 2, the three logics have in common that they, in different ways, extract information from their contexts and depoliticise climate mitigation. In brief, the global logic creates a demand for global information, and renders local knowledge less visible. The scientific logic emphasises the relationship between science and policy, experts and decision-makers, not society or the people. The neoliberal logic suggests that the market, not elected representatives, knows best how to govern climate change, and gives power to private actors, rather than states. Instead of moving even further away from the mangroves, seagrasses and marshes where we started, I propose a return to the coastal zone, and a dive into the details that make up the big picture. More specifically, instead of continuing to extract information, to separate content from context, I believe it to be in order to bring differences back.

Coastal Ecosystems

> *Guayaquil, June 2015.* The so-called Blue Carbon Initiative (BCI) holds a workshop and meeting in Ecuador's largest city. The city is well-visited by tourists, but not foremost because of what the city itself has to offer or its surrounding nature, but because it is the last stop before reaching the Galapagos Islands.
>
> Guayaquil is situated by the Gulf of Guayaquil and surrounded by mangroves. As one of the workshop-participants, discussing the future of coastal marine ecosystems, I wanted to take the opportunity to visit these mangroves. Having unsuccessfully tried to convince the other workshop participants to join me, my guide Carol, despite being sceptical about willingly heading into an area with so many mosquitos, showed me around. There were indeed many mosquitos, and all kinds of wildlife including the large iguanas that are common in the area. The mosquitos were, however, no disturbance to the idea of pristine nature and are not visible on the photos I took. All the plastic debris floating around were.

Globally, coastal ecosystems of mangroves, salt marshes and seagrasses are declining (Pendleton et al., 2012). Threats include pollution, human settlement, urbanisation, aquaculture, agriculture, forestry, and climate change (Greenberg et al.2006; Katwijk et al., 2016; Makowski & Finkl, 2018). The mangroves of Ecuador have decreased by one quarter since the 1970s despite regulation (Beitl, 2016). Most of the losses were caused by the expansion of aquaculture, which seems to have stabilised in Ecuador since 2000, but continues to grow worldwide (Hamilton & Lovette, 2015).

In this thesis, coastal ecosystems refers to ecosystems that are situated at the intersection between land and sea, excluding the open ocean and purely terrestrial ecosystems. The coastal ecosystems of foremost interest in this thesis are mangroves, seagrasses and salt marshes. These are sometimes referred to as coastal marine ecosystems. *Marine* gives an indication that freshwater ecosystems are excluded. This is a simplification as salinity varies. In fact, some of the species that occupy these ecosystems prefer freshwater, and typically live where rivers meet the sea/in estuaries. The defining factor is thus not the degree of salinity, but location. This in turn is defined by the distribution of the ecosystems, which varies from location to location, not the *de jure* definition of the coastal zone (UN General Assembly, 1982), although this may be important for issues related to management and policy.

Mangrove refers to a collection of some 70 different species – mainly trees, tall and short, and shrubs – that have in common that they have adapted to life in the intertidal zone in tropical and subtropical areas of the world (Spalding et al., 2010). Some species prefer high salinity, some low (Chanda et al., 2016). There are different estimates of their cover. One fairly recent estimate suggests that mangroves cover approximately 8 million hectares globally[12] (Hamilton & Casey, 2016), another estimate suggests that there are around 15 million hectares of mangroves spread over 123 countries (Spalding et al., 2010). Although annually between 0.16% and 0.39% of the global mangrove cover is lost, the rate of deforestation has slowed down and in some places stabilised (Hamilton & Casey, 2016). That said, the rate of loss also differs between estimates and 11 out of 70 true mangrove species (excluding hybrids) have been found to qualify for the "Red List" as "Critically Endangered", "Endangered", or "Vulnerable" by the International Union for Conservation of Nature (IUCN) (Polidoro et al., 2010).

Figure 1: Mangrove forest.
Guayaquil, Ecuador. Photo credit: Terese Thoni

Salt marshes (also known as tidal marshes) are coastal ecosystems that are regularly flooded. As with mangroves, plants that live here tolerate a more or less salty existence. Indeed, they often connect freshwater and salt water ecosystems (Mcowen et al., 2017). Salt marshes are characteristically occupied by low-growing terrestrial plants, such as grass, bushes and herbs (ibid). As with mangroves, estimates of global cover differ. One recently published database estimates of some 5 million hectares in 43 countries, but this estimate is considered modest due to lack of data (Mcowen et al., 2017).

Seagrasses cover approximately 18 million hectares globally, but this number is likely an underestimation due to lack of data (Spalding et al., 2003). There are around 60 known species of seagrasses (Short et al., 2007). Seagrasses grow in

[12] 8 million hectares is 80,000 km2. As a comparison, the total surface of the Earth is 510 million km2 (30% land, 70% ocean)

shallow coastal marine and estuary environments all over the world except Antarctica (Green & Short, 2003). Seagrasses are flowering underwater plants with roots, in contrast to seaweed (or microalgae), which do not have roots.

Coastal ecosystems provide humans with many ecosystem services; benefits people obtain from ecosystems (MEA, 2005). These include, inter alia, nursery for fish species (Hantanirina & Benbow, 2013; Jardine & Siikamäki, 2014; Spalding et al., 2003), cultural and aesthetical values (Pendleton et al., 2012; Vierros, 2013), poverty alleviation (Benessaiah, 2012) livelihoods, fuel, and pharmaceutical products (Chung et al., 2013).

Coastal ecosystems have long been governed through conservation, for instance in Marine Protected Areas (MPAs) (NOAA, 2016). MPAs and other protected areas may be managed if this is considered the best protection arrangement, but not commercially exploited (Lausche, 2011). In addition, market demand, in particular the demand and value of fish and aquaculture, has also affected the management of coastal ecosystems (Hantanirina & Benbow, 2013; Jardine & Siikamäki, 2014; Lovelock & McAllister, 2013; Pendleton et al., 2012; Sondak & Chung, 2015). During the past ten years, the value of other ecosystem services provided by coastal ecosystems, namely carbon sequestration and storage, has been given increased attention, captured in the terminology of *Blue Carbon*.

Compared to terrestrial ecosystems that have most of their organic carbon stored in living trees and plants, much of the carbon in coastal marine ecosystems is stored in soil and sediments (Bu et al., 2015; Fourqurean et al., 2012a; Lunstrum & Chen, 2014; Nobrega et al., 2015), which in turn means that they store carbon over a comparably longer time-frame than many of the terrestrial ecosystems (Chung et al., 2013; Grimsditch et al., 2013; Pendleton et al., 2012; Reef & Lovelock, 2014).

New Materialism

In Section 2 I outlined the “big picture” of the making of Blue Carbon. I argued that the three logics – the global, scientific and neoliberal - are helpful concepts to think through and unfold the making of Blue Carbon. I also argue that these three have in common that they in turn operate on a “logic of extraction” that washes away differences and makes the politics less visible. To move beyond this meta-level analysis, I suggest that we need to pay renewed attention to the materiality of Blue Carbon. Here I turn to a literature that has been called “new materialism”. It is an emerging field and its name and boundaries are not settled. “Neo materialism” or “relational materialism” are other labels used. When looking at the literature that populates the “new”/”neo” materialism, it becomes clear that it draws on literature and traditions that are far from new (cf. Kuntz & Pickup, 2016). It has, however, a new take on materialism in the form of a dialogical model instead of a dialectical. I treat Actor-Network Theory (ANT), or *Sociology of translation* as it has also been called (Callon, 1986), as an important part of new materialism[13]. ANT builds on a relational-materialist understanding. ANT was in turn born out of STS, but STS is broader and covers both macro- and micro-level studies, in contrast to ANT that focusses on micro-level studies. STS is also broader in the sense that some studies are quite focussed on discursive patterns, while ANT focusses distinctively on material–semiotic analyses. To understand the making of Blue Carbon, conceptions of the material more generally and a relational world-view (more below), are the main features of new materialism that I make use of, rather than a complete mapping of all the "associations" that constitute the actor-network of Blue Carbon (cf. Latour, 1991).

ANT – and new materialism generally - is, despite its name, more a methodology or ontology (metaphysics; way of understanding reality), than a theory (Latour, 2005, cf. Law & Singleton, 2013). ANT provides concepts that can be used to study actor-networks. To study the making of Blue Carbon, the main merit of new materialism is that the material, the non-human and artefacts become more important in social analysis (e.g. Law, 2009; Latour, 1991). In the context of this study, this is an advantage as it means that what is actually central to the whole issue of Blue Carbon – coastal ecosystems – as well as the material artefacts used to measure carbon in them, are brought forward instead of being treated like background or simply overlooked. In the next chapter, I outline the methods I have used. Below, I present the main ideas of new materialism, that I use in, foremost, Section 5 and **Paper IV** to discuss my findings.

ANT and Materiality

In environmental science, it is fundamental to understand processes in the environment. Hence, "the environment" is not treated as something static, but as constantly changing, temporal and dynamic. This approach is similar to Actor-Network Theory (ANT). The making of Blue Carbon, I argue, needs to be understood both against the social as well as the environmental processes involved. After all, Blue Carbon is not something that exists in the environment – it is a concept that represents ways of making coastal ecosystems governable as carbon, but it does not mean anything in isolation. It can, I argue, be more fruitfully thought of as the effect(s) of a range of interactions, processes and, ultimately, performances, including the three logics outlined in the previous section. Indeed, in ANT, nothing exists without its connections - *associations* – connections between actors and/or

[13] ANT as represented by e.g. Latour, Law and Callon goes back to, at least, the 1980's.

artefacts (e.g. Latour, 1991). This in turn collapses the difference between context and content.

We have known about the carbon in coastal wetlands much longer than the concept of Blue Carbon has been around (Pidgeon, 2018). It was not until there was a political interest in carbon in coastal ecosystems that Blue Carbon was coined. That said, there are, of course, also important material aspects associated with Blue Carbon, and this materiality is both man-made and nature-made. We have on the one hand documents like the methodologies used to calculate the amount of carbon in these ecosystems in comparable ways, the augers used to sample soils and sediments and the elemental analyser that combusts all the carbon in the sample. We also have the coastal ecosystems where "Blue Carbon" is found. Some of these ecosystems have sediments that date back millennia, long before anyone had ever thought about "carbon", let alone ways of measuring it.

ANT has been described as:

> […] a disparate family of material-semiotic tools, sensibilities and methods of analysis that treat everything in the social and natural worlds as a continuously generated effect of the webs of relations within which they are located. It assumes that nothing has reality or form outside the enactment of those relations. It studies, explore and characterise the webs and the practices that carry them (Law, 2009, p. 141).

The focus of ANT, is, as the name suggests, on the actor-network. An actor-network consists of all the connections of the entities in the actor-network (Müller, 2015). All actors can also be networks, and vice versa – it is a matter of perspective, hence the concept "actor-network" (e.g. Latour, 2005). The social is something that comes to be, not something stable that we should take for granted – like a "domain or type of material" (Latour, 2005, p. 1). Likewise is power something that is created in the actor-network and does not exist outside of it – there is no external structure that dictates what happens to the actors. Methodologically, an ANT-analysis, simplified, is the analysis of how people and artefacts (including ideas) - come together in networks and create the social (Law, 2009). The network consists of mediators and intermediators. The latter are unimportant to social analysis and can thus be ignored. One of the main criticisms of traditional social theory that ANT puts forward is that too many mediators are treated as intermediators and thus excluded from the analysis (Callon, 1986; Latour, 2005). Another distinguishable feature of ANT is that, because social force is created within the network, power relations cannot be presupposed. This means that at least theoretically, humans in the network cannot be assumed to have more power than artefacts.

ANT, and new materiality in general, brings forward relationality to the analysis (Bumpus, 2011; Rudy, 2005). Relationality means that there is no "outside" –

everything is connected. For climate change, this also brings in materiality in a very real sense – we have one home, one planet, and we cannot think that climate change is something that happens externally to us (cf. Kuntz, 2015; Latour, 2011). From this follows that reality is temporal and multiple (Law, 2004; Law & Urry, 2005). Another way of describing this is to see reality as a process (Callon, 1986).

Enactment

The focus of this thesis is the making of Blue Carbon - governing coastal wetlands as carbon. The use of the word "making" suggests a process, something that is in the making; it is being made. In this section, I briefly describe what new materialism brings forward in terms of world view, assumptions and theoretical concepts that can be used to explore the making of Blue Carbon.

From relationality follows that knowledge about our world is never neutral. This goes for all fields and all disciplines, including, as relevant for this thesis, climate science and Blue Carbon-science. Recognising the subjectivity of knowledge, however, does not mean that we, for instance, cannot measure the level of carbon dioxide in a reliable way (see also Edwards, 2010). However, the fact that we measure carbon dioxide in the atmosphere to begin with, how we do it, the value we put into it, what we do with it, are all aspects of the measuring of carbon dioxide that are socially constructed. That said, while the rationale behind the measuring carbon dioxide is constructed, carbon dioxide is, of course, material as well. We can study both nature and society empirically. What the recognition of a science that is not free of norms tells us is that the results of such studies should not be confused with an objective encounter with our world. Here I turn to Law and Urry (2005), who, when discussing the possibility of "reliable social facts" such as suicidal rates or public opinion, argue that claiming that there are no reliable social facts is "[…] both too romantic and too scientistic" – too romantic because it suggests that we cannot know reality, and too scientistic because it suggests there is an ultimate truth about it. Instead, they argue, "the real is real enough. It is obdurate. It cannot be wished away. But it is also made. And in some measure that which is socially real is made by, and through, the instruments of social analysis" (Law & Urry, 2005, p. 396). Furthermore, they argue, that some social realities are enacted by social science methods "[…] *does not make them any less real*" (ibid. p. 395, italics in original, see also Demeritt, 2002). While Law and Urry's (2005) discussion here focusses on social inquiry, it could perhaps best be understood as an elaboration and addition to the scholarly debate on the social construction of science that goes further back in time, at least to Kuhn's notion of paradigm shifts (Kuhn, 1962). What I take with me from Law and Urry, as well as the broader discussion on the co-production of science and policy (as described in Section 2) is that the discussion on the enactment of research methods is relevant both to my inquiries into the making of Blue Carbon (Section 4) and, for instance, the methods used to measure Blue Carbon in soils and sediments (see **Paper III**).

From relationality follows that there is not one reality "out there" ready to be discovered. Relationality implies multiplicity, rather than plurality (Mol, 2002; Rudy, 2005). That there are varieties of the real, and not just one truth, but varieties of truths (Law, 2004). The result of the making of Blue Carbon may be a world where everyone agrees that it is a good idea to implement Blue Carbon-projects as mitigation strategies, but that does not mean that the idea of Blue Carbon is stable, that it cannot change or never will change. Moreover, Blue Carbon is not just being made, it makes – enacts – effects too. That means that a Blue Carbon-world may reinforce itself. However, the end result will never truly be something that just "is", rather it becomes, it comes into being (Law & Urry, 2005; Mol, 1999).

Positing that change better describes our world than stability does not imply that it is not important to study stability. On the contrary, I argue, it is precisely because the world is changing that we need to understand stability and our perception of stability and of control (see Section 5, also **Paper IV**).

In a dynamic and constantly changing world, science helps organise the world, helps us make sense of it through simplifications (Callon, 1984; Ormond & Goodman, 2015). Making governable is thus about structuring and making knowable *as best we can.* Against this backdrop, the authority of science can be understood as the power to help organise the world. Science creates rules about the world/reality, which in turn be used by policy. In this sense, "science is politics by other means" (cf. Latour, 1988, p. 229).

In this section, I have pointed out some concepts and ways of thinking that new materialism brings forward that I find useful in exploring possible effects of the making of Blue Carbon. A such, this section links primarily back to research question 4 about what social realities Blue Carbon enacts, or makes possible. This is a theme discussed more in Section 5 below as well as in **Papers III** and **IV**. The underlying understanding here is that Blue Carbon methods do not only describe the world in terms of carbon stocks, emissions and sinks, they enact it. Blue Carbon as method, strategy, and way of thinking, makes visible specific aspects and values. For instance, measuring Blue Carbon generates meaning about coastal ecosystems, linked to specific governance mechanisms, which in turn affects the management of these ecosystems, their distribution, wellbeing, and so on. Consequently, research of any sort cannot be understood as passively observing and describing the world, but actively creating it. The following section focusses on the materials and methods used in this thesis, and continues the discussion on enactment.

4. Studying the Making of Blue Carbon

> In an ant's world, the smaller you are the harder it is to see obstacles […] Ants' eyes are not like ours. Ants have compound eyes with many units, called ommatidia. Their eyes look like an array of LEDs you'd see in a traffic light (except in a dome shape). Each ommatidia sees one point in space so the whole eye sees one image but different portions of it.
>
> *Palavalli-Nettimi (2018) "In an ant's world"*

As explained in the previous sections, to understand the making of Blue Carbon there is merit in looking at the big picture – the overarching context – as well as in describing the process on a micro-scale level. The big picture tries to make sense of the issue through looking at sameness. The micro-scale study on the other hand focusses on describing differences. Hence, the overarching methodology is one of going back and forth between detachment and attachment (cf. Latour, 2018), where the macro and micro-scale studies tell different sides of the same story.

Latour (2005, p. 9) says that he did not like the name Actor-Network Theory, until he realised that its abbreviation is also *ant* as in the animal – "an ant writing for other ants – this fits my project very well!". Latour calls the ant blind, but as the quote above illustrates, they are not. If you imagine sitting next to an ant looking in the same direction, the ant will see the same thing as you but as fractions that make up the whole, like pieces in a puzzle or a picture scaled up so you see all its pixels. But, the smaller the ant, the harder it gets for it to see the whole, and thus to see obstacles in its way. Translated into doing research, which is the topic of this section, I find that this vision –seeing the world through the eyes of an ant – is a good illustration of how we do need different tools, different methods, to put different pieces together to better understand the whole (better, but never fully). Contrarily, staying small and isolated, our vision gets more and more blurred, the pixels bigger and bigger and the whole more and more difficult to see.

From Macro to Micro Level and Back

According to Latour, "everything" is data (Latour, 2005), which opens up for an eclectic approach to inquiry, although in depth ethnographical work seems to be crucial to new materialism (e.g. Callon, 1984; Law & Singleton, 2013; Latour, 1988; Pereira, 2010). Indeed, it is hard to come up with any other method that brings out the differences, and the context specific information, the materials and the semiotics, like ethnography does. In addition, Latour argues (e.g. 1991; 2005), an ANT-analysis focusses on description, not explanation – explanations are born out of descriptions and no other tools are needed. If the description does not provide an explanation, then it is an incomplete description.

Because new materialism tends to study issues that are currently debated, currently unfolding – "science in the making" (Section 2), the number of threads to examine is almost endless. Some threads are short, some long, some split, and some tangled. This means that this thesis, for instance, does not put an end to the story of the making of Blue Carbon, because Blue Carbon is currently in the making. However, the motivation behind micro-scale studies is usually not to endlessly follow thread after thread until finally having said everything there is to say. My motivation for looking at Blue Carbon is not to describe it and stop there, but to, ultimately, raise questions regarding how it is being made, and thereby somehow participate in its making. In this sense, I believe, an important part of new materialism is to be able to stop. This also means that I have to accept that I may have missed an important thread that merits scrutiny, and hope that someone else picks it up, and adds it to the yarn. After all, knowledge is always partial (cf. e.g. Haraway, 1988). That said, the intention here is not to explain exactly how something "is" – what Blue Carbon is, or the role of science is, was and always will be. Indeed, adhering to a relational, multiple ontology means that there is nothing inherently stable. Or at the very least that everything is always potentially unstable. The way we perceive issues as stable or not, however, is not the same as them actually being stable, which the concept of black-boxing draws attention to. That the black box of a system is closed, is not the same thing as saying that it is impossible to open, merely that we do not consider opening it, we do not think about its inner workings, because as long as it works, we only see what goes into it, and what comes out (Latour, 1999).

I have used new materialism primarily as a tool to think differently about my material, my cases and, indeed, their materiality. I have not conducted a detailed ethnographic case study like, for instance, Mol (2002) and her ground-breaking study on the "body multiple". To me, my most important methodological decision has been to be able to move between the macro and the micro scales. That means that I have consciously chosen broadness in terms of number of approaches and paths. This is not in itself an unusual decision. Micro-scale studies always relate to the broader picture in some sense, asking "what is this a case of?" (e.g. Bryman, 2012). Choosing broadness here primarily refers to the fact that I have looked at three different cases – the survey of the future of the IPCC, the SED and Blue Carbon. The reason for that is, to reiterate, that I felt that to understand Blue Carbon I needed to understand the role of science and the interaction between policy and science. That said, that this study would turn out the way it did was not planned. My approach has been primarily inductive, sometimes to the extent that it felt like my material picked the approach, not me.

The cost of broadness is, as always, loss of depth. As described above, the logic of extraction (Kuntz, 2015), or modes of abstraction (Allan, 2017), washes off some of the context specific information, focusing on finding patterns in the text. All scientific work accommodates this logics, as explaining something always is a trade-off between gaining understanding, and losing context in the creation of a representation. Different research traditions do this in different ways, and, importantly, with different levels of awareness of, and resistance to, this process (cf. Jasanoff, 2015). New materialism sets out to not explain, but to describe, and let the explanation come from the description (e.g. Latour, 2005).

New materialism is concerned with activity, rather than a pre-defined structure. This provides tools that allow us to focus on and question presumptions, for instance by trying to observe how the actors involved define an issue, instead of defining it ourselves first. More concretely, ANT as a methodological approach involves mapping the network in question, but compared to traditional social network analysis, not only humans are included (Callon, 1984; Latour, 1988, 2005; Law, 2009). However, not even ANT is immune to the logic of extraction, because a relational ontology means that the network, in theory, is endless, and thus a representation of an actor-network is a simplification (Callon, 1986, see also Law & Singleton, 2013). It is an ongoing trade-off, temporal and always in the making. There are things, however, that can be done to counteract this simplification with contextualisation, before another simplification can begin, followed by contextualisation. The black-box has to be reopened, when it is considered flawed, and new actors involved (Callon, 1986). In the end, the goal is not to find the "best" approach. Indeed, as Foucault puts it more generally, things are not right or wrong but "dangerous" in different ways (interview, quoted in Rouse, 2005, p. 115). Different methods perform different realities. Understanding Blue Carbon only from the point of view of ANT is not a goal in itself - that too would be dangerous. What I have tried to do in this thesis is to show that there are alternative ways and that these have consequences that should be considered, not that one method is better than another.

In the papers of this thesis, distinct frameworks have been used or developed that have in common that they in one way or another try to break down a bigger issue into smaller pieces, and/or to bring in more context. In **Paper I**, we apply a framework about the distance between science and policy (Sundqvist et al., 2018), to a new case, and discuss what it does to the case. We argue that even though the framework is a useful explanatory tool, the risk is that it also makes the issue more black and white than it is, and that ways forward are hard to find. For that, we argue, nuances are needed. In **Paper II**, we focus on boundary work, but advance the concept of “boundary moments” to allow for a more detailed analysis of the making of boundary work. We argue that this reveals the internal dynamics better, as it shows that the boundary is constantly renegotiated. In **Paper III**, we break down soil carbon methodologies and show that each step is a choice with associated uncertainties that merit discussion. In **Paper IV**, I use a framework that breaks down the process of co-production into smaller steps, that in turn enables analysis of these. In sum, while each paper performs a logic of extraction, they also, in different ways, try to resist it by bringing back some of the context otherwise lost, and analyse this context in its own right.

Analysing Representations

What I refer to as macro level-analysis is, simply put, “traditional” qualitative social science analysis (cf. Bryman, 2012), primarily text analysis with categorisation. By text, I refer to all kinds of semiotic representations, such as peer reviewed literature, grey literature, blog posts and interviews.

To get to know the text material, I have used QSR International's NVivo 11 software – a data analysis tool, primarily for qualitative analysis, but also limited quantitative coding. These types of tools provide an opportunity to see a material in different ways. For instance, it has enabled me to – literally, see specific concepts and their direct textual contexts without all the other text, from a vast number of total pages in a way that only a tedious session of printing, cutting and gluing together text would have otherwise enabled. This is a specific and clear example of how coding and text analysis can take away context, and bring forward another understanding. However, there is of course the risk of not understanding the meaning of a text when not read in its entirety. Moreover, while these types of tools clearly can make analysis more efficient and create a specific type of understanding, they are not helpful when one does not know what one is looking for. In general, I have started with the data, and then tried to understand it – an inductive approach, which meant that I primarily used qualitative methods over quantitative.

More specifically, and as described in **Paper II** primarily, for text analysis specifically the general approach has been to try to get familiar with the material, and let common themes and patterns crystallise themselves from the material. After this, specific codes have been created and a more deductive approach taken over. In addition, I have to a limited extent also used content analysis, looking for and counting the occurrence of specific ideas, for instance most dominating policy framings in the scholarly literature on Blue Carbon (**Paper IV**).

In **Paper III**, we conducted a structured literature review. By structured we mean that we analysed all published literature on Blue Carbon given certain criteria. This is close to what could be called a qualitative structured literature review (Northey et al., 2015). We also gathered data from the reviewed studies and analysed this data, in a manner that borrows ideas from quantitative structured literature reviews, also called meta-analysis (ibid).

The material used for text analysis comes from a number of sources (personal communication is dealt with below more extensively). For the structured literature review, we included all scholarly literature that focussed on Blue Carbon published between 2013 and 2017, in total close to 200 articles. I have complemented this with more recent literature, some of it featured in **Paper IV**, some here in the Kappa. To be able to distinguish what arenas and actors were relevant to Blue Carbon, I set up a database in NVivo that I filled with potentially relevant material, such as media reporting from the UNFCCC-negotiations, foremost the Earth Negotiation Bulletin (ENB), mangrove REDD-readiness projects, all CDM afforestation/ reforestation projects (55), Nationally Appropriate Mitigation Actions (NAMA-proposals, around 200), National Adaptation Programme of Action (NAPAs, 50 countries), and "endorsed projects" under the Adaptation Committee, INDCs and UNFCCC negotiation texts and decisions from 2010 and onwards. Other documents included information from webpages about Blue Carbon (using NVivo's NCapture as an add-on to my browser that allows immediate download to the database), reports from Non-Governmental Organisations (NGOs) and other relevant actors, such as the Ramsar Convention and the Convention on Biological Diversity (CBD).

The database has been an ongoing project. Setting up a database has its limitations. For instance, there are limits to what objects that can be included, and it works best with text and audio, but it is also possible to include photos of objects and in turn code the photos. I think of this as a tool that can be used to keep at least two of effects of research) – especially given the large amount of data that can be collected when "everything" is data. In this way, if not everything than at least a large part of its representations can be kept in one place.

Analysing the material in the database enabled me to single out documents and agenda items relevant to Blue Carbon, and a timeline, as presented in **Paper IV**. Not all material has been studied in detail. For instance, I only found one Blue Carbon-NAMA.

Ethnographic Approach

With micro level-analysis, I refer to approaches to try to get some of the context specific information back, and understand what it means also against the big picture. This means that I have tried to follow Blue Carbon as a governance objects into different environments – from the UN climate negotiations to mangrove forests and soil carbon analysis. In addition, I have made use of text analysis also here, but instead of trying to find similarities and patterns, I have looked for "differences" and irregularities. This could be anything from singling out negotiation strategies out of the ordinary and look closer at them, to looking at differences in growth behaviour between seagrass species.

Even though there are few detailed descriptions of general methods to adhere to when carrying out an analysis in line with new materialism, I have found guidance in both general and more specific accounts in other studies. I have, as a specific tool, used brainstorm-like mapping exercises inspired by situational analysis (Clarke, 2005). One of the first things I did when I started looking into Blue Carbon was to create a map with the most important arenas and actors, which I published in a separate report (Göransson, 2016). Along the journey, I have complemented this mapping with non-actors such as narratives and concepts as semiotic representations, and equipment and tools as material representations. The co-production framework of state steering and scientific assembling by Allan (2017), which I use and discuss in **Paper IV**, is another example of a specific tool I have used. Allan's model provides a structure to move back and forth between the micro and the macro study and to bring forward semiotics and materiality.

As part of the micro level-analysis, I have used an ethnographic approach of the Blue Carbon-community. Participatory observation is common in ethnography and usually implies being part of a specific community, rigorously studying it (Gillespie & Michelson, 2011). This could be, for instance, as a member of a hooligan group or living in a remote village in a rainforest. I find ethnographic approach more fitting description of my methodological considerations, than participatory observation, because the latter implies observing a community, rather than engaging with it (cf. Kuntz, 2015). The emphasis on working *with* a community, rather than studying it, objectifying it, reveals a normative element that is often connected with ethnographic studies (Northey et al., 2015). Against a relational ontology where connections make up reality, dichotomies that try to separate "out there" and "in here", content and context, subject and object, and agency and structure, are seen as arbitrary (e.g. Latour, 1991; 2000; Law, 2004). Following ANT, agency is seen as being distributed through webs of relations (Latour, 2005). Similarly, in situational analysis, the concept of "context" is seen as hindering social analysis, leading to too simple explanations to "situations" or relations (Clarke, 2005). Instead, the context is created in the situation (ibid).

I was never an official member of the Blue Carbon-community, partly by choice because I was not sure if I should or wanted to help promote the issue, and if so how this would affect my results on the one hand, and the Blue Carbon-community on the other (cf. Northey et al., 2015). I followed the general recommendations for ethnographic studies of explaining that I research the issue and collect data, but not revealing what my expectations were (ibid). While I understand that this makes the study considered more scientifically sound, I am not sure this approach is seen as normatively inferior by everyone. For instance, there is no way for me to know if the people I talked to thought that I would help advance their cause. I have tried to reduce the risk of unintentionally creating false expectations on my study, by being as open as possible and making myself available to questions regarding the study.

There is also no obvious "home" of the Blue Carbon-community, which makes traditional, long-term ethnographic studies challenging. The Blue Carbon-community is relatively small, but spread out. Some members work intensively together, often for limited periods, such as during the course of a specific study with fieldwork and writing up a paper. The closest I came to be a member of the Blue Carbon-community was probably as I was invited as a speaker to the meeting of the Blue Carbon Initiative in Guayaquil. In conjunction with this meeting I organised a visit to a nearby mangrove forest, as mentioned also in Section 3.

Even though I have not been an official member of the community, I have tried to stay close to it. For instance, I have keep regular contact with members of the community, and especially in the beginning of my PhD studies I met up with members frequently. This involved informal conversations in conjunction with negotiations, dinners, lunches, events around new publications, following key actors and engaging with key actors on social media, and emailing extensively with members. Most of these occasions were informal.

In addition to engaging with the Blue Carbon-community, a crucial part of my studies has been to attend relevant, international, events, foremost the negotiations under the UNFCCC. At these occasions, I followed discussions on the role of science on the one hand and Blue Carbon on the other, and these events were an opportunity to engage with the Blue Carbon-community, in addition to following the negotiations. Regarding the role of science, the most important events were the Structured Expert Dialogue (SED), which led to **Paper II**, the Research Dialogue, where Blue Carbon was discussed along other "technical and scientific" issues, and IPCC special events. To understand what lies behind the importance of the IPCC has been an ongoing interest throughout my studies, and discussed in **Papers I** and **II** (also **Papers III** and **IV** in the context of Blue Carbon).

At the climate negotiations, I followed Blue Carbon where I knew it would be addressed – specific negotiations but also side events and events in conjunction with the negotiations. I tried to follow Blue Carbon where it went – a task that became more and more challenging the more I learnt about it. At first, I focussed on the Research Dialogue, but since then I have put together an ever growing list of relevant agenda items (some no longer existing), such as: discussions on markets – under the Kyoto Protocol and beyond (e.g. Non-market-based approaches, Framework for Various Approaches, CDM), mitigation strategies (within NDCs, NAMAs), land-use issues (REDD+, agriculture, LULUCF) and adaptation (Nairobi work programme, National Adaptation Plans, Adaptation Committee) (see also **Paper IV**). When I had to prioritise, I focussed on the role of ecosystems – be it in adaptation, as Nature-based solutions, land-use change or elsewhere. The table below lists the events I attended.

Table 2: Events attended, dates and places

Event	Dates and Place
Forum on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction. Organised by the United Nations Academic Impact for the International Studies Association	Feb. 28 2017, New York
COP 21	Nov. 30 2015-Dec. 12 2015 December 2015, Paris
GLF 3	Dec. 5-6 2015, Paris
Blue Carbon and other Coastal Ecosystem Services – Next steps in international and national policy making and implementation. Workshop organised by the Blue Carbon Initiative	June 23-25 2015, Guayaquil
SB 42	June 1-11 2015, Bonn
COP 20	Dec. 1-12 2014, Lima
GLF 2	Dec. 6-7 2014, Lima
SB40	June 4-15 2014, Bonn
Integrating Ecosystem-based Adaptation into National Adaptation Plans; Ecosystem-based Adaptation Knowledge Exchange. Workshops organised by Conservation International.	June 7 2015, Bonn
COP 19	Nov. 11-22 2013, Warsaw
GLF 1	Nov. 16-17 2013, Warsaw
UNFCCC Workshop on technical and scientific aspects of ecosystems with high-carbon reservoirs not covered by other agenda items under the Convention	Oct. 24-25 2013, Bonn

Comments: Abbreviations: COP – Conference of the Parties, GLF – Global Landscapes Forum, SB – Subsidiary Body (intersessional negotiation under the UNFCCC)

I have also followed a number of events and negotiations remotely. I find it worth mentioning those in Table 3 below, as I have used information directly accessed via webcast from these events.

Table 3: Webcasts of important events, dates and place

Event	Dates and Place
Oceans and Coastal Zones Toward COP25 - Addressing the IPCC Findings Relevant to the Ocean and Climate Nexus. Side event in conjunction with SB50	June 25 2019, Bonn *video link*
GLF: Blue Carbon Summit	July 17, 2018, Jakarta *webcast*
GLF: Peatlands Matter	May 18 2017, Jakarta *webcast*
UNFCCC SED. 11 occasions – 4 parts and one special event.	June 2013-June 2015, in conjunction with UNFCCC negotiations. *I attended SED2-SED4:2 in person, SED1+SED4:3-SED4:4 accessed via webcast. See Paper II.*

Comments: Abbreviations: COP – Conference of the Parties, IPCC – Intergovernmental Panel on Climate Change, GLF – Global Landscapes Forum, SB – Subsidiary Body (intersessional negotiation under the UNFCCC), UNFCCC – United Nations Framework Convention on Climate Change, SED – Structured Expert Dialogue.

I attended the UNFCCC-events as observer-NGO, apart from the 2013 technical workshop where I also supported the UNFCCC Secretariat. At COP 19, I helped with the organisation around the Adaptation Forum. In conjunction with COP 19 and 20, and SB 42, I attended the Nairobi work programme Focal Point Forum, representing my department as one of two focal points. For the same reason, I also participated in the workshops on Ecosystem-based Adaptation in 2015, also there representing my department. These events had limited access and provided a possibility to get an insiders' view into the broader discussions on the governance of ecosystems under the UNFCCC, as well as an opportunity to get to know relevant actors. It also gave me a better understanding about types of knowledge used to inform the negotiations. While the technical workshop made most use of scientific knowledge, the others brought forward expertise from practitioners as well as traditional and indigenous knowledge.

I attended the Global Landscapes Forum for the same reason – to understand the broader context of Blue Carbon as well as different governance approaches for coastal ecosystems. The event in 2013 hardly mentioned the coastal zone. The focus on Blue Carbon was much more outspoken at the event in 2015.

In addition to the policy and advocacy side, I have explored Blue Carbon also as scientific practice. While working on **Paper III**, I had the opportunity to collaborate with a soil-science colleague, who could answer all my questions about different methods. I also studied a number of standardisations and methodologies in detail. The Institute of Soil Science at Hamburg University also assisted me with my queries regarding equipment used to measure carbon in soil.

Personal Communication

As a complement to the other material analysed, I used expert interviews in different ways. I have approached potential interviewees based primarily on their knowledge about certain issues or events. My interviewees are an eclectic collection of individuals from negotiators to researchers, UNFCCC staff and staff of conservation organisations. Only 5 out of 24 were women. I approached many more potential interviewees. While both the climate change negotiations and the case of Blue Carbon are dominated by men, and I do not have exact numbers, my impression is that women are underrepresented in my material. In addition, none of the women I talked to agreed to talk on the record. One explanation could be that men, thanks to their privileged position, see female interviewers as harmless, reveal more information to and are more inclined to talk to female interviewers than women are (Ackerly & True, 2010). In feminist methodology, semi- or unstructured interviews are seen as more in line with feminist norms and goals. My interviews were at most semi-structured, and I made an effort reaching out to women in particular, but more could surely have been done to investigate and address this issue. In the end, I do believe that it affected the value I attributed to the interviews negatively.

Expert interviews has been defined as interviews with "[…] a group of individuals, who hold, or have held, a privileged position in society and, as such […] are likely to have more influence on political outcomes than general members of the public" (Richards, 1996, p. 199), drawing attention to power relations involved. This would certainly be a fitting description of some of my interviews. When conducting interviews in general it is important to be aware of possible underlying power structures between the interviewer and the interviewee (Ackerly & True, 2010). For elite interviews in general, the power lies with the interviewee, and the interviewer has to adapt to the interviewee's request (Plesner, 2011; Richards, 1996). However, with a growing understanding of the issue, the interviews took more the character of interviewing "sideways" (Plesner, 2011), that is, more a give and take and a more equal distribution of power, when my interviewees started asking me questions back. In terms of ethical considerations, this opens up new dimensions. On the one hand, a more equal relationship characterised by, for instance, a mutual language, and that both parties bring interests to the table (Plesner, 2011). At the same time, as mentioned above, this requires perhaps a certain degree of openness about interests and expectations.

I used interviews foremost to access information, but also for summaries of information, and to guide me to where to look for additional information. The interviews differed in character from planned and booked months ahead with a number of pre-formulated questions, to spontaneous and unstructured, such as running into a negotiator on their way between meetings and taking the opportunity to ask a couple of questions. In the latter case, I always tried to follow up, and find a time to meet again. The table below lists personal communications of particular importance to the study.

Table 4: Personal communication.
List of personal communication with organisations, informants title/description, date and place/means.

Organisation and title, generalised	Date and place
TNC, carbon market expert	Aug. 9 2019, *via email*
UNFCCC Secretariat, science-policy expert	Sep. 6 2017, *via Skype*
UNEP affiliation, Blue Carbon policy and practice expert	Dec. 8 2015, Paris*
Swedish University of Agricultural Sciences, Forest carbon accounting expert	Dec. 8 2015, Paris
UNFCCC Secretariat (former), science-policy expert	July 24 2015, *via Skype*
Conservation International, EbA expert	July 22 2015, *via email*
Duke's Nicholas School of the Environment, Blue Carbon policy expert	June 24 2015, Guayaquil
Counterpart International, national coastal mitigation expert	June 25, 2015, Guayaquil
NOAA, ocean policy expert	June 12 2015, *via Skype*
Research consulting firm, climate finance and climate investment expert	June 3 2015, Bonn
Wetlands International, one wetlands expert, one communication strategist	Dec. 11 2014, Lima*
UNEP, EbA expert	Dec. 9 2014, Lima
University of Central Asia, expert on soil carbon and remote sensing	Dec. 8 2014, Lima*
Negotiator Peru (former), REDD+ expert	Dec. 8 2014, Lima*
CSR consulting firm and University of British Colombia, carbon trading and green accounting expert	Dec. 5 2014, Lima*
Research consulting firm, Blue Carbon science expert and IPCC author	Nov. 30 2014, Lima*
Negotiator CfRN, Blue Carbon policy expert	Nov. 28 2014, Lima*
IUCN, Blue Carbon policy expert	July 2 2014, Berlin
Negotiator European Union, REDD+ policy expert	June 15 2014, Bonn*
SPREP, EbA expert	June 13 2014, Bonn*
ICCI and former IPCC head of delegation, science-policy expert	June 13 2014, Bonn, follow-up Dec. 10 2015, Paris*
Negotiator United States, coastal and ocean policy expert	June 11 2014, Bonn
Aboriginal Carbon Foundation, carbon trading expert	June 10 2014, Bonn*

Comments: Formal and informal interviews and conversations. All names and some agencies have been anonymised. Titles and other identifying details have been generalised to protect the informants identity. *Recording in author's possession. Abbreviations: TNC – The Nature Conservancy, UNFCCC – United Nations Framework Convention on Climate Change, EbA – Ecosystem-based Adaptation, NOAA – National Oceanic and Atmospheric Administration (US), UNEP – United Nations Environment Programme, REDD+ – Reducing Emissions from Deforestation and forest degradation in Developing countries, CSR – Corporate Social Responsibility, IPCC – Intergovernmental Panel on Climate Change, CfRN – Coalition for Rainforest Nations, IUCN – International Union for Conservation of Nature, SPREP – Secretariat of the Pacific Regional Environment Programme, ICCI – International Cryosphere Climate Initiative.

I always proposed to record the interviews, but the informants did not always feel comfortable with this and in these cases, I decided to go ahead anyway with the conversation and take notes/write field notes. I realise that this is not optimal, but when the choice is one between having a conversation or not, it is, in my view, an easy one, although the possibility of later referencing the information accessed is limited. As mentioned above, I often used interviews to guide my search for relevant information and events. That is, I coupled different types of information to verify the content and/or make it more transparent. In terms of transparency, referencing a report from an organisation beats an interview with an anonymous informant. However, without the interview in this example, I may not have been able to find the report. Personal communication also beats reports in terms of getting an impression of the stakes at play, attitudes and emotions. In addition, for the context of the climate change negotiations specifically, another motivation behind the use of interviews is access. To get closer to the heart of the negotiations as an observer, I needed a complementary strategy when I was not granted access. In addition, it is impossible for a single person to follow all relevant debates as so many different events are taking place simultaneously, and receiving information directly from someone who attended an event can be very useful.

Reflexivity and Enactment

Before presenting the results of the study, I want to draw attention to underlying assumptions linking back to Section 3, namely a relational ontology and the idea of enactment. These two concepts say something about why research cannot, and should not, be neutral. As discussed previously, it is precisely because the internal workings of science are not neutral that they need to be open to scrutiny (Beck, 2015; Jasanoff, 2008). The aim is to make science better, not weaker. As a contrast, climate change sceptics draw on science to enhance their claims (e.g. Lahsen 2005, Pielke Jr. 2005), which decreases its credibility through being politicised – science is thus not separated from policy, but made more political (Beck 2011).

The concept of enactment draws attention to the power of (social) analysis to enact reality - “in some measure that which is socially real is made by, and through, the instruments of social analysis” (Law & Urry, 2005, p. 396). This means that we need to be open with the choices we make, and take part in the methodological discussion, because the power of science means looking at what is or could be made more real or less real (Law & Urry, 2005). It also opens up the possibility to look at how the world could be otherwise (Law 2004).

A relational ontology and the idea of enactment go hand in hand. With a relational ontology follows that I cannot extract myself from the issues I study. We are always already part of the situation/context/case/reality. As mentioned above in the context of ethnography, seen in this way, research is not about studying systems, but being in it, working with it (Kuntz, 2015). Similarly, in environmental science, one of the first things that is taught relates to webs and how all species are connected, which means that if one goes extinct, this will have negative ripple effects across the web. New materialism brings attention to relationality, or how we are relationally bound to everything around us, which means that we are also morally and socially bound to one another and to that what we call nature. This, in turn, makes dialectical models redundant, and dialogical ones more important.

5. Making Governable

> I am making an urgent appeal. Not as a negotiator, not as a leader of my delegation, but as a Filipino. I appeal to the whole world, I appeal to the leaders from all over the world. To open our eyes to the stark reality that we face. I appeal to ministers. The outcome of our work is not about what our political masters want. It is about what is demanded by us by 7 billion people. I appeal to all, please no more delays, no more excuses […] If not us, then who? If not now, then when? If not here, then where?
> *Naderev Saño, chief negotiator for the Philippines, at COP18*

> There is an old saying – "if you are not willing to lead, then get out of the way". And I would ask the United States: we ask for your leadership, we seek your leadership. But, if for some reason you are not willing to lead, leave it to the rest of us – please, get out of the way.
> *Kevin Conrad, negotiator Papua New Guinea, at COP13*

In this chapter, I will present the most important results from the four papers, and discuss what they in turn tell us when read alongside each other. To make sense of my material and my results, I discuss them against the theoretical and ontological underpinnings of this thesis that I presented in sections 2 and 3.

I draw inspiration from David Beer's (Beer, 2016) work on the spread of data as measurement, circulation and possibility. Even though the theme is another one – the power of metrics – there are also similarities with Blue Carbon, particularly the importance of numerical representations – and linked to this measurement – and an overarching structure of competition (linked to neoliberalism). Especially the last question about possibility is, I find, useful to try to go beyond descriptions of events to thinking about the making – the becoming. Thinking about what is made possible leads me to discuss what is made visible (and invisible) and what promises specific practices carry.

The quotes above are from lead negotiators at the UNFCCC-negotiations. They are there as a reminder that even though the negotiations are focussed on producing text, and even though much of my discussion below will focus on the overarching structures, the institutions, ecosystems and non-human material aspects, there are, of course, people at the negotiations, and in addition to the participants of the negotiations, many more people are potentially affected by what is said and done there.

This section will proceed as follows. First, I provide a detailed description of the negotiations as a background to understand where some of the making of Blue Carbon takes place, as this is a setting that is otherwise rather inaccessible. This section is built foremost on my observations at the climate change negotiations. Next I describe how Blue Carbon fits into this context. From here follows a description of methods used to make Blue Carbon visible in this context, and other political contexts. Finally, I discuss what a micro-scale analysis reveals in terms of values made visible, and what reality Blue Carbon enacts..

The UNFCCC

The United Nations Framework Convention on Climate Change was born in Rio in 1992 during "Earth Summit". It has 196 Parties – 195 nations plus the European Union. This means that the UNFCCC is one of the biggest international institutions bringing together almost every nation on the planet. When talking about the UNFCCC or "the Convention", for short, it is often meant in a general sense – the work under the Convention. However, *the Convention*, as mentioned in Section 2, is the text of the Convention that the Parties have signed (United Nations, 1992). In addition to the text, the UNFCCC also has other physical features, perhaps the most obvious one being the Secretariat of the UNFCCC with its offices in Bonn, Germany. The task of the Secretariat is to support the implementation of the Convention, and associated agreements (UNFCCC Secretariat, 2018a). It produces and distributes information about, for instance, negotiation progress and climate change action, but does not carry out research and does not try to influence the negotiations in a specific direction (Busch, 2009). One of the major tasks of the Secretariat is to organise the international climate change negotiations – the meetings of the Conference of the Parties (COPs) – together with the host countries.

A COP-session is a big machinery of logistics on the one hand and diplomacy on the other. The first one, COP 1, was held in Berlin in 1995. COP-sessions last around two weeks, the first week being run by bureaucrats representing their governments, the second including the so called "high-level segment" when ministers and/or heads of states ultimately conclude the work. Between COP-sessions, there are intersessional negotiations when preparatory work is carried out. These are similar in their modalities and agenda items, but smaller in both scale and resources, as well as media attention and political pressure.

When talking about the climate change negotiations, it is common to talk about *a* COP. This is not an accurate description[14]. First of all, the COP is the decision-making body of the UNFCCC, this body is made up of representatives from 196 Parties. The COP meets, in general, once a year often in the beginning of December. However, a COP-*session* takes place in conjunction with sessions of all the UNFCCC-bodies[15] and actually contains hundreds of meetings and negotiations. COP-sessions have been described as theatrical (Ehrenstein, 2018), a description I find accurate in some ways. They are theatrical in the sense that they are well orchestrated and follow a script of proceedings. The large plenary sessions could perhaps also be described as spectacular. However, most of the meetings are small and technical. Although statements that are textbook cases of political speech - powerful and rhetorically elegant, like the ones that introduced this section - are sometimes delivered, that mainly happens in plena when countries deliver their written statements. Even there, they are exceptions. Most meetings are instead focussed on producing text about a specific issue.

How the venue looks differs, but it has to be large enough to accommodate on average 25,000 participants[16], an exhibition hall for hundreds of exhibitors and hundreds of side events (UNFCCC Secretariat, 2018a, 2018b, 2018c). There have to be places to eat and rest, space for the delegations and the Secretariat that is not accessible to observers, press conference rooms, medical aid, technical support, large plenaries and lots of meeting rooms of different sizes.

[14] Taking about *a* COP is linguistically practical, and for those familiar with the UNFCCC-negotiations unproblematic, which is why I tend to use it in the same, simplistic way, but for those unfamiliar with the process I want to clarify what "a COP" entails.

[15] In 2018 they were: Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP), Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA), Subsidiary Body for Implementation (SBI), Subsidiary Body for Scientific and Technological Advice (SBSTA), and Ad Hoc Working Group on the Paris Agreement (APA).

[16] From Parties, observer states, observer organisations and media. The host country often also provides a second venue that is open to the public.

Figure 2: UN climate change negotiations.
Plenary hall at COP18 (top), entrance to the COP19-venue (a football stadium) (bottom left), and inside a medium-sized meeting room at COP20 (bottom right). Photo credit: T. Thoni.

Meeting rooms, in general, have some kind of front row where the co-chairs/co-facilitators sit together with representatives from the UNFCCC Secretariat. When text, such as decisions or draft conclusions, is discussed, it is often displayed on a big screen behind the front row. The screen is connected to a computer, run by the Secretariat. When a Party wants to say something, it raises its "flag" (a sign with the name of the country. See also Ehrenstein, 2018). If suggestions to the text are made, these are displayed on the screen so that everyone can see. All text that has not been agreed upon by the Parties is "bracketed" – square brackets are inserted around the text discussed. As an example, just before the opening of the 21st COP in Paris 2015, there were more than one thousand open brackets in the text that would later become the Paris Agreement (PA) (Revkin, 2015). This means that the negotiators had 12 days to come to over 1000 agreements (the number of brackets also increased in the beginning before falling) regarding the text of the PA, along with many more concerning the "regular" negotiations, including on the decision to adopt the PA. In the UNFCCC, decisions are taken with consensus, which means that in Paris, 195 nations – of all possible political constellations from democracies to dictatorships, and varying resources – had to agree on how to formulate a universal agreement on climate change.

As argued in Section 2, the logics of the climate regime – global, neoliberal and scientific – are embedded in the Paris Agreement. As explained before, the PA is universal in the sense that it does not separate countries into groups as strongly as the Kyoto Protocol. The PA also continues to enable the use of market-mechanisms, and it is informed by science. Indeed, it even requests the IPCC to come back with a special report on the difference between 1.5 and 2 degrees warming, which the IPCC also responded to (IPCC, 2018).

Blue Carbon and the UNFCCC

It has been ten years since the United Nations Environment Programme (UNEP) with the Food and Agricultural Organization (FAO) and the Intergovernmental Oceanographic Commissions (IOC-UNESCO), and others, released the report "Blue Carbon – The Role of Healthy Oceans in Binding Carbon" that is often said to have coined the concept of Blue Carbon and placed it on the political agenda (e.g. Thomas, 2014). A quick look at the first couple of pages of the report reveals that the story of Blue Carbon is portrayed in line with the logics of the climate regime – global, scientific and neoliberal. The preface by UNEP's Executive Director Achim Steiner[17] starts with the following statement: "If the world is to decisively deal with climate change, every source of emissions and every option for reducing these should be scientifically evaluated and brought to the international community's attention" and that "[s]cience is now also telling us that we need to urgently address the question of 'blue' carbon" (Nellemann et al., 2009, p. 5). Then the report goes on to argue as follows:

> "While emissions' reductions are currently at the centre of the climate change discussions, the critical role of the oceans and ocean ecosystems has been vastly overlooked. […] By preventing the further loss and degradation of these ecosystems and catalyzing their recovery, we can contribute to offsetting 3–7% of current fossil fuel emissions (totaling 7,200 Tg C yr–1) in two decades – over half of that projected for reducing rainforest deforestation. […] Coastal ecosystem services have been estimated to be worth over US$25,000 billion annually, ranking among the most economically valuable of all ecosystems. […] Improved integrated management of the coastal and marine environments, including protection and restoration of our ocean's blue carbon sinks, provides one of the strongest win-win mitigation efforts

[17] UNEP is now (2019) UN-Environment, and Inger Andersen Executive Director.

> known today, as it may provide value-added benefits well in excess of its costs, but has not yet been recognized in the global protocols and carbon trading systems (Nellemann et. al, 2009, p. 6f).

Hence, already in the first pages of the report, Blue Carbon is framed as a global issue (the fact that three UN-bodies are behind it would have made another approach surprising). Science is also present in the role of speaking "truth to power" as well as bringing authority to evaluations of emission reduction strategies. Finally, Blue Carbon-management is presented as a way to offset emissions, in profitable ways – following the logic of neoliberalism.

Against this backdrop, this section will try to go deeper into these logics and look at specific ways that coastal ecosystems are made governable as carbon, and possible effects of this process – the making of Blue Carbon. Blue Carbon is and always was about climate change mitigation. Coastal ecosystems have and are rendered governable in other ways than as carbon, as explained below, but the focus here is on Blue Carbon specifically, and how the making of Blue Carbon affects coastal ecosystems.

Following the release of the UNEP-report, Blue Carbon was quickly introduced to the climate change negotiations. At COP 16 in Cancun, Mexico, Blue Carbon was presented at a side event, and contact was established with the IPCC (**Paper IV**). The IPCC was, at this time, preparing an update of the guidelines for greenhouse gas inventories - the Wetlands Supplement (IPCC, 2014). A group called the Blue Carbon Initiative (BCI) stands out as particularly important to understand the development of the Blue Carbon-issue (**Papers III and IV**). The BCI is chaired by two environmental NGOs – Conservation International and the International Union for Nature Conservation (IUCN), with one UN-body – the Intergovernmental Oceanographic Commission (IOC-UNESCO). It is in turn divided in two wings – one policy wing looking at strategies to include Blue Carbon in policy at all levels of administration (e.g. Herr et al., 2012; 2017; Howard et al., 2017) and a science wing producing information needed for policy (e.g. Crooks et al., 2019; Holmquist et al., 2018). In **Paper IV** I argue that the case of Blue Carbon is a good example to illustrate how science and policy are intertwined, and the work of the BCI particularly interesting as a case of co-producing science and policy. For instance, the BCI were involved in the IPCC Wetlands Supplement, and established contact with the Coalition for Rainforest Nations (CfRN) – the same group of countries that promoted the inclusion of forests under the UNFCCC and the CfRN in turn took the lead at proposing the inclusion of Blue Carbon under the Convention.

In brief, what then follows is that Blue Carbon is officially introduced to the UNFCCC negotiations, treated as a scientific and technical issue[18], and its proponents asking for Blue Carbon to become an own agenda item, following the developments of REDD+ (forests) (ENB, 2011; UNFCCC, 2011, 2012, 2014). The rhetoric follows that of forest degradation at large, namely that the degradation of Blue Carbon-ecosystems is a significant source of carbon emissions, and therefore their protection merits the inclusion in the Climate Convention (e.g. UNFCCC, 2013). However, unlike forests, coastal ecosystems were unable (at least at the writing of this thesis) to get their own agenda item (**Paper IV**). Notwithstanding this apparent loss for the Blue Carbon-community, the work towards policy-uptake has continued, such as in Nationally Determined Contributions to the UNFCCC with large emitters such as Australia, the United States and the United Arab Emirates conducting inventories of their Blue Carbon-stocks (Crooks et al., 2018; Holmquist et al., 2018; IPBC, 2018; **Papers III, IV**). Australia is also chair of the International Partnership for Blue Carbon – a new organisation established at COP 21 in Paris in 2015, bringing together state and non-state actors (**Paper IV**).

As mentioned above, coastal ecosystems were made governable before the concept of Blue Carbon existed, and there are still a multitude of governance practices around coastal wetlands, such as conservation in Marine Protected Areas (Section 3). Blue Carbon is therefore only one way of making coastal wetlands governable. Protected areas are, however, limited in scope. In contrast, the concept of ecosystem services (ES) draws attention to the value of natural landscapes lying outside the borders of protected areas. Coastal marine ecosystems provide many different ecosystem services and goods (Chung et al., 2013; Pendleton et al., 2012; Vierros, 2013). While some ecosystem services of coastal marine ecosystems, such as fish, have long been valued (including on the market), the focus on their carbon benefits is more recent (Hantanirina & Benbow, 2013; Jardine & Siikamäeki, 2014; Lovelock & McAllister, 2013; Pendleton et al., 2012; Sondak & Chung, 2015). When "Blue Carbon ecosystems", like mangroves, salt marshes and seagrass meadows, are degraded or converted, they may transform from carbon sinks to carbon sources and contribute to climate change (Kroeger et al., 2017; Pendleton et al., 2012; Siikamäki et al., 2013), which is a key argument for suggesting that efforts to protect these ecosystems and their Blue Carbon should be part of an overarching, global, strategy for climate change mitigation (Pendleton et al., 2012).

There is also another side to the climate change framing – adaptation. There are adaptation projects under the UNFCCC focussing on the Blue Carbon-ecosystems (**Paper IV**). Adaptation strategies do not require any counting of carbon, or indeed

[18] Foremost discussed under SBSTA agenda items Research and Systematic Observation, and the Research Dialogue. It was discussed at a so called technical workshop – one supposedly free of negotiations – about ecosystems with high carbon reservoirs in 2013 (see **Paper IV**).

any focus on carbon at all. The coastal zone is an important focus of climate change adaptation for several reasons, and there are many projects that combine management of coastal ecosystems and climate change adaptation, not least Ecosystem-based Adaptation (EbA) projects (Sierra-Correa & Kintz, 2015; Temmerman et al., 2013). Adaptation, has, however, received less attention and a smaller share of the available climate financing compared to mitigation (Beck, 2011; UNEP, 2018). There is also a large gap between available funds and what is needed, and the possibility to use market-based mechanisms is smaller than for mitigation, although adaptation can be coupled with PES as well (e.g. Scarano, 2017; UNEP, 2018). Blue Carbon-proponents argue that mitigation is the most powerful policy-framing for coastal ecosystems, and in the scholarly literature that takes a position on policy, adaptation receives less attention than mitigation (**Paper IV**).

Voluntary carbon markets are a means of making coastal ecosystems governable as carbon/climate change mitigation that is officially outside the UNFCCC (regulatory market). Market-based mechanisms are further discussed below.

Measuring Blue Carbon

The Blue Carbon stock is calculated from estimates of different carbon pools, such as living plants above ground/sediments, dead plants above ground/sediments (debris, felled trees), living material in the soil/sediments (roots) and soil carbon (**Papers III, IV**).

There are a number of standardisations that can be used to methodically measure Blue Carbon – some are specific for the individual ecosystems, some are generic (**Papers III, IV**). Some are specifically meant to produce market-based mechanisms, some for national inventories (**Paper III**, also Macreadie et al 2018).

In brief, the main steps of carbon accounting are as follows: stratification, sampling, sample treatment and analysis (**Papers III, IV**). There are several in depth descriptions available (Fourqurean et al., 2012a; 2012b; Howard et al., 2014; Johannessen & Macdonald, 2016; Kauffman & Donato, 2012). Stratification means dividing the area that is being sampled into different land-use types in order to organise the work and be able to extrapolate data and generalise results. What sampling strategy is used depends on carbon pool and type of ecosystem. Generally, a strategy for how to pick the specific sampling locations is chosen, such as along a transect (**Paper III**). This step is more straightforward in theory than in practice as Blue Carbon-ecosystems are often challenging to sample (Howard et al., 2014). For instance, as described in section 3 from my own visit to mangroves in Ecuador, the areas can be flooded, full of mosquitos and only accessible by boat. Mangroves often have large root systems, and/or trees growing densely, making it physically challenging to move around (also **Paper IV**). Seagrasses may have to be sampled by scuba divers, depending on water depth. Another physical challenge involves the sampling of soils using augers. Some are driven into the sediments using only man-power, some have an engine (Howard et al., 2014). Sample depth varies between studies and depending on purpose of the sampling (Johannessen & Macdonald, 2016), but a general rule is that to measure the whole soil/sediment pool, samples should be taken down to the so called parent material (Kauffman & Donato, 2012). Next, the auger is twisted to cut of potential roots, and a vacuum is created to be able to exert the auger without compressing the sample (a not uncommon problem described in the literature (**Paper III**). The sample, if it is a deeper one, is sliced into subsamples. Some augers have holes in them, allowing the sampler to take out sub samples at given intervals (Howard et al., 2014). These intervals are usually more frequent in the upper meter, as it is considered most interesting, and less frequent deeper down (**Paper III**). That said, an issue that is discussed in the literature is at what depth carbon in coastal soils and sediments can be said to be stored long-term (Johannessen & Macdonald, 2016). Different processes in the sediments cause carbon to be released to the atmosphere as carbon dioxide, unless the environment is free of oxygen – biomixing and biturbation of the surface layer (grazing, crabs turning the sediment around, wave energy moving sediments are some examples) and microbes cause carbon to remineralise also deeper into the sediments (Johannessen & Macdonald, 2016). This means that measuring the upper layer of the sediments may be misleading in terms of how big the stable carbon pool is (ibid). For carbon credit projects whether the carbon captured by Blue Carbon-ecosystems is stored long term or not is captured in the concept of *permanence* and its surrounding debate – an issue discussed not just in the context of Blue Carbon but also forests (**Paper IV,** also Emmer et al., 2015). Most restoration projects have a success rate of around 50 percent (Bell-James, 2016). Projects in the Philippines demonstrate that in a worst case scenario, Blue Carbon-projects may increase emissions and degrade the ecosystems: "Mangrove afforestation in the Philippines has generally been unsuccessful [...] there is a danger that the planting process and initial mangrove growth may shade out and destroy the seagrass, before itself failing" (Sharma et al., 2017, p. 369).

Related to the issue of what happens to the carbon once it has been captured by Blue Carbon-ecosystems, another outstanding issue discussed in the literature is where the carbon comes from and how this should be calculated (**Paper IV**). Carbon is in this context divided in two groups – allochthonous (from outside the Blue Carbon-ecosystem) and autochthonous (from inside) (Howard et al., 2014). For carbon credits to produce real emission reductions, the carbon accounted for would have had to be lost without the, in this case, Blue Carbon-project. For instance, runoff water from land may carry with it carbon that is captured by Blue Carbon-ecosystems, but it can only be counted as an emission reduction if the carbon would not have been captured elsewhere without the Blue Carbon-project (Johannessen & Macdonald, 2016). Whether or not it can be properly accounted for is contested – some standards take this into consideration and, for instance, exclude all allochthonous carbon, but the precision with which this can be done is unclear (Johannessen & Macdonald, 2016; 2018a; Oreska et al., 2018).

The third step is sample treatment. For soil carbon, we describe this in detail in **Paper III**. Generally, samples have to be checked to ensure that they contain only parts from the carbon pool samples, so for instance roots are removed from soil samples, and samples are homogenised. Seagrass meadows and marshes are, when in situ samples are taken (instead of default-values), harvested (Githaiga et al., 2017). Mangroves are instead commonly measured, for instance the tree trunk diameter at breast height, and based on these measurements carbon contents are calculated (see below and Kauffman & Donato, 2012, also **Paper IV**). To measure carbon content, samples then go through combustion of some kind, and carbon is either directly or indirectly measured, using, for instance, an elemental analyser. Some approaches involve treating samples with acids and wash them (Fourqurean et al, 2012b; Howard et al., 2014, also **Paper III)**.

If there is one thing that can be said to summarise the activity of measuring Blue Carbon, then it is that it is a resource intensive activity. It requires expensive equipment (or less expensive but more uncertain Howard et al., 2014; Kauffman & Donato, 2012), time and knowledge. Resource restriction can be overcome by estimating carbon contents without measuring it *in situ*. Examples of this include the IPCC Wetlands Supplement that provides default values for coastal wetlands. These so called Tier 1 values may, however, be highly uncertain, with values for soil carbon differing up to plus/minus 90 percent (Howard et al., 2014). Another approach is to use allometric equations – a tool common in Blue Carbon-studies (**Paper III**, also Benson et al., 2017; Kauffman & Bhomia, 2017; Thompson et al., 2014). An allometric equation is, simply speaking, calculating the size of something in relation to something else. Hence, if we know the ratio between, for instance, tree trunk diameter, canopy coverage and Above Ground Biomass, we can estimate the carbon content of the above ground living pool (for mangroves, in this example). These equations can provide good estimates, especially if they are site specific (derived from sampling in the same location), and they are popular as they are "non-destructive" – instead of having to drill into tree trunks for samples, a model can be used. The downside is that they can also be highly uncertain, and there is no way of knowing if that is the case without actually going through the process of sampling *in situ*. If resources are an issue, that may not be an option. For instance, one study comparing values from allometric equations and in situ measurements found that in some locations the difference was 1000 percent (Adame et al., 2017).

Blue Carbon and the Big Picture

The account above makes it clear that measuring carbon in Blue Carbon-ecosystems is not without its challenges. Despite these, how can we understand the drive and motivation behind conducting Blue Carbon-research, lobbying for its inclusion in policy and/or carrying out Blue Carbon-projects? In this section, I discuss how the making of Blue Carbon can be understood as an effect of and part of the big picture – the global, scientific and neoliberal logics presented in Section 2, and elaborate on the material, institutional and discursive dimensions of these settings.

A Global Logic

Making coastal wetlands governable as carbon is enabled by the UNFCCC, and has been already since the inception of the Convention as its Article 4.1d calls for "management, conservation and enhancements of sinks and reservoirs of all greenhouse gases not controlled by the Montreal Protocol including […] oceans as well as […] other coastal and marine ecosystems". It took, however, until 2011 until Blue Carbon was officially introduced to the negotiations.

It is easy to find examples of how the Blue Carbon-issue fits with the context of the climate regime. The UNEP-report (Nellemann et al., 2009), often seen as the one that coined the concept of Blue Carbon", is one example already mentioned. Blue Carbon-standardisations, such as the IPCC Wetlands Supplement chapter 4 or the ones used for the voluntary market (for instance by the Verified Carbon Standards, VCS), carry the promise of transparent and quantifiable reporting, an issue considered of utmost importance to the UNFCCC-process, as seen, for instance, in the Paris Agreement where the Parties to the agreement are bound to engage in carbon accounting and reporting, but not to reduce emissions (see also Section 2). For instance, Article 4, paragraph 13 of the PA states that:

> Parties shall account for their nationally determined contributions. In accounting for anthropogenic emissions and removals corresponding to their nationally determined contributions, Parties shall promote environmental integrity, transparency, accuracy, completeness, comparability and consistency, and ensure the avoidance of double counting, in accordance with guidance adopted by the Conference of the Parties serving as the meeting of the Parties to this Agreement.

Key concepts related to carbon accounting and reporting are (global) sinks and sources. The idea of a carbon sink also underpins the rationale behind Blue Carbon – Blue Carbon is of interest to the international climate policy community because it represents a carbon sink considered to be of international relevance (UNFCCC, 2013, also **Paper IV**). Looking at the Blue Carbon-literature, global estimates have been made, albeit with high uncertainty-ranges (Fourqurean et al., 2012a; Johannessen & Macdonald, 2016; Pendleton et al., 2012). For instance, a commonly cited estimate of global carbon burial in seagrasses (Kennedy et al., 2010) has been found to overestimate the rate with a mean factor of between 4 and 465 times, and with a factor of between 5 and 7400 times including the whole uncertainty range (Johannessen & Macdonald, 2018b). These figures have triggered a debate in the Blue Carbon-community. There is disagreement regarding the exact numbers, if they are indeed overestimations and how problematic it may be, but there is a general agreement that global estimates are uncertain (Johannessen & Macdonald, 2016; Johannessen & Macdonald, 2018b ; Macreadie et al., 2018; Oreska et al., 2018). For losses, a commonly cited global estimate found that 0.15–1.02 billion tonnes of carbon dioxide are lost annually due to degradation of Blue Carbon-ecosystems (Pendleton et al., 2012). To understand the uncertainty range it can be compared with Germany's annual emissions. The higher end of the spectrum places lost Blue Carbon at around the magnitude of Germany's emissions in 2002. The lower end is where Germany hopes to be in 2045 (Umwelt Bundesamt, 2019).

Reviewing the scholarly literature, a common theme is to argue that the issue of Blue Carbon is important globally, despite the fact that globally they occupy only a small piece of the Earth's surface (e.g. Howard et al., 2017, also **Papers III, IV**). Their small distribution, however, is brought forward as a problem, because they tend to be overlooked in global models and estimates of carbon storage (Hutchison et al., 2014; Macreadie et al., 2014). This means that Blue Carbon-ecosystems are not "seen" by GCMs. A common counter-argument is that per area unit, they are more efficient than terrestrial forests (e.g. Awari & Mullah, 2014; Bigford, 2014; Lunstrum & Chen, 2014). And because forests are recognised by the UNFCCC, other ecosystems with high carbon reservoirs should be recognised too (UNFCCC, 2014). Hence, the inability of GCMs to account for Blue Carbon has not meant that the issue has not been discussed as a global issue.

The logic of climate change as a global issue means that it does not matter where emission reductions are made (Section 2). This is a rationale that comes across in the discussion about Blue Carbon, especially looking at the voluntary carbon market (e.g. Needelman et al., 2018; Oreska et al, 2018). However, looking at the development of Blue Carbon within the UNFCCC, the most efficient narrative may not have been to make it global, but instead to make it national[19]. In the end, Blue Carbon-proponents did not need for all countries to endorse Blue Carbon, they only needed for the structure of the UNFCCC to allow for Blue Carbon-projects (**Paper IV**). At the time that Blue Carbon was introduced to the UNFCCC, there was uncertainty regarding the future pathway of the UNFCCC. It was right after COP 15 in Copenhagen in 2009, where the Parties failed to come to an agreement. In the

[19] As done, for instance, for Australia, the USA and the United Arab Emirates.

end, the Paris Agreement solved the disagreement by creating a structure where agreement on the design and strategy of national commitments was not needed. The new bottom-up structure, the continuous allowance of market-based mechanisms and a reference to the importance of all sources and sinks, are all enabling factors for the implementation of Blue Carbon-projects, the way they are currently framed, nationally (**Paper IV**). In line with this bottom-up approach, it is also up to each country to define what a wetland is (IPCC, 2014), just as it is up to every country to decide how the land category "forest" should be defined. This means that in some countries, mangroves can be included in climate policy through REDD+ - defined as forests (**Paper IV**). Other countries can define mangroves as wetlands and use other tools. Hence, for proponents of Blue Carbon, at least from Paris and onwards, the most efficient strategy in terms of implementing Blue Carbon-projects is no longer to make Blue Carbon global, but to explain what Blue Carbon-projects can do for countries, and what they can do for the private sector.

A Scientific Logic

Blue Carbon has been framed as a scientific and technological issue in the international policy debate – seen to under what UNFCCC agenda items it has been treated and negotiated (above and **Paper IV**). The scientific information about the role of Blue Carbon-ecosystems in the carbon cycle was important in order to bring together an interest group, and in terms of its framing as a political issue (Crooks et al., 2019, **Paper IV**). Coastal ecosystems are also considered in a number of other regimes as a conservation/biodiversity issue – for instance the Convention on Biological Diversity (CBD) and the Ramsar Convention (**Paper IV,** Göransson 2016). Thus, coastal ecosystems were not new to international negotiations when they were introduced to the UNFCCC, but without information regarding their role as carbon sinks, the issue would not have been considered in the climate change regime as mitigation. The information needed, in turn, requires scientific methods, expertise and technical equipment.

Around the same time as Blue Carbon was introduced to the UNFCCC, it was also decided that there would be a chapter on coastal wetlands in the IPCC's supplementary guidelines on greenhouse inventories in wetlands (Wetlands Supplement, **Paper IV**). According to the Blue Carbon-community, this was a crucial step as the recognition by the IPCC gave it credibility:

> The UNFCCC meeting in Mexico was extremely important because we engaged the IPCC at that point, which then gave us a lot of credibility [...] If we hadn't gone to Mexico we'd be some sort of niche thing right now. It was one of those non-linear events that got things rolling. It was very important. (*Researcher, Blue Carbon, Lima, 30-11-2014*)

The Wetlands Supplement includes standardised, methodological guidance and default values, making information regarding the carbon contents of coastal ecosystems more comparable. The Supplement gave Blue Carbon an official recognition as a carbon sink, and, as the IPCC is intergovernmental, a recognition of its global and political importance (see also **Papers I, II**). The recognition of Blue Carbon by the IPCC, was also a recognition that there is enough, robust, research available to make Blue Carbon governable, even though some controversy remained (**Paper IV**).

The view on the IPCC as giving Blue Carbon "credibility" can be understood against the dominant view regarding what science is and its role in policy and/or society (section 2, **Papers I, II**). There is a hierarchy between scientific disciplines and knowledge types (Section 2). With regard to the UNFCCC, information from the IPCC is ranked as the most important source of information for the Convention (Section2, **Paper II**). However, information produced using the Wetlands Supplement can be highly uncertain. The IPCC guidelines are divided in levels of certainty – tiers – and for the lowest level, Tier 1, no *in situ* measurements are required and the estimates can be rather uncertain. Instead, default values are used – provided by the IPCC on the basis of available research (**Papers III, IV**).

In the main products of the IPCC – its assessment reports – uncertainty is an important issue and since its inception there have been changes/amendments to how uncertainties have been presented and displayed (e.g. Hulme & Mahony, 2010; Petersen, 2011). Hence, uncertainty is an issue that has been thoroughly addressed in the IPCC-reports and a key issue has been transparency. This is in line with the idea of robust science – uncertainty in itself is not necessarily an issue, after all science is by definition uncertain (at least since Popper's idea to base scientific epistemology on falsification became a principle of scientific work), but uncertainties have to be transparently displayed and discussed (**Paper II**, and section 2). Therefore, at its core, what makes science seen as robust has primarily to do with its methods, rather than results (cf. Parkhurst, 2017). The Wetlands Supplement (and similar guidelines) are methodological descriptions – they present a standardised way of measuring greenhouse gases – but the information is generated by other actors. The IPCC is here connected with the methods, and the methods are considered robust. Even when methods are standardised and transparently displayed, it does not necessarily mean that the information produced by these methods is certain. As explained above, results of Blue Carbon-research, especially global estimates, come with wide uncertainty ranges, but the research is generally systematically carried out, follows accepted methods and is transparently communicated (**Paper III**).

Research on coastal ecosystems has changed since the conceptualisation of Blue Carbon. Before anyone talked about Blue Carbon, carbon was routinely measured, but this type of research has become more and more important with the growing political and societal interest in Blue Carbon (**Papers III, IV**, Crooks et al., 2019). The most important development within research on coastal ecosystems is arguably the recent interest in *change*. When Blue Carbon was introduced to the UNFCCC there was hardly any research on changing carbon contents in Blue Carbon-ecosystems following different types of interventions. Today, it is an important research interest (Crooks et al., 2019; Pidgeon, 2018, also **Paper IV**).

In the context of climate change, the role and legitimacy of science is on the one hand embedded in ideas regarding science as neutral and separated, and at the same time the ability to provide policy-relevant information (**Papers I, II**). This apparent paradox becomes even more pronounced looking at the role of the IPCC – both broking knowledge, and providing policy with neutral information. This struggle is partly addressed by separating the work of the IPCC into different steps – some with policy involvement, some without (**Paper II**). Studying the micro-level dynamics of the interaction between science and policy suggest, however, that the boundary between science and policy in the climate regime is temporal, constantly negotiated (**Papers I, II**). Studying the micro-scale dynamics of the Blue Carbon negotiations reveals a similar image of actors wearing different hats, the co-production of Blue Carbon science, and a dynamic boundary work (**Paper IV**). While these processes are not necessarily problematic, they may result in democratic deficits if debates that are political and normative are closed down as "science for policy" (**Paper II** see also Parkhurst, 2017). Acknowledging the temporality and the negotiations of the boundary between science and policy, appear, however, to be risky in terms of potential redistribution of legitimacy (**Paper II**). Against this backdrop, it is perhaps not surprising that boundaries between science and policy, expertise and non-expertise, different types of knowledge and different types of expertise come across as fairly stable (ibid).

The preference for quantitative research, and the widespread use of rankings and standardisations stand in contrast to a dynamic science-boundary. Research on Blue Carbon is dominated by the natural sciences, followed by economics (**Paper III**). Social sciences other than economics are rare (see e.g. Barbesgaard, 2017; Vierros, 2013, for exceptions). The IPCC is also dominated by the natural sciences and economics (above, Section 2, **Paper II**). The natural sciences and economics provide the type of information that is interesting when climate change is thought of as a global, neoliberal and scientific issue. The natural sciences and economics produce quantitative and numerical information about our world. This also follows the dominant ideas regarding science and its role (**Paper I,** Hulme, 2011). Qualitative research on the other hand is usually considered not possible to generalise, and thus not able to produce global information – it produces localised and context specific information and complex relationships, not grand narratives.

A Neoliberal Logic

Neoliberalism, as elaborated on in Section 2, promotes, among other things, growth, the accumulation of capital and competition. Competition, in the context of Blue Carbon, comes in various forms (**Paper IV**). There is competition between ideas around the governance of Blue Carbon – even though the dominant framing has to do with mitigation and carbon emissions, there are also other proposals for governance, such as adaptation and conservation (adaptation still within the UNFCCC, conservation taking Blue Carbon to other arenas), and there is competition between what types of ecosystems should be included under the concept of Blue Carbon (Jennifer Howard et al., 2017).

Table 5: CO2 emissions (tonnes per capita).
Data from the World Bank. https://data.worldbank.org/indicator/en.atm.co2e.pc

Ranking	Country	Region	CO2/captia
1	Qatar	Middle East & North Africa	43,9
2	Curacao	Latin America & Caribbean	37,7
3	Trinidad and Tobago	Latin America & Caribbean	34,0
4	Kuwait	Middle East & North Africa	25,8
5	Bahrain	Middle East & North Africa	23,5
6	United Arab Emirates	Middle East & North Africa	22,9
7	Brunei Darussalam	East Asia & Pacific	22,2
8	Sint Maarten (Dutch part)	Latin America & Caribbean	19,5
9	Saudi Arabia	Middle East & North Africa	19,4
10	Luxembourg	Europe & Central Asia	17,4
11	United States	North America	16,5
12	New Caledonia	East Asia & Pacific	16,0
13	Gibraltar	Europe & Central Asia	15,7
14	Australia	East Asia & Pacific	15,4
15	Oman	Middle East & North Africa	15,2

Comments: In blue, Blue Carbon-forerunner countries. All countries are classified as "high income countries" by the World Bank.

Market-based mechanisms are based on the idea that the market, not politics, is better at finding where and how emission reductions can be done most efficiently (Ervine, 2018). Cost-efficiency, profit, cost-benefit analysis, and similar are key words to promote market-based mechanisms used both in the climate regime, and in the Blue Carbon-literature and by Blue Carbon-proponents (e.g. Hinson et al. 2017; Siikamäki et al., 2012; Smetacek & Zingone, 2013; Sutton-Grier & Moore, 2016; UNFCCC, 2019a). Looking at the forerunners of Blue Carbon we find countries like the US, Australia and the United Arab Emirates (Table 5, **Paper IV**). These are not known as forerunners of climate action. They are countries that have large investments in carbon heavy industries, and their inhabitants subscribe to carbon heavy lifestyles.

In the scholarly Blue Carbon-literature, the preferred policy-response is the use of market-based mechanisms (**Paper IV**). Market-based mechanisms have been given a lot of attention not only in the scholarly literature, but also among Blue Carbon-actors such as Environmental NGOs, and some are actively involved in the voluntary market and carbon offsetting (**Paper IV**). The VCS has published a number of methodologies that are relevant for Blue Carbon (Emmer et al., 2015; VCS, 2014, 2015).

Looking to the UNFCCC, perhaps the most relevant market-based option today is REDD+, although it is only applicable to mangroves, and only if the national definition of forests includes mangroves. Even though the direct application of REDD+ on Blue Carbon is limited, the development of REDD+ was important to the development of Blue Carbon politically (**Paper IV**). Although there is a lot of interest in market-based mechanisms and the possibility of protecting coastal ecosystems and creating revenue at the same time, Blue Carbon-strategies and projects do not have to be linked to market-based mechanisms. Reducing emissions nationally without financial support from other countries through, for instance, rewetting and restoring old coastal wetlands is one example and a possibility that has existed for a long time. However, some of the rationales between market and non-market based mechanisms are interlinked (**Paper IV**). For instance, carbon accounting is not necessarily part of market-based strategies, but market-based strategies cannot exist without carbon accounting. Nationally protecting coastal wetlands as avoided emissions and doing this instead of, for instance, putting new legislation in place is based on a similar logic as the carbon offset-market, but if it is done "internally", a market is not necessarily required, just a budget and accounting.

Making Visible

In the previous section, I discussed how the development of Blue Carbon can be understood against overarching logics of the climate regime. One thing that these three logics – the global, scientific and neoliberal - have in common, as previously argued, is that they in different ways extract information from their contexts, and in so doing they also make invisible/less visible the politics in climate change mitigation. This "logic of extraction" (Kuntz, 2015), makes the politics of climate change less visible and redirects responsibility away from governments and away from the people. Making climate change global means that information about climate change is sorted, aggregated and summarised, and making localised information less visible. It also means that the decision-making process is moved further away from the people. Making climate change neoliberal means rolling back government involvement and bringing in the "invisible hand of the market". It also means redistributing power from governments to the private sector. Making climate change scientific makes the role of scientific information, particularly quantitative, more important, and other types of knowledge less important. These tendencies in turn, may create a democratic deficit (see Section 2).

Methodologically, coding text acts on a similar logic of extraction, or reductionism, bringing forward sameness rather than differences (Kuntz, 2015, see also Section 4 of this Kappa and **Paper I**). To try to counteract these tendencies and dig deeper into the developments of Blue Carbon, this section looks at what practices and ideas the making of Blue Carbon makes visible, and what practices and ideas are made invisible. The latter involves discussing alternatives and counter-narratives where such exist. The emphasis here is on "discussing", or even starting to discuss – this thesis is drawing to a close, but my aspiration for this section is for it to be a starting point for a new discussion about our relationship with coastal wetlands. The Blue Carbon-literature is fairly mainstreamed and there are not many published papers that go against the logic of extraction (cf. **Papers III, IV**). Therefore, alternative ideas are less well underpinned than the dominant ones. Thinking about how it *might be otherwise* requires alternative stories, and new ways of thinking. In addition to micro-scale ANT/materiality studies, one way of enabling such a development – already underway - is to bring the humanities and the arts more strongly into the climate change discussion, for instance to create new stories around climate change or as tools to imagining climate change worlds in ways that scientific literature cannot (Hulme, 2011; Nikoleris et al., 2017; Robin, 2018; Yusoff & Gabrys, 2011). The discussion in this section should thus not be seen as exhaustive, but rather an attempt to twist and turn the Blue Carbon-issue, and spark discussion. This, in turn, means looking at differences in contrast to sameness, complexities in contrast to grand narratives, and situatedness in contrast to aggregation.

Against the backdrop of the big picture – climate change as global, neoliberal and scientific, the development of Blue Carbon comes across as natural. For instance, having included the forestry sector under the Convention, showing an interest in coastal wetlands and other ecosystems with high carbon reservoirs makes sense. However, looking at the details – perhaps in particular the ever growing number of standardisations and methodologies – there is also an underlying complexity, and temporality, that these "logics" are unable to capture.

As described in Section 2, the backbone of climate change mitigation under the UNFCCC is carbon accounting and the idea that it is possible to count and control flows of carbon in a global budget of sinks and sources. This idea is materialised in the professions and the many standardised protocols that enable this counting and controlling (Lovell & MacKenzie, 2011; Timmermans & Epstein, 2010, see also **Paper IV**). Standardisations sort and order our world (cf. Beer, 2016 and the power of metrics).

By categorising information, complexity is reduced – along the lines of the logic of extraction. The effect, however, goes beyond losing local information to be self-reinforcing. Some information and some processer are made visible through standardisations, others are made invisible (cf. Bilotta et al., 2014; Robertson, 2012). For instance, given that the international climate change regime operates on ideas of the global, neoliberal and scientific climate, topics that want to be seen need to relate to this, which reinforces the logics and spreads them to other areas. Looking at the negotiations under the UNFCCC, the inclusion of the forestry sector seems to have created a momentum for including other ecosystems that fit the description of carbon rich, including coastal wetlands (UNFCCC, 2013, **Paper IV**). This, however, has not been a linear development, but one characterised by competition – in line with a neoliberal logic as discussed above. When Blue Carbon was introduced to the UNFCCC, its proponents took advantage of the work carried out by other ecosystem-communities (**Paper IV**). In addition, looking at the Blue Carbon-literature, there is an ongoing debate regarding the definition of Blue Carbon – the whole ocean or only the coastal zone, for instance, as well as what types of ecosystems or species should be included[20] (**Papers III, IV**). As a specific example, a number of Blue Carbon-researchers and conservation organisations involved in Blue Carbon (Howard et al., 2017, p. 48) argue that:

> Based on the governance challenges associated with open-ocean geographies and/or the current science demonstrating that they are inconsequential stores of carbon, four components – corals, kelp, phytoplankton, and marine fauna – are ineligible to be included in current UNFCCC mitigation finance mechanisms and should not be prioritized at this time in climate mitigation efforts. Instead, conservation practitioners should consider other international policy and funding opportunities (eg biodiversity conservation and climate adaptation) to support the protection and restoration of these important components of coastal and marine ecosystems.

[20] Suggestions have been made to include, for instance, coral reefs, fish carbon, seaweed, mudflats and more (**Paper III**).

If the rationale ordering our world is one of competition, and the value that defines this competition is carbon, it creates a world where ecosystems are understood hierarchically depending on carbon content – they are not all the same, not all as valuable (**Paper IV**, see also the rankings of the soil carbon pools we produced for **Paper III**). The argument in the quote above is built on carbon services of different ecosystems, however, it also brings forward another factor that is deemed important, namely jurisdiction and institutional settings. Hence, it is not the amount of carbon alone that decides which ecosystems should receive funding, jurisdiction and the institutional setting matter too (this also goes against the idea of a "free" market). In the example in the quote above, phytoplankton, for instance, may be important to the carbon cycle, but because they do not fit the institutional setting, they are not made visible in international climate change negotiations.

Another example of the interplay between context and practices is that of regulated carbon markets. As these markets only allow for a limited amount of carbon offsetting, Blue Carbon market-based mechanisms have to compete with other ecosystems for the possibility of providing carbon credits. Again, in a system where the unit used to see value is carbon, the most carbon rich ecosystems will benefit, and other ecosystems will be left outside the carbon market (**Paper IV**).

The main point here is not to provide an explanation or evaluation of the importance of different ecosystems versus others, but to show that the way something – in this case Blue Carbon – is made governable and the context it operates in makes possible certain practices and makes visible certain values (**Paper IV**, see also **Papers I, II** and the hierarchical ordering of types of knowledge). This in turn may or may not be beneficial to different goals, but regardless of the effects, it merits attention. The key question to pose here, I believe, is: what limits to the management of coastal ecosystems and climate change mitigation do the making of Blue Carbon create? Through this question, I propose, we can (re)attach the issue more strongly and transparently in politics, and are better equipped to decide if the making of Blue Carbon is, in the end, a winning strategy or too good to be true.

To start with, what are the promises attached to the making of Blue Carbon? Climate change mitigation, as explained in section 2, is bound up with the counting of carbon, and Blue Carbon follows this logic (**Paper IV**). This counting, the budgets and the many standardisations and methodologies enabling this counting come with a promise of control and of order (cf. Knox-Hayes, 2013; Ormond & Goodman, 2015, also **Paper IV)**. Coastal ecosystems, on the other hand, are chaotic and irregular (cf. Cronon, 1995). This is a feature that is hard to see in coastal wetland methodologies (cf. Robertson, 2000), and not one conveyed in the climate change negotiations. As described previously, aggregating an issue to the international level means that nuances are inevitably lost. In the climate change negotiations, the idea behind including ecosystems as carbon sinks is rather straightforward, and when objection has risen, concepts and tools like "monitoring, reporting and verification", "permanence", "leakage", "double counting" and "sustainable management", have been brought forward to address the issues raised (Dehm, 2016; Turnhout et al., 2017; Peskett & Todd, 2013; Scheba & Scheba, 2017 see also **Paper IV)**. However, even though uncertainties may be possible to reduce, they will never disappear simply because coastal ecosystems are not static (**Papers III, IV**) – they are living, moving and changing. This aliveness, in turn, gets transformed and materialised in the uncertainties associated with the measuring of carbon in these ecosystems. In this process, the uncontrollable nature of nature gets produced as something that is in fact controllable, because uncertainty is generally something that we can address, something that we can reduce (cf. Parkhurst, 2017).

That uncertainties in science can indeed be addressed, and reduced but not completely eliminated is uncontroversial in modern science (**Papers I, II**). My point here is rather that our ability to control "nature" gets mixed up with ability to reduce technical uncertainties in science, and that uncertainty ranges hold more information than what the actual numbers are telling us.

In the context of Blue Carbon, the extent to which uncertainties can be reduced is perhaps primarily a question of resources rather than scientific and technological advancement – Blue Carbon-ecosystems provide challenging arenas for field studies in many ways (**Paper III**), and an endless number of scuba divers is probably not an option for most project managers. Dealing with uncertainties then becomes a question about whether we are willing to live with the potential effects of these uncertainties, or not. This in turn is primarily a political question, not technical or scientific. For instance, carbon accounting in coastal wetlands means that carbon services are recognised and made visible, while other "ecosystem services" are "co-benefits" at most (**Paper IV**). Making carbon visible and other ecosystem services invisible could make it difficult to maintain environmental integrity. For instance, when the main goal of a (mangrove) forestry project becomes to capture carbon, then creating monocultures with the species that captures most carbon or captures most quickly might be considered the optimal strategy, but that does nothing to promote biodiversity (e.g. Alongi, 2011; Ellison et al., 2011; Lau, 2013). In the context of seagrasses there is an ongoing debate about the effects of grazing, for instance by turtles (Gillis et al., 2017; Johnson et al., 2017). The carbon services in turn are materialised in standards that are used for measuring carbon. In this process, expertise plays an important role in making the "Blue" carbon visible – in order to see Blue Carbon, equipment, technical devices, equations and statistics are needed (**Papers III, IV**). Blue Carbon is not possible to see with our eyes – a trained eye can separate sediments that are rich in carbon from those that are not (Howard et al., 2014) – but the molecules require specific equipment to be detected, and even here there are limits. For instance, it is not possible to directly measure the fraction of organic carbon in a soil sample. This is instead done indirectly through measuring the total amount of carbon, compared with an estimated amount of inorganic carbon (**Paper III**). Moreover, the nature of coastal wetlands – submerged – creates an additional need for expertise to explain and make understandable what is going on under the surface, and in areas that are difficult for people to physically access. Hence, it is not just the usage of carbon accounting standards and the expertise needed to use these standards that perform ecosystems as carbon service providers, but also, inter alia, availability of an elemental analyser, the strength of the researcher(s) inserting the soil auger to the soil/sediment, the size and features of the auger, and the material used to embed sediment samples for combustion (Alongi, 2012; DelVecchia et al., 2014; Howard et al., 2014).

There are, thus, limits to the way coastal wetlands can be represented in the scientific information used to inform the climate change negotiations. There are also limits to the representation of Blue Carbon. Coastal ecosystems occupy such a small surface area globally, that they are not recognised in GCMs. That said, other types of models are common tools used in the context of Blue Carbon. Models are numerical representations, meaning that seen through models, the world, or a coastal ecosystem or anything else takes on geometrical shapes. To make sense of information, it is summarised in variables making similar items the same. Modelling carbon flows in coastal wetlands involves making a choice regarding the number of variables to include (**Paper III**). A good model is not necessarily a model that includes as many variables as possible, but the lowest number of variables to adequately explain a phenomenon, depending on purpose and available resources (Thompson & Smith, 2019; also Holmquist et al 2018 in the context of Blue Carbon).

Similarly, allometric equations are used as a non-destructive way to measure carbon (**Paper III**). Here, science offers a way to see the carbon in an ecosystem without actually seeing it, not even directly measuring it. However, carbon varies a lot between species and places (Alongi, 2012). Species- and site-specific equations are not always available and no matter how we construct them, they present a simplification of the world (see also Adame et al., 2017).

As mentioned before, the way Blue Carbon is made visible through science is in line with climate change in general at least at an international level – the natural sciences and the economies dominate. This means that the numerical representations of Blue Carbon are made more visible than other representations (**Paper IV**). For instance, the value of coastal ecosystems for local communities living from them is in the scholarly Blue Carbon-literature only sparsely represented (Barbesgaard, 2017; Thompson et al., 2017), and in the climate change negotiations represented in concepts like “added value” or “safeguards” (Dehm, 2016; Ingalls et al., 2018). That said, numerical information can also be built around social constructions. For instance, in carbon accounting in coastal ecosystems it is important to separate between organic and mineral soils, because mineral soils contain a large portion of inorganic carbon which needs to be separated from calculations of organic carbon. The definition of organic versus mineral soils, however, is merely a proportional range that in turn is context specific (**Paper III**). Hence, in carbon accounting in Blue Carbon-ecosystems if a soil is classified as organic, the amount of inorganic carbon is usually set to zero. That is, however, a simplification as all soils contain both organic and inorganic carbon, and thus in this case this choice leads to overestimation of the carbon content (**Paper III**). A similar argument could perhaps be made for various national definitions of different ecosystems - what is seen in one country as a forest or a wetland may not be understood the same way in another country (**Paper IV**). The IPCC standardisations accommodate different definitions of ecosystems (IPCC, 2014), but it opens up the question regarding comparability of literature and accountings. They also show that even the most basic "facts" are not necessarily as stable or neutral as they are made out to be. These examples, though perhaps mundane, illustrate ways that the practices of carbon accounting and the usage of standardisations produce sameness where there is difference and how these differences are made invisible. They also illustrate that all uncertainty is not captured in standardisations.

The "scientific method" handles uncertainties through being systematic and transparent. The ideal is that science should be conducted and presented in such a way that anybody can replicate it (**Paper II**). Even though many would argue that this too is a simplification, it is a dominant narrative that helps explain the authority of certain types of scientific work (ibid). The scientific method renders science legitimate (Gieryn, 1983; Parkhurst, 2017; **Paper II).** The scientific community accepts uncertainties in the results – science does not try to verify results but to falsify them (section 2). In the case of Blue Carbon, a lot of uncertainty appears to be acceptable, especially for global estimates as discussed above (Adame et al., 2017; Duarte, 2017; Johannessen & Macdonald, 2016; Lovelock et al., 2017; Pendleton et al., 2012). However, when these uncertainties are carried into other social worlds they may create unintended effects, as the example of carbon accounting generally and the creation of carbon credits specifically illustrate.

An argument for the use of market-based mechanisms is that climate change is in fact an economic problem. The market economy has failed to protect our environment, because it has not taken environmental degradation into account, it has been free to destroy the environment (Russi et al., 2013). To fix this, to address this externality, we need economic tools (Canu et al., 2015; Farber, 1987). As explained by Luisetti and colleagues "in order to make the real value of ecosystems more 'visible' within governance, the ecosystem services framework highlights nature's worth in monetary terms" (Luisetti et al., 2013, p. 101). Hence, we have environmental problems because the environment has not been covered by the market, and the solution is to include the environment. However, it quickly becomes evident that not all "services" the environment produces can be included in the market because information about them cannot be produced in a format that the market understands (Robertson, 2006, **Paper IV)**. Hence, if we accept the logic of the market, then we also accept that some values and some resources are left aside and will thus be left unmanaged, free and unprotected, and this can be justified as it is the rules of the game (cf. Lave et al., 2010). The question then is, are we willing to take the consequences in terms of making some parts of the environment seen by the market, and others left outside? Do the benefits outweigh the risks? Or, for coastal ecosystems specifically, are the consequences of making aspects of these ecosystems visible through the making of Blue Carbon and associated tools (market-based or not) acceptable? From the point of view of relational ontology, but also mainstream environmental science, this is a risky venture – if everything is connected, then it is not safe to let some parts fall.

Market-based mechanisms carry the promise of finding the most cost-effective strategies to combat climate change – the strategies that hurt the least (Ervine, 2018). This logic is particularly visible in the debate around offsetting (cf. **Paper IV**). However, at the same time it is unclear how effective at reducing emissions these strategies have been. Methodologies for producing Blue Carbon-credits have been accused of categorically overestimating the size of Blue Carbon, although the Blue Carbon-community claims differently (Johannessen & Macdonald, 2016; 2018a; Oreska et al., 2018)[21]. Regardless of whether Blue Carbon-projects over- or underestimate carbon contents, the effect may be problematic. Overestimation is problematic because that will make us believe that we are more on track to solving climate change than we are (also **Papers III, IV**). Underestimation on the other hand means devaluing the carbon services of coastal ecosystems, made visible in the making of Blue Carbon (**Paper IV**). The price on carbon is and has for a longer time been so low that it is difficult to finance Blue Carbon-projects, which may be reflected in the low number of realised Blue Carbon-projects (cf. Lau, 2013; Sutton-Grier & Moore, 2016; Ullman et al., 2013). Moreover, as the standards are so complicated and the measuring of Blue Carbon so resource intense, it is difficult to see how small-scale projects could be financially stable (Needelman et al., 2019), other than, perhaps, if several ecosystem services are stacked and sold together (Friess et al., 2015; Greiner et al., 2013). Hence, thus far, the promise of market-mechanisms to address the loss of coastal ecosystems by recognising the value of nature's services may ironically have decreased the value of coastal ecosystems as

[21] Having followed the dispute in the scholarly literature and compared it with the methodologies in question, I conclude that both sides seem to have a point. BC-methodologies and a large share of the scholarly literature about BC do seem to overestimate carbon burial rates because they account for carbon that is only temporarily stored. At the same time BC-methodologies like the VCS's VM0033 are designed in a way that when no in situ measurements are done, default values that are thought to undervalue the carbon service are used. See also **Paper IV**.

the making of Blue Carbon has made the carbon services visible, but all other services invisible (**Paper IV**). With regard to overestimation of carbon this is particularly problematic because one of the biggest threats to coastal ecosystems is climate change (**Papers III, IV**). As degradation of these ecosystems leads to carbon stored being released back to the atmosphere, it may turn into a self-reinforcing process/feedback effect. In climate mitigation language, this problem is called non-permanence – the carbon stored is not stored long-term and thus the mitigative effect lost (Emmer et al., 2015; Johannessen & Macdonald, 2016, **Paper IV**). Carbon crediting systems usually promise that the carbon is stored for 100 years or more (Oreska et al., 2018, **Paper IV**). It is, of course, impossible for these systems to make such promises. To address this issue, carbon credit issuers may have insurance systems (**Paper IV**). These ensure that in addition to the project credits, the project also creates additional credits as a form of insurance (Emmer et al., 2015; Needelman et al., 2018; Oreska et al., 2018). If, for instance, a forest burns down or a hurricane destroys an area of mangroves, the investment in carbon credits is not all for nothing.

The results of this thesis cannot say whether carbon stocks and burial in coastal ecosystems are generally over- or underestimated, but they show that the results are uncertain (**Paper III**) and that these uncertainties are not possible to fully address, because that is simply not how the underpinning science works – no science is free of uncertainties (**Papers I, II**), and losing information is part of the process (Section 4). In addition, significantly reducing uncertainty would be so resource intensive that it could hardly be justified (**Paper IV**). The problem of uncertainty shows potential risks with Blue Carbon-projects. It is also a problem that we cannot completely fix, we have to either understand the risks and counteract or accept them, or find other approaches.

In sum, governing coastal ecosystems as carbon seems inefficient in several ways. Carbon contents are difficult to measure, yet governing them as carbon requires exactly that - measuring carbon. Despite this seemingly inherent contradiction and the inability to make coastal ecosystems fit the tidy and ordered world of accounting and standardisations, making coastal ecosystems governable as carbon has gained traction. How can we try to understand this development? Understanding it against the logics of the global, neoliberal and scientific, the making of Blue Carbon makes more sense. Efforts have been made to explain the global value of coastal ecosystems, and to make the making of Blue Carbon fit the development of its institutional setting. The backbone of this setting is carbon accounting, and carbon accounting in turn makes market-based mechanisms possible. Scientific information makes Blue Carbon understandable in the climate regime, and seen by the market. The counting of carbon in coastal wetlands reinforces its own logic through triggering the making of other governance tools such as carbon credits. This development in turn has created new relationships between researchers, decision-makers and practitioners/project developers.

In this section, I have tried to illustrate and exemplify what promises the making of Blue Carbon carries and makes possible, but also what limits to the management of coastal ecosystems and climate change mitigation the making of Blue Carbon results in. As just explained, the rationale behind Blue Carbon makes sense in the climate regime in many ways. It is also easy to see why the promise of Blue Carbon is appealing – protect valuable ecosystems, save the climate and, if you are a project developer and use market-based mechanisms – profit from it.

The limits are less evident through the decontextualisation and depoliticisation embedded in the making of Blue Carbon. For instance, I have given examples of important uncertainties that merit discussion because they contain information that can be important to decision-making about coastal ecosystems. However, decontextualizing and aggregating these uncertainties make them difficult to understand, because they can only be properly understood looking at the details, the underlying material and, indeed, the context (cf. **Paper III**). This logic of extraction, while powerful at making governable in the specific way described above and powerful at justifying specific behaviours, also makes invisible alternative ways of making governable. In this sense, the making of Blue Carbon produces truths about our world, even if the underlying information is uncertain (cf. Beer, 2016). The tools used to make coastal marine ecosystem governable as carbon, such as standardisations, create structure and control. They enact coastal ecosystems as governable objects, and the inherent unruliness of the ecosystems become uncertainty ranges. At the same time, the rationale behind Blue Carbon makes us the objects. We are the ones having something done to us. Coastal ecosystems perform carbon services for us. And perhaps it is here, not in the objectification but in the subjectification of ecosystems that we find the truth produced in the making of Blue Carbon that most urgently needs to be addressed. Market driven or not, Blue Carbon as a mitigation strategy does two things – either avoid or capture emissions. What it does not do, is to address the core issue behind the climate crisis – the consumption of fossil fuels.

It is clear that Blue Carbon-strategies alone will not solve the climate crisis, and it is therefore important that when Blue Carbon strategies are implemented, they do not compromise other parts of the climate change mitigation portfolio.

It is also clear that coastal ecosystems are invaluable to humans. Not implementing Blue Carbon-strategies is, however, not the same as not taking action to preserve them, even though some may say that there is no alternative. In addition, it is still unclear if Blue Carbon-projects will be able to result in permanent, stable and additional emission reductions, in particular in view of the threat climate change in turn poses to these ecosystems. Financially, most Blue Carbon-projects are not profitable on their own (e.g. Sutton-Grier & Moore 2016; Needelman et al. 2019). Against this backdrop, it still remains unclear if making governable as carbon is the best management strategy to protect coastal ecosystems. Looking at existing institutions, there are other options, such as climate change adaptation. With climate change being a more and more imminent threat to mankind, new financial options may be made available. In terms of emissions avoided or captured, the climate benefit is the same, counted or not.

6. Blue Carbon Blues?

In this thesis, I have studied the making of Blue Carbon – how coastal ecosystems have been and are rendered governable as carbon and how they entered the international global policy arena. To situate this study, I have pointed to two other issues. The first one deals with how nature is rendered governable more broadly, as discussed for instance in Section 2 about environmental neoliberalism. The other one is the urgency of the climate crisis, as outlined in the introduction and, for instance, articulated in the IPCC's special report in 1.5 degrees warming (IPCC, 2018). The slowness and hesitation of the societal response to climate change creates, it seems, a growing need to capture already emitted emissions, and governing coastal ecosystems as carbon can be understood as a part of this.

More specifically, I have explored the promises and limitations attached to Blue Carbon, guided by a set of four research questions. The first, and most general of these, asked:

> What characterises the material, institutional and discursive settings in which the idea of Blue Carbon was articulated?

To understand the making of Blue Carbon it is, I argue, necessary to move outside of its immediate context and content, and instead think about what Blue Carbon is an effect of, and how to get to this "what". In exploring this question, I identified three logics of the climate regime that I found helpful (Section 2). These are, I argue, the global, scientific and neoliberal logics. These logics, in turn, are articulated and reproduced in the material, institutional and discursive settings of the climate regime, such as GCMs, carbon credit projects, the reports by the IPCC, and the negotiation halls of the UNFCCC. Other examples include new concepts such as the global carbon sink, carbon credits, Global Warming Potential, and carbon dioxide equivalents that make it easier to think, and govern, in accordance with the global, scientific and neoliberal logics.

To make global governance objects (see e.g. Allan, 2017; Corry, 2014) information is taken out of its context, gets simplified and/or lost. As an effect, I argue, the debate gets depoliticised less accessible and more exclusive (cf. **Papers II, IV**). For instance, the neoliberal logic leaves decision-making to the market (or investors, in the case of secondary markets), the global runs on global information instead of local, and the scientific creates hierarchies between types of knowledge and disciplines, potentially excluding relevant information from the policy sphere.

My second research question focussed more directly on Blue Carbon:

> How are coastal wetlands made governable as a response to, or result of, the logics of the climate regime?

The promise of Blue Carbon is appealing – protecting crucial ecosystems, protecting our climate, and creating additional "co-benefits" such as biodiversity. Blue Carbon is a good fit for, effect of, and part of the global, scientific and neoliberal logics of the climate regime. However, studying the making of Blue Carbon at a micro-level, especially the methods used for estimating carbon and the uncertainties in the methods, revealed that the nature of coastal ecosystems is not an evident fit for carbon accounting and standardised protocols.

The process of making Blue Carbon results in certain ideas being more visible, and certain practices justified. At the same time, as some values are made visible, other values are made invisible. In this sense it is also a self-reinforcing system, as it creates truths about our world, simplifications, and washes away the nuances needed to create alternatives, to think about how it *might be otherwise* (Law, 2004, see also **Paper I**).

To understand the making of Blue Carbon in its current gist, I found that the role of science is particularly important as we need science and expertise to literally see Blue Carbon, but also to perform technical practices such as carbon accounting (**Paper IV**). With my third research question I asked:

> What role has the co-production of science and policy played in the making of Blue Carbon?

Given the definition of Blue Carbon, linking it to climate change mitigation, I found it helpful to explore the role of science in the climate regime more generally, to understand its role in relation to Blue Carbon as well. In brief, the conclusions of these studies are that science plays an important role towards policy (see **Papers I, II**). This connects science and policy. However the dominating role of science is, however, that science, at the same time, still can and should be separated from policy. This creates a challenging balancing act for the actors involved, resulting in a range of hierarchies of types of information and knowledge. It is thus not all information that is used to inform climate policy, but a specific type of information. However, climate change concerns everyone, and it is therefore not given that it is best solved between (a specific kind of) science and policy. More diversity and inclusion could potentially bring forward new solutions, and more support.

Similar hierarchies can be found in the context of Blue Carbon, with the natural sciences and economics dominating. I also found that even though Blue Carbon-inventories are relatively uncertain, they are still seen as robust because they adhere to a traditional understanding of the role of science, and are constructed around the scientific method (**Papers I, II, III**). Related to uncertainties, my result pointed out that these are not possible to understand out of context, without understanding the underlying material (**Paper III**, cf, **Paper I**). This may be problematic if it leads to a (perceived) depoliticisation of political and normative issues.

Finally, research question 4 asked:

> What realities do Blue Carbon enact, in terms of social values made visible and invisible?

Blue Carbon-strategies are built on measuring carbon in coastal ecosystems and every step of the process comes with their own uncertainties (**Paper III**). These uncertainties can perhaps be reduced, but not fully addressed. Based on the results of my thesis I cannot say if the uncertainties are biased towards either over- or underestimation, perhaps sometimes the one sometimes the other. Both are, however, potentially problematic. Underestimation means that less value, as measured in carbon, is ascribed to these ecosystems than they are actually worth. Overestimation may lead to less action on climate change than is required to meet political climate goals, such as those of the Paris Agreement.

An important and growing concern and uncertainty has to do with climate change. Blue Carbon-strategies are generally motivated by how threatened these ecosystems are, not least in the face of climate change. However, that they are threatened is in turn a risk of failure of Blue Carbon-projects, which would create more emissions, and more risk. Even if uncertainty regarding sinks and sources would be slim to none – if the overestimations perfectly outweigh the underestimations - making governable as carbon creates a hierarchy between ecosystems. This could be problematic, especially if no efficient strategies for visualising other values (including non-market values) are used.

As the process of making governable erases differences and nuances, thinking about what is made invisible in this process is, naturally, challenging. Counteracting the tendency to decontextualise, generalise and simplify involves, I believe, opening up the "black box" of science. That, however, does not mean that there is no role for science merely that we may need to expand the scope of what type of science is considered (cf. **Paper II**). More qualitative research, arts and the humanities would increase pluralism of the types of information considered regarding coastal ecosystems (**Paper III, IV**). These disciplines can also bring nuances to debates around, for instance, geoengineering with seagrasses. Instead of focussing on if and how it can be done and how uncertainties can be reduced, these disciplines could facilitate dialogues regarding whether we should undertake such a venture in the first place. In this line, as an outlook for future studies, I think that it would be interesting to use the tools that new materialism offers in other ways than I have done, and to bring in other disciplines such as behavioural sciences to study material relationality in coastal ecosystems. What Blue Carbon-standardisations do to us – how they make us feel and the effects of this, is a topic I find worth exploring more in the future. Another example of a future study could be to explore if and how the logics of extraction and decontextualisation also make us detached from our coastal ecosystems emotionally, and the potential effects in terms of enabling different policies and management. The field of environmental psychology has already told us about negative health effects associated with (an imagined) detachment from nature – a different, but potentially related, blues.

References

Ackerly, B., & True, J. (2010). *Doing Feminist Research in Political and Social Science*. Basingstoke: Palgrave.

Adame, M. F., Cherian, S., Reef, R., & Stewart-Koster, B. (2017). Mangrove root biomass and the uncertainty of belowground carbon estimations. *Forest Ecology and Management, 403*, 52-60. doi:10.1016/j.foreco.2017.08.016

Agger, B. (1991). Critical Theory, Poststructuralism, Postmodernism: Their Sociological Relevance. *Annual Review of Sociology, 17*, 105-131.

Agrawala, S. (1999). Early science–policy interactions in climate change: lessons from the Advisory Group on Greenhouse Gases. *Global Environmental Change, 9*(2), 157-169. doi:http://dx.doi.org/10.1016/S0959-3780(99)00003-5

Alaimo, S. (2010). *Bodily Natures: Science, Environment, and the Material Self*. Bloomington, Indianapolis: Indiana University Press.

Allan, B. B. (2017). Producing the Climate: States, Scientists, and the Constitution of Global Governance Objects. *International Organization, 71*(1), 131-162. doi:10.1017/S0020818316000321

Alongi, D. M. (2011). Carbon payments for mangrove conservation: ecosystem constraints and uncertainties of sequestration potential. *Environmental Science & Policy, 14*(4), 462-470. doi:http://dx.doi.org/10.1016/j.envsci.2011.02.004

Alongi, D. M. (2012). Carbon sequestration in mangrove forests. *Carbon Management, 3*(3), 313-322. doi:10.4155/cmt.12.20

Andresen, S., & Agrawala, S. (2002). Leaders, pushers and laggards in the making of the climate regime. *Global Environmental Change, 12*(1), 41-51. doi:http://dx.doi.org/10.1016/S0959-3780(01)00023-1

Arrhenius, S. (1896). On the Influence of Carbon Acid in the Air upon the Temperature of the Ground. *Philosophical Magazine and Journal of Science, 41*(5), 237-276.

Awari, E. H., & Mullah, A. M. J. (2014). Properties of the mangrove community sediment on the island of El Souda Western Saudi Arabia. *Journal of Agricultural Science (Toronto), 6*(6), 165-175.

Baber, W. F., & Bartlett, R. V. (2011). The Role of International Law in Global Governance. In J. S. Dryzek, R. B. Norgaard, & D. schlosberg (Eds.), *The Oxford Handbook of Climate Change and Society* (pp. 653-665). Oxford; New York: Oxford University Press.

Bäckstrand, K. (2011). Legitimacy of Global governance after Copenhagen. In J. S. Dryzek, R. B. Norgaard, & D. schlosberg (Eds.), *The Oxford Handbook of Climate Change and Society* (pp. 669-684). Oxford; New York: Oxford University Press.

Bäckstrand, K., & Elgström, O. (2013). The EU's role in climate change negotiations: from leader to 'leadiator'. *Journal of European Public Policy, 20*(10), 1369-1386. doi:10.1080/13501763.2013.781781

Bakker, K. (2005). Neoliberalizing Nature? Market Environmentalism in Water Supply in England and Wales. *Annals of the Association of American Geographers, 95*(3), 542-565. doi:10.1111/j.1467-8306.2005.00474.x

Bakker, K. (2007). The "Commons" Versus the "Commodity": Alter-globalization, Anti-privatization and the Human Right to Water in the Global South. *Antipode, 39*(3), 430-455. doi:10.1111/j.1467-8330.2007.00534.x

Barbesgaard, M. (2017). Blue growth: savior or ocean grabbing? *The Journal of Peasant Studies*, 1-20. doi:10.1080/03066150.2017.1377186

Beck, S. (2011). Moving beyond the linear model of expertise? IPCC and the test of adaptation. *Regional Environmental Change, 11*(2), 297-306. doi:10.1007/s10113-010-0136-2

Beck, S. (2015). Science. In E. Lövbrand & K. Bäckstrand (Eds.), *Research Handbook on Climate Governance* (pp. 286-296). Cheltenham, UK & Northampton, USA: Edward Elgar Publishing.

Beck, S., Borie, M., Chilvers, J., Esguerra, A., Heubach, K., Hulme, M., . . . Görg, C. (2014). Towards a Reflexive Turn in the Governance of Global Environmental Expertise: The Cases of the IPCC and the IPBES. *GAIA, 23*(2), 80-87.

Beer, D. (2016). *Metric Power*. London: Palgrave Macmillan.

Beitl, C. M. (2016). The Changing Legal and Institutional Context for Recognizing Nature's Rights in Ecuador: Mangroves, Fisheries, Farmed Shrimp, and Coastal Management since 1980. *Journal of International Wildlife Law & Policy, 19*(4), 317-332. doi:10.1080/13880292.2016.1248688

Bell-James, J. (2016). Developing a Framework for 'Blue Carbon' in Australia: Legal and Policy Considerations. *University of New South Wales Law Journal, 39*(4), 1583-1611.

Benessaiah, K. (2012). Carbon and livelihoods in Post-Kyoto: Assessing voluntary carbon markets. *Ecological Economics, 77*, 1-6. doi:10.1016/j.ecolecon.2012.02.022

Benson, L., Glass, L., Jones, T. G., Ravaoarinorotsihoarana, L., & Rakotomahazo, C. (2017). Mangrove Carbon Stocks and Ecosystem Cover Dynamics in Southwest Madagascar and the Implications for Local Management. *Forests, 8*(6). doi:10.3390/f8060190

Berg, M., & Lidskog, R. (2018a). Deliberative democracy meets democratised science: a deliberative systems approach to global environmental governance *Environmental Politics, 27*(1), 1-20. doi:10.1080/09644016.2017.1371919

Berg, M., & Lidskog, R. (2018b). Pathways to deliberative capacity: the role of the IPCC. *Climatic Change, 148*(1), 11-24. doi:10.1007/s10584-018-2180-8

Bernstein, S. F. (2001). *The compromise of liberal environmentalism*. [e-book]. Columbia University Press.

Betsill, M. H., Matthew J. (2011). The Contours of “Cap and Trade”: The Evolution of Emissions Trading Systems for Greenhouse Gases. *Review of Policy Research, 28*(1), 25.

Biagioli, M. (1999). *The Science Studies Reader*. New York and London: Routledge.

Bigford, T. E. (2014). Aquatic Blue Carbon. *Fisheries, 39*(4), 150-+. doi:10.1080/03632415.2014.897231

Bilotta, G. S., Milner, A. M., & Boyd, I. (2014). On the use of systematic reviews to inform environmental policies. *Environmental Science & Policy, 42*, 67-77. doi:http://dx.doi.org/10.1016/j.envsci.2014.05.010

Bjurström, A., & Polk, M. (2011a). Physical and economic bias in climate change research: a scientometric study of IPCC Third Assessment Report. *Climatic Change, 108*(1-2), 1-22. doi:10.1007/s10584-011-0018-8

Blaxekjær, L. Ø., & Nielsen, T. D. (2015). Mapping the narrative positions of new political groups under the UNFCCC. *Climate Policy, 15*(6), 751-766. doi:10.1080/14693062.2014.965656

Blok, A. (2014). Articulating social science in the wild of global natures?: on economics and anthropology in transnational environmental politics. *Environment & planning A, 46*(9), 2125-2142.

Bolin, B. (2008). *A History of the Science and Politics of Climate Change: The Role of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press.

Borghesi, S., & Montini, M. (2016). The best (and worst) of GHG Emission Trading Schemes: Comparing the EU ETS with its followers. *Frontiers in Energy Research*. doi:10.3389/fenrg.2016.00027

Braun, K., & Dodge, J. (2018). Critical policy studies and the politics of post-truth politics. *Critical Policy Studies, 12*(1), 1-2. doi:10.1080/19460171.2018.1444498

Broecker, W. S. (1975). Climatic Change: Are We on the Brink of a Pronounced Global Warming? *Science, 189*(4201), 460-463. doi:10.1126/science.189.4201.460

Brundtland, G. H. (1987). *Our Common Future: Report of the World Commission on Environment and Development*. Geneva: UN-Dokument A/42/427 <http://www.un-documents.net/ocf-ov.htm>

Bryman, A. (2012). *Social Research Methods.* Oxford: Oxford University Press

Bu, N.-S., Qu, J.-F., Li, G., Zhao, B., Zhang, R.-J., & Fang, C.-M. (2015). Reclamation of coastal salt marshes promoted carbon loss from previously-sequestered soil carbon pool. *Ecological Engineering, 81*, 335-339. doi:10.1016/j.ecoleng.2015.04.051

Bulkeley, H., & Newell, P. (2010). *Governing Climate Change*. Abingdon: Routledge.

Bumpus, A. G. (2011). The Matter of Carbon: Understanding the Materiality of tCO2e in Carbon Offsets. *Antipode, 43*(3), 612-638. doi:10.1111/j.1467-8330.2011.00879.x

Busch, P.-O. (2009). The Climate Secretariat: Making a Living in a Straitjacket. In F. Biermann & B. Siebenhüner (Eds.), *Managers of Gloabal change: The Influence of International Environmental Bureaucracies* (pp. 245-264). Cambridge, London: The MIT Press.

Bush, V. (1945). *Science The Endless Frontier*. Washington: United States Government Printing Office.

Callon, M. (1984). Some elements of a sociology of translation: domestication of the scallops and the fishermen of St Brieuc Bay. *Sociological Review*, 32(1), 196-233. doi:10.1111/j.1467-954X.1984.tb00113.x

Callon, M. (1986). The sociology of an actor-network: The case of the electric vehicle. In M. Callon, J. Law, & A. Rip (Eds.), *Mapping the Dynamics of Science and Technology: Sociology of Science in the Real World* (pp. 19-34): Palgrave Macmillan UK.

Canu, D. M., Ghermandi, A., Nunes, P., Lazzari, P., Cossarini, G., & Solidoro, C. (2015). Estimating the value of carbon sequestration ecosystem services in the Mediterranean Sea: An ecological economics approach. *Global Environmental Change-Human and Policy Dimensions, 32*, 87-95. doi:10.1016/j.gloenvcha.2015.02.008

Castree, N. (2008). Neoliberalising Nature: The Logics of Deregulation and Reregulation. *Environment and Planning A: Economy and Space, 40*(1), 131-152. doi:10.1068/a3999

Chanda, A., Mukhopadhyay, A., Ghosh, T., Akhand, A., Mondal, P., Ghosh, S., . . . Hazra, S. (2016). Blue Carbon Stock of the Bangladesh Sundarban Mangroves: What could Be the Scenario after a Century? *Wetlands, 36*(6), 1033-1045. doi:10.1007/s13157-016-0819-7

Chung, I. K., Oak, J. H., Lee, J. A., Shin, J. A., Kim, J. G., & Park, K.-S. (2013). Installing kelp forests/seaweed beds for mitigation and adaptation against global warming: Korean Project Overview. *Ices Journal of Marine Science, 70*(5), 1038-1044. doi:10.1093/icesjms/fss206

Ciplet, D., & Roberts, J. T. (2017). Climate change and the transition to neoliberal environmental governance. *Global Environmental Change Part A: Human & Policy Dimensions, 46*, 148.

Clarke, A. (2005). *Situational analysis: grounded theory after the postmodern turn*. Thousand Oaks, USA: Sage Publications.

Corbera, E., Calvet-Mir, L., Hughes, H., & Paterson, M. (2015). Patterns of authorship in the IPCC Working Group III report. *Nature Climate Change, 6*, 94. doi:10.1038/nclimate2782

Corry, O. (2014). The Rise and Fall of the Global Climate Polity. In J. Stripple & H. Bulkeley (Eds.), *Governing the Climate: New Appraoches to Rationality, Power and Politics* (pp. 219-234). New York, USA: Cambridge University Press.

Craig, T. (2014). Citizen Forums against Technocracy? The Challenge of Science to Democratic Decision Making. *Perspectives on Political Science, 43*(1), 31-40. doi:10.1080/10457097.2012.720836

Cronon, W. (1995). The Trouble with Wilderness; or, Getting Back to the Wrong Nature. In W. Cronon (Ed.), *Uncommon Ground: Rethinking the Human Place in Nature* (pp. 69-90). New York: W. W. Norton & Co.

Crooks, S., Sutton-Grier, A. E., Troxler, T. G., Herold, N., Bernal, B., Schile-Beers, L., & Wirth, T. (2018). Coastal wetland management as a contribution to the US National

Greenhouse Gas Inventory. *Nature Climate Change, 8*(12), 1109-1112. doi:10.1038/s41558-018-0345-0

Crooks, S., Windham-Myers, L., & Troxler, T. G. (2019). Defining Blue Carbon: The Emergence of a Climate Context for Coastal Climate Dynamics. In L. Windham-Myers, S. Crooks, & T. G. Troxler (Eds.), *A Blue Carbon Primer: The State of Coastal Wetland Carbon Science, Practice and Policy* (pp. 1-8). Boca Raton, Florida, USA: CRC Press: Taylor and Fracis Group.

D'Alisa, G., Demaria, F., & Kallis, G. (2015). *Degrowth : a vocabulary for a new era*. New York: Routledge.

De Pryck, K., & Gemenne, F. (2017). The Denier-in-Chief: Climate Change, Science and the Election of Donald J. Trump. *Law and Critique, 28*(2), 119-126.

Dehm, J. (2016). Indigenous Peoples and REDD+ Safeguards: Rights as Resistance or as Disciplinary Inclusion in the Green Economy. *Journal of Human Rights and the Environment.* 7(2), 170-217.

DelVecchia, A. G., Bruno, J. F., Benninger, L., Alperin, M., Banerjee, O., & de Dios Morales, J. (2014). Organic carbon inventories in natural and restored Ecuadorian mangrove forests. *PeerJ, 2*, e388-e388. doi:10.7717/peerj.388

Demeritt, D. (2002). What is the 'social construction of nature'? A typology and sympathetic critique. *Progress in Human Geography, 26*(6), 767-790. doi:10.1191/0309132502ph402oa

Dooley, K., & Gupta, A. (2017). Governing by expertise: the contested politics of (accounting for) land-based mitigation in a new climate agreement. *International Environmental Agreements, 17*(4), 483-500. doi:10.1007/s10784-016-9331-z

Dryzek, J. S. (2006). *Deliberative Global Politics. Discourse and Democracy in a Divided World*. Cambridge: Polity Press

Duarte, C. M. (2017). Reviews and syntheses: Hidden forests, the role of vegetated coastal habitats in the ocean carbon budget. *Biogeosciences, 14*(2), 301-310. doi:10.5194/bg-14-301-2017

Edwards, P. N. (2010). *A Vast Machine: Computer models, climate data and the politics of global warming*. Cambridge MA, USA: MIT Press.

Ehrenstein, V. (2018). Carbon sink geopolitics. *Economy and Society, 47*(1), 162-186. doi:10.1080/03085147.2018.1445569

Elgert, L. (2010). Politicizing sustainable development: the co-production of globalized evidence-based policy. *Critical Policy Studies, 3*(3-4), 375-390. doi:10.1080/19460171003619782

Ellison, D., Lundblad, M., & Petersson, H. (2011). Carbon accounting and the climate politics of forestry. *Environmental Science & Policy, 14*(8), 1062-1078. doi:http://dx.doi.org/10.1016/j.envsci.2011.07.001

Emmer, I., von Unger, M., Needelman, B., Crooks, S., Emmett-Mattox, S., & Simpson (eds.), S. (2015). *Coastal Blue Carbon in Practice: A Manual for Using the VCS Methodology for Tidal Wetland and Seagrass Restoration VM0033*. Edited and published by Restore America’s Estuaries, Arlington <https://www.estuaries.org/bluecarbon-markets>

ENB. (2011). *UN Climate Change Conference in Bonn: 6 - 17 June 2011. SB 34. Report Compilation. Vol. 12 No. 502-513*. International Institute for Sustainable Development (IISD) <http://www.iisd.ca/climate/sb34/>

Enserink, B., Kwakkel, J. H., & Veenman, S. (2013). Coping with uncertainty in climate policy making: (Mis)understanding scenario studies. *Futures, 53*, 1-12. doi:https://doi.org/10.1016/j.futures.2013.09.006

Ervine, K. (2014). Diminishing Returns: Carbon Market Crisis and the Future of Market-Dependent Climate Change Finance. *New Political Economy, 19*(5), 723-747. doi:10.1080/13563467.2013.849672

Ervine, K. (2018). *Carbon*. Cambridge, UK & Medford, US: Polity Press.

Farber, S. (1987). The value of coastal wetlands for protection of property against hurricane wind damage. *Journal of Environmental Economics and Management, 14*, 143-151. doi:10.1016/0095-0696(87)90012-X

Fazey , I., Evely, A., Reed, M., Stringer, L., Kruijsen , J., White, P., . . . Trevitt, C. (2013). Knowledge exchange: a review and research agenda for environmental management. *Environmental Conservation, 40*(01), 19-36. doi:doi:10.1017/S037689291200029X

Ford, J. D., Cameron, L., Rubis, J., Maillet, M., Nakashima, D., Willox, A. C., & Pearce, T. (2016). Including indigenous knowledge and experience in IPCC assessment reports. *Nature Climate Change, 6*, 349. doi:10.1038/nclimate2954

Ford, J. D., Vanderbilt, W., & Berrang-Ford, L. (2011). Authorship in IPCC AR5 and its implications for content: climate change and Indigenous populations in WGII. *Climatic Change, 113*, 201-213.

Fourier, J.-B. J. (1827). Mémoire sur les températures du globe terrestre et des espaces planétaires. *Mémoire de l'Académie des Sciences de l'Institut de France, 7*, 569-604.

Fourqurean, J. W., Duarte, C. M., Kennedy, H., Marba, N., Holmer, M., Angel Mateo, M., . . . Serrano, O. (2012a). Seagrass ecosystems as a globally significant carbon stock. *Nature geoscience, 5*(7), 505-509. doi:10.1038/ngeo1477

Fourqurean, J., Kendrick, G., Collins, L., Chambers, R., & Vanderklift, M. (2012b). Carbon, nitrogen and phosphorus storage in subtropical seagrass meadows: Examples from Florida Bay and Shark Bay. *Marine and Freshwater Research, 63*, 967 - 983. doi:https://doi.org/10.1071/MF12101

Friess, D. A., Phelps, J., Garmendia, E., & Gomez-Baggethun, E. (2015). Payments for Ecosystem Services (PES) in the face of external biophysical stressors. *Global Environmental Change-Human and Policy Dimensions, 30*, 31-42. doi:10.1016/j.gloenvcha.2014.10.013

Funtowicz, S. O., & Ravetz, J. R. (1993). Science for the post-normal age. *Futures, 25*(7), 739-755. doi:http://dx.doi.org/10.1016/0016-3287(93)90022-L

Fuss, S., Canadell, J. G., Peters, G. P., Tavoni, M., Andrew, R. M., Ciais, P., . . . Yamagata, Y. (2014). Betting on negative emissions. *Nature Climate Change, 4*, 850. doi:10.1038/nclimate2392

Gareau, B. J. (2011). Green Neoliberalism. In D. Mulvaney & P. Robbins (Eds.), Green Politics: An A-to-Z Guide. Thousand Oaks, California: SAGE Publications, Inc. Retrieved from http://sk.sagepub.com/reference/greenpolitics. doi:10.4135/9781412971867

Gieryn, T. F. (1983). Boundary-Work and the Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies of Scientists. *American Sociological Review, 48*(6), 781-795. doi:10.2307/2095325

Gillespie, A., & Michelson, M. R. (2011). Participant Observation and the Political Scientist: Possibilities, Priorities, and Practicalities. *PS: Political Science & Politics*, 44, 261-265.

Gillis, L. G., Belshe, F. E., Ziegler, A. D., & Bouma, T. J. (2017). Driving forces of organic carbon spatial distribution in the tropical seascape. *Journal of Sea Research, 120*, 35-40. doi:10.1016/j.seares.2016.12.006

Githaiga, M. N., Kairo, J. G., Gilpin, L., & Huxham, M. (2017). Carbon storage in the seagrass meadows of Gazi Bay, Kenya. *PLoS ONE, 12*(5). doi:10.1371/journal.pone.0177001

Gold Standard. (2019). *Envisioning the Voluntary arbon Market post-2020*. Statement for consultation, retreived from: <https://www.goldstandard.org/our-work/innovations-consultations/envisioning-voluntary-carbon-market-post-2020>, accessed 2019-09-06.

Göransson, T. (2016). *Blue Carbon and Ecosystem-based Adaptation: Mapping of Arenas.* CEC Report No. 03 Centre for Environmental and Climate Research, Lund University. ISBN 978-91-981577-7-2

Green, E. P., & Short, F. T. (Eds.). (2003). *World Atlas of Seagrasses*. Berkeley, USA: University of California Press.

Greenberg, R., Maldonado, J. E., Droege, S., & McDonald, M. V. (2006). Tidal Marshes: A Global Perspective on the Evolution and Conservation of Their Terrestrial Vertebrates. *BioScience*(8), 675. doi:10.1641/0006-3568(2006)56

Greiner, J. T., McGlathery, K. J., Gunnell, J., & McKee, B. A. (2013). Seagrass Restoration Enhances "Blue Carbon" Sequestration in Coastal Waters. *PLoS ONE, 8*(8). doi:10.1371/journal.pone.0072469

Grimsditch, G., Alder, J., Nakamura, T., Kenchington, R., & Tamelander, J. (2013). The blue carbon special edition - Introduction and overview. *Ocean & Coastal Management, 83*, 1-4. doi:10.1016/j.ocecoaman.2012.04.020

Gupta, A., & Möller, I. (2018). De facto governance: how authoritative assessments construct climate engineering as an object of governance. *Environmental Politics*, 1-22. doi:10.1080/09644016.2018.1452373

Gupta, J. (2010). A history of international climate change policy. *Wiley Interdisciplinary Reviews: Climate Change, 1*(5), 636-653. doi:10.1002/wcc.67

Gupta, J., & van Asselt, H. (2006). Helping operationalise Article 2: A transdisciplinary methodological tool for evaluating when climate change is dangerous. *Global Environmental Change, 16*(1), 83-94. doi:10.1016/j.gloenvcha.2005.11.006

Guterres, A. (2018). Remarks at High-Level Event on Climate Change: 26 September 2018. <https://www.un.org/sg/en/content/sg/speeches/2018-09-26/remarks-high-level-event-climate-change>, accessed 2019-09-03.

Haas, P. (1992). Epistemic Communities and International Policy Coordination. *International Organization, 46*(1), 1-35.

Haas, P. (2004). When does power listen to truth? A constructivist approach to the policy process. *Journal of European Public Policy, 11*(4), 569-592. doi:10.1080/1350176042000248034

Hage, M., Leroy, P., & Petersen, A. C. (2010). Stakeholder participation in environmental knowledge production. *Futures, 42*(3), 254-264. doi:http://dx.doi.org/10.1016/j.futures.2009.11.011

Hajer, M. A. (1995). *The Politics of Environmental Discourse: Ecological Modernization and the Policy.* Oxford: Oxford University Press.

Hamilton, S. E., & Casey, D. (2016). Creation of a high spatio-temporal resolution global database of continuous mangrove forest cover for the 21st century (CGMFC-21). *Global Ecology and Biogeography, 25*(6), 729-738. doi:10.1111/geb.12449

Hamilton, S. E., & Lovette, J. (2015). Ecuador's mangrove forest carbon stocks: A spatiotemporal analysis of living carbon holdings and their depletion since the advent of commercial aquaculture. *PLoS ONE, 10*(3). doi:10.1371/journal.pone.0118880

Hamrick, K., & Gallant, M. (2017). *Unlocking Potential: State of the Voluntary Carbon Markets 2017*. Retrieved from Washington DC: Forest Trends' Ecosystem Marketplace:

Hantanirina, J. M. O., & Benbow, S. (2013). Diversity and coverage of seagrass ecosystems in south-west Madagascar. *African Journal of Marine Science, 35*(2), 291-297. doi:10.2989/1814232x.2013.800580

Haraway, D. (1988). Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. *Feminist Studies, 14*(3), 575-599. doi:10.2307/3178066

Herr, D., Pidgeon, E., & Laffoley, D. (2012). *Blue Carbon Policy Framework: Based on the discussion of the International Blue Carbon Policy Working Group*. IUCN: Gland & CI: Arlington <http://thebluecarboninitiative.org/>

Herr, D., Unger, M., Laffoley, D., & McGivern, A. (2017). *Pathways for implementation of blue carbon initiatives. Aquatic Conservation: Marine and Freshwater Ecosystems,* 27(S1), 116-129. doi:10.1002/aqc.2793

Hinchliffe, S. (2008). Reconstituting nature conservation: Towards a careful political ecology. *Geoforum, 39*(1), 88-97. doi:https://doi.org/10.1016/j.geoforum.2006.09.007

Hinson, A. L., Feagin, R. A., Eriksson, M., Najjar, R. G., Herrmann, M., Bianchi, T. S., . . . Boutton, T. (2017). The spatial distribution of soil organic carbon in tidal wetland soils of the continental United States. *Global Change Biology, 23*(12), 5468-5480. doi:10.1111/gcb.13811

Holmquist, J. R., Windham-Myers, L., Bliss, N., Crooks, S., Morris, J. T., Megonigal, J. P., . . . Woodrey, M. (2018). Accuracy and Precision of Tidal Wetland Soil Carbon Mapping in the Conterminous United States. *Scientific Reports, 8*(1), 9478. doi:10.1038/s41598-018-26948-7

Houghton, J. T., Jenkins, G. J., & Ephraums, J. J. (Eds.). (1990). *Climate Change: The IPCC Scientific Assessment*. Cambridge, New York, Port Chester, Melbourne, Sydney: Cambridge University Press.

Howard, J., Hoyt, S., Isensee, K., Pidgeon, E., Telszewski, M. (eds.). (2014). *Coastal Blue Carbon: Methods for assessing carbon stocks and emissions factors in mangroves, tidal salt marshes, and seagrass meadows*. Arlington, Virginia, USA: CI, IOC-UNESCO, IUCN.

Howard, J., Sutton-Grier, A., Herr, D., Kleypas, J., Landis, E., McLeod, E., . . . Simpson, S. (2017). Clarifying the role of coastal and marine systems in climate mitigation. *Frontiers in Ecology and the Environment, 15*(1), 42-50. doi:10.1002/fee.1451

Hughes, H. 2015. Bourdieu and the IPCC's symbolic power. *Global Environmental Politics* 15(4), pp. 85-104. (10.1162/GLEP_a_00323)

Hulme, M. (2010). Problems with making and governing global kinds of knowledge. *Global Environmental Change, 20*(4), 558-564. doi:http://dx.doi.org/10.1016/j.gloenvcha.2010.07.005

Hulme, M. (2011). Meet the humanities. *Nature Climate Change, 1*, 177. doi:10.1038/nclimate1150

Hulme, M., & Mahony, M. (2010). Climate change: What do we know about the IPCC? *Progress in Physical Geography, 34*(5), 705-718. doi:10.1177/0309133310373719

Hutchison, J., Manica, A., Swetnam, R., Balmford, A., & Spalding, M. (2014). Predicting Global Patterns in Mangrove Forest Biomass. *Conservation Letters, 7*(3), 233-240. doi:10.1111/conl.12060

Ingalls, M. L., Meyfroidt, P., To, P. X., Kenney-Lazar, M., & Epprecht, M. (2018). The transboundary displacement of deforestation under REDD+: Problematic intersections between the trade of forest-risk commodities and land grabbing in the Mekong region. *Global Environmental Change, 50*, 255-267. doi:https://doi.org/10.1016/j.gloenvcha.2018.04.003

IPBC. (2018). *Incorporating coastal wetlands in inventories*. International Partnership for Blue Carbon (IPBC): <http://bluecarbonpartnership.org/wp-content/uploads/2018/12/IPBC-Wetlands-Lessons-Learned.pdf>

IPCC. (2013). *Principles Governing IPCC work*. Version amended at the 37th session of the IPCC. First version approved at its 14th session. Retreived from: <https://www.ipcc.ch/documentation/procedures/>, accessed 2019-09-03.

IPCC (2014). 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands,Hiraishi, T., Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J., Fukuda, M. and Troxler, T.G. (eds). Published: IPCC, Switzerland.

IPCC. (2018). *Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* V. Masson-Delmotte, P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, T. Waterfield (eds.): In Press.

IPCC. (2019). The Structure of the IPCC <https://www.ipcc.ch/about/structure/>, accessed 2019-09-05.

Jäger, J. (1998). Current thinking on using scientific findings in environmental policy making. *Environmental Modeling & Assessment, 3*(3), 143-153. doi:10.1023/A:1019066907165

Jäger, C.C. & Jäger, J. (2011). Three views on two degrees. *Regional Environmental Change*, *11*(1), 15-26. https://doi.org/10.1007/s10113-010-0190-9

Jardine, S. L., & Siikamäki, J. V. (2014). A global predictive model of carbon in mangrove soils. *Environmental Research Letters, 9*(10). doi:10.1088/1748-9326/9/10/104013

Jasanoff, S. (1987). Contested Boundaries in Policy-Relevant Science. *Social Studies of Science, 17*(2), 195-230. doi:10.2307/284949

Jasanoff, S. (1990). *The Fifth Branch: Science Advisers as Policymakers*. Cambridge, MA, USA: Harvard Univserity Press.

Jasanoff, S. (2008). Speaking honestly to power. *American Scientist*, 96(3), 240-243.

Jasanoff, S. (2010). A New Climate for Society. *Theory, Culture and Society*, 27(2-3), 233-253.

Jasanoff, S. (2015). Science and Technology Studies. In E. Lövbrand & K. Bäckstrand (Eds.), *Research Handbook on Climate Governance* (pp. 36-48). Glos, UK; Massachusetts, USA: Edward Elgar Publishing.

Jiajia, L., & Junjie, Z. (2018). Regional Cooperation on Carbon Markets in East Asia. *Asian Development Review*(2), 153. doi:10.1162/adev_a_00118

Johannessen, S. C., & Macdonald, R. W. (2016). Geoengineering with seagrasses: is credit due where credit is given? *Environmental Research Letters, 11*(11). doi:10.1088/1748-9326/11/11/113001

Johannessen, S. C., & Macdonald, R. W. (2018a). Reply to Oreska et al 'Comment on Geoengineering with seagrasses: is credit due where credit is given?' *Environmental Research Letters, 13* (038002). doi:https://doi.org/10.1088/1748-9326/aaae71

Johannessen, S. C., & Macdonald, R. W. (2018b). Reply to Macreadie et al Comment on 'Geoengineering with seagrasses: is credit due where credit is given?'. *Environmental Research Letters, 13*(2). doi:10.1088/1748-9326/aaa7b5

Johnson, R. A., Gulick, A. G., Bolten, A. B., & Bjorndal, K. A. (2017). Blue carbon stores in tropical seagrass meadows maintained under green turtle grazing. *Scientific Reports, 7*. doi:10.1038/s41598-017-13142-4

Kallis, G., Demaria, F., & D'Alisa, G. (2015). Introduction: Degrowth. In G. D'Alisa, F. Demaria, & G. Kallis (Eds.), *Degrowth: A vocabulary for a new era* (pp. 1-17). New York; London: Routledge.

Katwijk, M. M., Thorhaug, A., Marbà, N., Orth, R. J., Duarte, C. M., Kendrick, G. A., . . . Verduin, J. J. (2016). Global analysis of seagrass restoration: the importance of large-scale planting. *Journal of Applied Ecology, 53*(2), 567-578. doi:doi:10.1111/1365-2664.12562

Kauffman, J. B., & Bhomia, R. K. (2017). Ecosystem carbon stocks of mangroves across broad environmental gradients in West-Central Africa: Global and regional comparisons. *PLoS ONE, 12*(11). doi:10.1371/journal.pone.0187749

Kauffman, J. B., & Donato, D. C. (2012). *Protocols for the measurement, monitoring and reporting of structure, biomass and carbon stocks in mangrove forests. Working Paper 86*. Bogor, Indonesia: CIFOR

Kennedy, H., Beggins, J., Duarte, C. M., Fourqurean, J. W., Holmer, M., Marbà, N., & Middelburg, J. J. (2010). Seagrass sediments as a global carbon sink: Isotopic constraints. *Global Biogeochemical Cycles, 24*(4). doi:10.1029/2010gb003848

Klus, A., Prange, M., Varma, V., & Schulz, M. (2019). Spatial analysis of early-warning signals for a North Atlantic climate transition in a coupled GCM. *Climate Dynamics, 53*(1/2), 97-113. doi:10.1007/s00382-018-4567-7

Knox-Hayes, J. (2013). The spatial and temporal dynamics of value in financialization: Analysis of the infrastructure of carbon markets. *Geoforum, 50*, 117-128. doi:http://dx.doi.org/10.1016/j.geoforum.2013.08.012

Knutti, R. (2008). Should we believe model predictions of future climate change? *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 366*(1885), 4647-4664. doi:doi:10.1098/rsta.2008.0169

Kroeger, K. D., Crooks, S., Moseman-Valtierra, S., & Tang, J. W. (2017). Restoring tides to reduce methane emissions in impounded wetlands: A new and potent Blue Carbon climate change intervention. *Scientific Reports, 7*. doi:10.1038/s41598-017-12138-4

Kuby, C. R. (2019). (Re)Thinking and (Re)Imagining Social(ing) With a More-Than-Human Ontology Given the Limits of (Re)(Con)Straining Language. *Cultural Studies ↔ Critical Methodologies, 19*(2), 126-143. doi:10.1177/1532708618807258

Kuhn, T. S. (1962, reprinted 2012). *The Structure of Scientific Revolutions* (50th anniversary ed ed.). Chicago, USA: University of Chicago Press.

Kuntz, A. M. (2015). *The Responsible Methodologist: Inquiry, Truth-Telling, and Social Justice*. New York: Routledge.

Kuntz, A. M., & Pickup, A. (2016). Critical Inquiry for the Social Good: Methodological Work as a Means for Truth-Telling in Education. *Critical Issues in Education, 7*(3), 171-177.

Kuwae, T., Kanda, J., Kubo, A., Nakajima, F., Ogawa, H., Sohma, A., & Suzumura, M. (2016). Blue carbon in human-dominated estuarine and shallow coastal systems. *AMBIO, 45*(3), 290-301. doi:10.1007/s13280-015-0725-x

Lahsen, M. (2005). Technocracy, Democracy, and U.S. Climate Politics: The Need for Demarcations. *Science, Technology & Human Values, 30*(1), 137-169.

Lanchbery, J., & Victor, D. (1995). The Role of Science in the Global Climate Negotiations. In H. O. Bergesen & G. Parmann (Eds.), *Green Globe Yearbook 1995: Yearbook of International Cooperation on Environment and Development* (pp. 29-39): Oxford University Press.

Lansing, D. M. (2012). Performing carbon's materiality: the production of carbon offsets and the framing of exchange. *Environment and Planning A, 44*(1), 204-220.

Latour, B. (1987). *Science in Action: How to Follow Scientists and Engineers Through Society*. Cambridge MA: Harvard University Press.

Latour, B. (1988). *The Pasteurization of France*. Cambridge, USA: Harvard University Press.

Latour, B. (1991). Technology is Society made Durable. In J. Law (Ed.), *A Sociology of Monsters: Essays on Power, Technology and Domination, Sociological Review Monograph N°38* (pp. 103-132).

Latour, B. (1993). *We have never been modern*. Hemel Hempstead: Harvester Wheatsheaf.

Latour, B. (1999). *Pandora's hope: essays on the reality of science studies*. Cambridge, Massachusetts: Harvard University Press.

Latour, B. (2000). When things strike back: a possible contribution of 'science studies' to the social sciences. *The British Journal of Sociology, 51*(1), 107-123. doi:10.1111/j.1468-4446.2000.00107.x

Latour, B. (2005). *Reassembling the Social: An Introduction to Actor-Network Theory*. Oxford: Oxford University Press.

Latour, B. (2011). *Waiting for Gaia. Composing the common world through arts and politics**. Paper presented at the A lecture at the French Institute, London, November 2011 for the launching of SPEAP (the Sciences Po program in arts & politics) London.

Latour, B. (2014). Agency at the time of the Anthropocene. *New Literary History, 45*, 1-18.

Latour, B. (2018). *Down to Earth: Politics in the New Climatic Regime*. Oxford, UK: Polity Press.

Lau, W. W. Y. (2013). Beyond carbon: Conceptualizing payments for ecosystem services in blue forests on carbon and other marine and coastal ecosystem services. *Ocean & Coastal Management, 83*, 5-14. doi:http://dx.doi.org/10.1016/j.ocecoaman.2012.03.011

Lausche, B. (2011). *Guidelines for Protected Areas Legislation*. Gland, Switzerland: IUCN.

Lave, R., Mirowski, P., & Randalls, S. (2010). Introduction: STS and Neoliberal Science. *Social Studies of Science, 40*(5), 659-675. doi:10.1177/0306312710378549

Law, J. (2004). *After Method: Mess in Social Science Research*. London and New York: Routledge.

Law, J. (2009). Actor Network Theory and Material Semiotics. In B. S. Turner (Ed.), *The New Blackwell Companion to Social Theory*. Oxford, UK: Wiley-Blackwel.

Law, J., & Singleton, V. (2013). ANT and Politics: Working in and on the World. *Qualitative Sociology*, 36(4), 485-502. doi:10.1007/s11133-013-9263-7

Law, J., & Urry, J. (2005). Enacting the Social. *Economy and Society, 33*(3), 390-410.

Levin, K., Cashore, B., Bernstein, S., & Auld, G. (2012). Overcoming the tragedy of super wicked problems: constraining our future selves to ameliorate global climate change. *Policy Sciences, 45*(2), 123-152. doi:10.1007/s11077-012-9151-0

Lidskog, R., & Sundqvist, G. (2002). The Role of Science in Environmental Regimes: The Case of LRTAP. *European Journal of International Relations, 8*(1), 77-101. doi:10.1177/1354066102008001003

Lidskog, R., & Sundqvist, G. (2011). Transboundary Air Pollution Policy in Transition. In R. Lidskog & G. Sundqvist (Eds.), *Governing the Air: The Dynamics of Science, Policy, and Citizen Interaction* (pp. 1-35). Cambridge, Massachusetts: MIT Press.

Lidskog, R., & Sundqvist, G. (2015). When Does Science Matter? International Relations Meets Science and Technology Studies. *Global Environmental Politics, 15*(1), 1-20.

Livingston, J. E., Lövbrand, E., & Alkan Olsson, J. (2018). From climates multiple to climate singular: Maintaining policy-relevance in the IPCC synthesis report. *Environmental Science & Policy, 90*, 83-90. doi:https://doi.org/10.1016/j.envsci.2018.10.003

Locatelli, T., Binet, T., Kairo, J., King, L., Madden, S., Patenaude, G., . . . Huxham, M. (2014). Turning the Tide: How Blue Carbon and Payments for Ecosystem Services (PES) Might Help Save Mangrove Forests. *AMBIO, 43*(8), 981-995. doi:10.1007/s13280-014-0530-y

Lövbrand, E. (2009). Revisiting the politics of expertise in light of the Kyoto negotiations on land use change and forestry. *Forest Policy and Economics, 11*(5), 404-412. doi:10.1016/j.forpol.2008.08.007

Lövbrand, E., & Bäckstrand, K. (2015). *Research Handbook on Climate Governance*. Cheltenham, UK & Northampton, USA: Edward Elgar Publishing.

Lövbrand, E., & Stripple, J. (2006). The Climate as Political Space: On the Territorialisation of the Global Carbon Cycle. *Review of International Studies, 32*(2), 217. doi:10.1017/S0260210506006991

Lövbrand, E., & Stripple, J. (2011). Making climate change governable: accounting for carbon as sinks, credits and personal budgets. *Critical Policy Studies, 5*(2), 187-200. doi:10.1080/19460171.2011.576531

Lövbrand, E., Stripple, J., & Wiman, B. (2009). Earth System governmentality: Reflections on science in the Anthropocene. *Global Environmental Change, 19*(1), 7-13. doi:http://dx.doi.org/10.1016/j.gloenvcha.2008.10.002

Lovell, H., & MacKenzie, D. (2011). Accounting for Carbon: The Role of Accounting Professional Organisations in Governing Climate Change. *Antipode, 43*(3), 704-730. doi:10.1111/j.1467-8330.2011.00883.x

Lovelock, C. E., & McAllister, R. R. J. (2013). 'Blue carbon' projects for the collective good. *Carbon Management, 4*(5), 477-479. doi:10.4155/cmt.13.50

Lovelock, C. E., Atwood, T., Baldock, J., Duarte, C. M., Hickey, S., Lavery, P. S., . . . Steven, A. (2017). Assessing the risk of carbon dioxide emissions from blue carbon ecosystems. *Frontiers in Ecology and the Environment, 15*(5), 257-265. doi:10.1002/fee.1491

Luisetti, T., Jackson, E. L., & Turner, R. K. (2013). Valuing the European 'coastal blue carbon' storage benefit. *Marine Pollution Bulletin, 71*(1-2), 101-106. doi:10.1016/j.marpolbul.2013.03.029

Lunstrum, A., & Chen, L. (2014). Soil carbon stocks and accumulation in young mangrove forests. *Soil Biology & Biochemistry, 75*, 223-232. doi:10.1016/j.soilbio.2014.04.008

Macreadie, P. I., E.Baird, M., M.Trevathan-Tackett, S., D.Larkum, A. W., & J.Ralph, P. (2014). Quantifying and modelling the carbon sequestration capacity of seagrass meadows - A critical assessment. *Marine Pollution Bulletin, 83*(2), 430-439. doi:10.1016/j.marpolbul.2013.07.038

Macreadie, P. I., Ewers-Lewis, C. J., Whitt, A. A., Ollivier, Q., Trevathan-Tackett, S. M., Carnell, P., & Serrano, O. (2018). Comment on 'Geoengineering with seagrasses: is credit due where credit is given?'. *Environmental Research Letters, 13*(2), 028002.

Makowski, C., & Finkl, C. W. (Eds.). (2018). *Threats to Mangrove Forests: Hazards, Vulnerability, and Management*. Cham: Springer.

McGrath, F. L., Erbaugh, J. T., Leimona, B., Amaruzaman, S., Rahadian, N. P., & Carrasco, L. R. (2018). Green without envy: how social capital alleviates tensions from a Payments for Ecosystem Services (PES) program in Indonesia. In (Vol. 23).

Mcowen, C. J., Weatherdon, L. V., Bochove, J.-W. V., Sullivan, E., Blyth, S., Zockler, C., . . . Fletcher, S. (2017). A global map of saltmarshes. *Biodiversity Data Journal, 5*. doi:10.3897/BDJ.5.e11764

MEA [Millennium Ecosystem Assessment]. (2005). *Ecosystems and Human Well-being: Synthesis.* Retrieved from Washington, DC: http://www.millenniumassessment.org/en/index.html

Meadows, D. H., Meadows, D. L., Randers, J., & Behrens III, W. W. (1972). *The Limits to growth; a report for the Club of Rome's project on the predicament of mankind*: New York : Universe Books, [1972].

Merton, R. K. (1945). Role of the Intellectual in Public Bureaucracy. *Social Forces, 23*(4), 405-415. doi:10.2307/2571834

Mol, A. (1999). Ontological politics. A word and some questions. *The Sociological Review, 47*(S1), 74-89. doi:10.1111/j.1467-954X.1999.tb03483.x

Mol, A. (2002). *The Body Multiple: Ontology in Medical Practice*. Durham and London: Duke University Press.

Montana, J. (2017). Accommodating consensus and diversity in environmental knowledge production: Achieving closure through typologies in IPBES. *Environmental Science & Policy, 68*, 20-27. doi:https://doi.org/10.1016/j.envsci.2016.11.011

Morgan, T. (2018). The techno-finance fix: A critical analysis of international and regional environmental policy documents and their implications for planning. *Progress in Planning, 119*, 1-29.

Müller, M. (2015). Assemblages and Actor-networks: Rethinking Socio-material Power, Politics and Space. *Geography Compass, 9*(1), 27-41. doi:10.1111/gec3.12192

Murray, T. A. (2012). Technocratic Structures of Climate Policy: Dead-end Debates, Neat Narratives and Manipulative Machiavellianism. *Journal of Public Administration and Governance, 2*(4), 119-127.

Needelman, B. A., Emmer, I. M., Emmett-Mattox, S., Crooks, S., Megonigal, J. P., Myers, D., . . . McGlathery, K. (2018). The Science and Policy of the Verified Carbon Standard Methodology for Tidal Wetland and Seagrass Restoration. *Estuaries and Coasts, 41*(8), 2159-2171. doi:10.1007/s12237-018-0429-0

Nellemann, C., Corcoran, E., Duarte, C. M., Valdés, L., De Young, C., Fonseca, L., & Grimsditch, G. (2009). *Blue Carbon. A Rapid Response Assessment*. United Nations Environment Programme; GRID-Arendal ISBN: 978-82-7701-060-1

Nikoleris, A., Stripple, J., & Tenngart, P. (2017). Narrating climate futures: shared socioeconomic pathways and literary fiction. *Climatic Change, 143*(3-4) pp. 307-319.

NOAA. (2016). What is a marine protected area? Marine protected areas conserve, manage, and protect. NOAA: <http://oceanservice.noaa.gov/facts/mpa.html>, accessed 2016-10-19.

Nobrega, G. N., Ferreira, T. O., Artur, A. G., de Mendona, E. S., Leao, R. A. d. O., Teixeira, A. S., & Otero, X. L. (2015). Evaluation of methods for quantifying organic carbon in mangrove soils from semi-arid region. *Journal of Soils and Sediments, 15*(2), 282-291. doi:10.1007/s11368-014-1019-9

Nogués-Bravo, D., Simberloff, D., Rahbek, C., & Sanders, N. J. (2016). Rewilding is the new Pandora's box in conservation. *Current Biology, 26*(3), R87-R91. doi:https://doi.org/10.1016/j.cub.2015.12.044

Northey, M., Tepperman, L., & Albanese, P. (2015). *Making Sense: Social Sciences* (6th ed.). Don Mills, Ontario, Canada: Oxford University Press.

Nursey-Bray, M. J., Vince, J., Scott, M., Haward, M., O'Toole, K., Smith, T., . . . Clarke, B. (2014). Science into policy? Discourse, coastal management and knowledge. *Environmental Science & Policy, 38*, 107-119. doi:http://dx.doi.org/10.1016/j.envsci.2013.10.010

Obama, B. (2015). Remarks by the President in State of the Union Address | January 20, 2015 [Press release]. <https://obamawhitehouse.archives.gov/the-press-office/2015/01/20/remarks-president-state-union-address-january-20-2015>

Oppenheimer, M. (2005). Defining Dangerous Anthropogenic Interference: The Role of Science, the Limits of Science. *Risk Analysis: An International Journal, 25*(6), 1399-1407. doi:10.1111/j.1539-6924.2005.00687.x

Oreska, M. P. J., McGlathery, K. J., Emmer, I. M., Needelman, B. A., Emmett-Mattox, S., Crooks, S., . . . Myers, D. (2018). Comment on Geoengineering with seagrasses: is credit due where credit is given? *Environmental Research Letters, 13*(3), 038001.

Ormond, J., & Goodman, M. K. (2015). A new regime of carbon counting: The practices and politics of accounting for everyday carbon through CO2e. *Global Environmental Change, 34*, 119-131. doi:https://doi.org/10.1016/j.gloenvcha.2015.04.011

Palavalli-Nettimi, R. (2018). In an ant's world, the smaller you are the harder it is to see obstacles. *The Conversation, 17 April 2018*. <doi:https://theconversation.com/in-an-ants-world-the-smaller-you-are-the-harder-it-is-to-see-obstacles-92837>

Parkhurst, J. (2017). *The Politics of Evidence - From evidence-based policy to the good governance of evidence*. Abingdon, Oxon, UK: Routledge.

Paterson, M. (2011). Selling Carbon: From International Climate Regime to Global Carbon Market. In J. S. Dryzek, R. B. Norgaard, & D. Schlosberg (Eds.), *The Oxford Handbook of Climate Change and Society* (pp. 611-624). Oxford; New York: Oxford University Press.

Pearce, W., Mahony, M., & Raman, S. (2018). Science advice for global challenges: Learning from trade-offs in the IPCC. *Environmental Science and Policy, 80*, 125-131. doi:10.1016/j.envsci.2017.11.017

Pendleton, L., Donato, D. C., Murray, B. C., Crooks, S., Jenkins, W. A., Sifleet, S., . . . Baldera, A. (2012). Estimating Global "Blue Carbon" Emissions from Conversion and Degradation of Vegetated Coastal Ecosystems. *PLoS ONE, 7*(9). doi:10.1371/journal.pone.0043542

Pereira, L. (2010). Becoming coca: A materiality approach to a commodity chain analysis of hoja de coca in Colombia. *Singapore Journal of Tropical Geography, 31*(3), 384-400. doi:10.1111/j.1467-9493.2010.00412.x

Peskett, L., & Todd, K. (2013). *Putting REDD+ Safeguards and Safeguard Information Systems Into Practice*. Retrieved from Geneva: UN-REDD, available at: <https://theredddesk.org/resources/putting-redd-safeguards-and-safeguard-information-systems-practice>

Petersen, A. (2011). Climate Simulation, Uncertainty, and Policy Advice – The Case of the IPCC. In G. Gramelsberger & J. Feichter (Eds.), *Climate Change and Policy* (pp. 91-111): Springer Berlin Heidelberg.

Pidgeon, E. (2018). Global Landscapes Forum: Blue Carbon Summit. Sub-plenary International Partnerships. Panel discussion18 July 2018, Jakarta. Webcast accessible at: <https://events.globallandscapesforum.org/blue-carbon-summit/agenda/day-2-wednesday-18-july-2018/subplenary-international-partnerships/>

Pielke, Jr, R. A. (2004). When scientists politicize science: making sense of controversy over The Skeptical Environmentalist. *Environmental Science & Policy, 7*(5), 405-417. doi:http://dx.doi.org/10.1016/j.envsci.2004.06.004

Pielke, Jr, R. A. (2012). Basic Research as a Political Symbol. *Minerva, 50*(3), 339-361. doi:10.1007/s11024-012-9207-5

Pielke, Jr, R. A. (2018). Opening Up the Climate Policy Envelope. *Issues in Science and Technology, 34*(4).

Plesner, U. (2011). Studying Sideways: Displacing the Problem of Power in Research Interviews with Sociologists and Journalists. *Qualitative Inquiry*, 17(July), 471-482.

Plumwood, V. (2009). Nature in the Active Voice. *Australian Humanities Review, Ecological Humanities, 46*(May 2009).

Polidoro, B. A., Carpenter, K. E., Collins, L., Duke, N. C., Ellison, A. M., Ellison, J. C., . . . Yong, J. W. H. (2010). The Loss of Species: Mangrove Extinction Risk and Geographic Areas of Global Concern. *PLoS ONE, 5*(4), e10095. doi:10.1371/journal.pone.0010095

Porras, I., Barton, D. N., Miranda, M., & Chacón-Cascante, A. (2013). *Learning from 20 years of Payments for Ecosystem Services in Costa Rica* London: International Institute for Environment and Development.

Pregernig, M. (2014). Framings of science-policy interactions and their discursive and institutional effects: examples from conservation and environmental policy. *Biodiversity and Conservation, 23*(14), 3615-3639. doi:10.1007/s10531-014-0806-3

Price, D. (1981). The spectrum from truth to power. In T. Kuehn & A. Porter (Eds.), *Science, technology, and national policy*. Ithaca: Cornell University Press.

Randalls, S. (2011). Broadening debates on climate change ethics: beyond carbon calculation. *The Geographical Journal, 177*(2), 127-137.

Reef, R., & Lovelock, C. E. (2014). Historical analysis of mangrove leaf traits throughout the 19th and 20th centuries reveals differential responses to increases in atmospheric CO2. *Global Ecology and Biogeography, 23*(11), 1209-1214. doi:10.1111/geb.12211

Revelle, R., & Suess, H. E. (1957). Carbon Dioxide Exchange Between Atmosphere and Ocean and the Question of an Increase of Atmospheric CO2 during the Past Decades. *Tellus, 9*(1), 18-27. doi:10.1111/j.2153-3490.1957.tb01849.x

Revkin, A. C. (2015, December 7). Behind the Brackets as Paris Negotiators Shape a Climate Change Deal, Opinion Pages. *Dot Earth: New York Times Blog*. <https://dotearth.blogs.nytimes.com/2015/12/07/behind-the-brackets-as-paris-negotiators-shape-a-climate-change-deal/>

Rich, R. F. (1991). Knowledge Creation, Diffusion, and Utilization: Perspectives of the Founding Editor of Knowledge. *Science Communication, 12*(3), 319-337. doi:10.1177/107554709101200308

Richards, D. (1996). *Elite Interviewing: Approaches and Pitfalls*. Politics, 16(3), 199-204.

Robertson, M. (2012). Measurement and alienation: making a world of ecosystem services. *Transactions of the Institute of British Geographers, 37*(3), 386-401. doi:10.1111/j.1475-5661.2011.00476.x

Robertson, M. M. (2000). No Net Loss: Wetland Restoration and the Incomplete Capitalization of Nature. *Antipode, 32*(4), 463-493. doi:10.1111/1467-8330.00146

Robertson, M. M. (2006). The Nature That Capital Can See: Science, State, and Market in the Commodification of Ecosystem Services. *Environment and Planning D: Society and Space, 24*(3), 367-387. doi:10.1068/d3304

Robin, L. (2018). Environmental humanities and climate change: understanding humans geologically and other life forms ethically. *Wiley Interdisciplinary Reviews: Climate Change, 9*(1), e499. doi:10.1002/wcc.499

Roosevelt, F. D. (1944). President Roosevelt's Letter. In V. Bush (Ed.), *Science The Endless Frontier* (1945). Washington: United States Government Printing Office.

Rouse, J. (2005). Power/Knowledge. In G. Gutting (Ed.), *The Cambridge Companion to Foucault* (2 ed., pp. 95-122). New York, USA: Cambridge University Press.

Rudy, A. P. (2005). On ANT and Relational Materialisms. *Capitalism Nature Socialism, 16*(4), 109-125. doi:10.1080/10455750500376065

Rummukainen, M. (2010). State-of-the-art with regional climate models. *Wiley Interdisciplinary Reviews: Climate Change, 1*(1), 82-96. doi:10.1002/wcc.8

Rummukainen, M. (2016). Added value in regional climate modeling. *Wiley Interdisciplinary Reviews: Climate Change, 7*(1), 145-159. doi:10.1002/wcc.378

Russi, D., ten Brink, P., Farmer, A., Badura, T., Coates, D., Förster, J., . . . Davidson, N. (2013). *The Economics of Ecosystems and Biodiversity for Water and Wetlands*. London and Brussels: IEEP; Gland: Ramsar Secretariat

Scarano, F. R. (2017). Ecosystem-based adaptation to climate change: concept, scalability and a role for conservation science. Perspectives in Ecology and Conservation, 15(2), 65-73. doi:https://doi.org/10.1016/j.pecon.2017.05.003

Scarano, F. R. Ecosystem-based adaptation to climate change: concept, scalability and a role for conservation science. *Perspectives in Ecology and Conservation*. doi:https://doi.org/10.1016/j.pecon.2017.05.003

Scarano, F. R. Ecosystem-based adaptation to climate change: concept, scalability and a role for conservation science. Perspectives in Ecology and Conservation. doi:https://doi.org/10.1016/j.pecon.2017.05.003

Scheba, A., & Scheba, S. (2017). REDD+ as 'inclusive' neoliberal conservation: the case of Lindi, Tanzania. *Journal of Eastern African Studies, 11*(3), 526-548. doi:10.1080/17531055.2017.1357102

Schroter, B., Matzdorf, B., Hackenberg, I., & Hauck, J. (2018). More than just linking the nodes: civil society actors as intermediaries in the design and implementation of payments for ecosystem services-the case of a blue carbon project in Costa Rica. *Local Environment, 23*(6), 635-651. doi:10.1080/13549839.2018.1460808

Sharma, S., Nadaoka, K., Nakaoka, M., Uy, W. H., MacKenzie, R. A., Friess, D. A., & Fortes, M. D. (2017). Growth performance and structure of a mangrove afforestation project on a former seagrass bed, Mindanao Island, Philippines. *Hydrobiologia, 803*(1), 359-371. doi:10.1007/s10750-017-3252-x

Short, F., Carruthers, T., Dennison, W., & Waycott, M. (2007). Global seagrass distribution and diversity: A bioregional model. *Journal of Experimental Marine Biology and Ecology, 350*(1), 3-20. doi:https://doi.org/10.1016/j.jembe.2007.06.012

Sierra-Correa, P. C., & Kintz, J. R. C. (2015). Ecosystem-based adaptation for improving coastal planning for sea-level rise: A systematic review for mangrove coasts. *Marine Policy, 51*, 385-393. doi:10.1016/j.marpol.2014.09.013

Siikamäki, J., Sanchirico, J. N., Jardine, S., McLaughlin, D., & Morris, D. (2013). Blue Carbon Coastal Ecosystems, Their Carbon Storage, and Potential for Reducing Emissions. *Environment, 55*(6), 14-29. doi:10.1080/00139157.2013.843981

Siikamäki, J., Sanchirico, J. N., & Jardine, S. L. (2012). Global economic potential for reducing carbon dioxide emissions from mangrove loss. *Proceedings of the National Academy of Sciences*, 109(36), 14369-14374. doi:10.1073/pnas.1200519109

Smetacek, V., & Zingone, A. (2013). Green and golden seaweed tides on the rise. *Nature, 504* (Perspectives 5 December), 84-88.

Sondak, C. F. A., & Chung, I. K. (2015). Potential blue carbon from coastal ecosystems in the Republic of Korea. *Ocean Science Journal, 50*(1), 1-8. doi:10.1007/s12601-015-0001-9

Spalding, M. D., Taylor, M. L., Ravilious, C., Short, F. T., & Green, E. P. (2003). Global overview: the distribution and status of seagrasses. In E. P. Green & F. T. Short (Eds.), *World Atlas of Seagrasses* (pp. 13-34). Berkeley, California: University of California Press.

Spalding, M., Kainuma, M., & Collins, L. (2010). *World Atlas of Mangroves*. London, UK: Earthscan.

Spruijt, P., Knol, A. B., Vasileiadou, E., Devilee, J., Lebret, E., & Petersen, A. C. (2014). Roles of scientists as policy advisers on complex issues: A literature review. *Environmental Science & Policy, 40*, 16-25. doi:http://dx.doi.org/10.1016/j.envsci.2014.03.002

Stainforth, D. A., Aina, T., Christensen, C., Collins, M., N. Faull, Framel, D. J., . . . Allen, M. R. (2005). Uncertainty in predictions of the climate response to rising levels of greenhouse gases. *Nature, 433*, 403–406.

Stern, N. (2007). *The Economics of Climate Change: The Stern Review*. Cambridge: Cambridge University Press.

Stone, D. (2002). Using Knowledge: the dilemmas of 'Bridging Research and Policy'. *Compare: A Journal of Comparative Education, 32*(3), 285-296. doi:10.1080/0305792022000007454

Sundqvist, G., Gasper, D., St.Clair, A. L., Hermansen, E. A. T., Yearley, S., Øvstebø Tvedten, I., & Wynne, B. (2018). One world or two? Science–policy interactions in the climate field. *Critical Policy Studies, 12*(4), 448-468. doi:10.1080/19460171.2017.1374193

Sutton-Grier, A. E., & Moore, A. (2016). Leveraging Carbon Services of Coastal Ecosystems for Habitat Protection and Restoration. *Coastal Management, 44*(3), 259-277. doi:10.1080/08920753.2016.1160206

Temmerman;, S., Meire;, P., Bouma;, T. J., Herman;, P. M. J., Ysebaert;, T., & Vriend;, H. J. D. (2013). Ecosystem-based coastal defence in the face of global change. *Nature;, 504*(5 December).

Thomas, S. (2014). Blue carbon: Knowledge gaps, critical issues, and novel approaches. *Ecological Economics,* 107, 22-38. doi:10.1016/j.ecolecon.2014.07.028

Thompson, B. S., Clubbe, C. P., Primavera, J. H., Curnick, D., & Koldewey, H. J. (2014). Locally assessing the economic viability of blue carbon: a case study from Panay Island, the Philippines. *Ecosystem Services, 8*, 128-140.

Thompson, B. S., Primavera, J. H., & Friess, D. A. (2017). Governance and implementation challenges for mangrove forest Payments for Ecosystem Services (PES): Empirical evidence from the Philippines. *Ecosystem Services, 23*, 146-155. doi:10.1016/j.ecoser.2016.12.007

Thompson, E. L., & Smith, L. A. (2019). Escape from model-land. *Economics, Discussion Papers*(2019-23). doi:http://www.economics-ejournal.org/economics/discussionpapers/2019-23

Timmermans, S., & Epstein, S. (2010). A World of Standards but not a Standard World: Toward a Sociology of Standards and Standardization*. *Annual Review of Sociology, 36*, 69-89.

Tulloch, L., & Neilson, D. (2014). The Neoliberalisation of Sustainability. *Citizenship, Social and Economics Education, 13*(1), 26-38. doi:10.2304/csee.2014.13.1.26

Turnhout, E., Gupta, A., Weatherley-Singh, J., Vijge, M. J., de Koning, J., Visseren-Hamakers, I. J., . . . Lederer, M. (2017). *Envisioning REDD+ in a post-Paris era: between evolving expectations and current practice.* Wiley Interdisciplinary Reviews: Climate Change, 8(1), e425. doi:doi:10.1002/wcc.425

Ullman, R., Bilbao-Bastida, V., & Grimsditch, G. (2013). Including Blue Carbon in climate market mechanisms. *Ocean & Coastal Management, 83*(Oct), 15-18.

Umwelt Bundesamt. (2019, updated 2019-04-24). Indicator: Greenhouse gas emissions. <https://www.umweltbundesamt.de/en/indicator-greenhouse-gas-emissions#textpart-1>, accessed 201-09-07.

UNEP (2018). *The Adaptation Gap Report 2018*. Nairobi: United Nations Environment Programme (UNEP).

UN General Assembly. (1982). Convention on the Law of the Sea, 10 December 1982. Available at <http://www.refworld.org/docid/3dd8fd1b4.html>

UN General Assembly. (1988). *A/RES/43/53 Protection of global climate for present and future generations of mankind. 70th plenary meeting. 6 December 1988*. Retrieved from <https://www.un.org/documents/ga/res/43/a43r053.htm>

UNFCCC Secretariat. (2018a). About the Secretariat. <https://unfccc.int/about-us/what-is-the-unfccc-secretariat>, accessed 2018-11-01

UNFCCC Secretariat. (2018b). Statistics on Participation and in-session engagement. <https://unfccc.int/process-and-meetings/parties-non-party-stakeholders/non-party-stakeholders/statistics-on-non-party-stakeholders/statistics-on-participation-and-in-session-engagement>, accessed 2018-11-01

UNFCCC Secretariat. (2018c). Statistics on Side Events and Exhibits. <https://unfccc.int/process-and-meetings/parties-non-party-stakeholders/non-party-stakeholders/statistics-on-non-party-stakeholders/statistics-on-side-events-and-exhibits>, accessed 2018-11-01.

UNFCCC. (1995). *Report of the Conference of the Parties on its First Session, held at Berlin from 28 March to 7 April 1995. FCCC/CP/1995/7/Add.1*. Geneva: United Nations.

UNFCCC. (2011). *Report of the Subsidiary Body for Scientific and Technological Advice on its thirty-fifth session, held in Durban from 28 November to 3 December 2011.* FCCC/SBSTA/2011/5. Geneva: United Nations.

UNFCCC. (2012, updated 2019). Research Dialogue 4, SBSTA 36. <unfccc.int/6896>, accessed 2019-09-02.

UNFCCC. (2013, updated 2019). UNFCCC Workshop on technical and scientific aspects of ecosystems with high-carbon reservoirs not covered by other agenda items under the Convention. <unfccc.int/7797>, accessed 2019-09-02.

UNFCCC. (2014). *Report on the workshop on technical and scientific aspects of ecosystems with high-carbon reservoirs not covered by other agenda items under the Convention: Note by the Secretariat*. FCCC/SBSTA/2014/INF.1. Geneva: United Nations.

UNFCCC. (2015). *Report on the structured expert dialogue on the 2013–2015 review.* FCCC/SB/2015/INF.1. Geneva: United Nations.

UNFCCC (2017, updated 2019) The Kyoto Protocol – Statues of Ratification. <https://unfccc.int/process/the-kyoto-protocol/status-of-ratification> Accessed 2019-09-06.

UNFCCC (2018) The Periodic Review. <https://unfccc.int/topics/science/workstreams/periodic-review> Accessed 2018-10-30.

UNFCCC. (2019a). Mechanisms under the Kyoto Protocol. <https://unfccc.int/process/the-kyoto-protocol/mechanisms>, accessed 2019-07-23.

UNFCCC. (2019b). What are Market and Non-Market Mechanisms? <https://unfccc.int/topics/market-and-non-market-mechanisms/the-big-picture/what-are-market-and-non-market-mechanisms>, accessed 2019-07-24.

UNFCCC. (2019c). International Emissions Trading <https://unfccc.int/international-emissions-trading>, accessed 2019-09-06.

United Nations. (1992). *United Nations Framework Convention on Climate Change* Retrieved from UNFCCC: Text of the Convention <http://unfccc.int/key_documents/the_convention/items/2853.php>

United Nations. (2015). *Paris Agreement*. Retrieved from UNFCCC: <http://unfccc.int/paris_agreement/items/9485.php>

van Asselt, H., & Zelli, F. (2018). International Governance. In A. Jordan, D. Huitema, H. van Asselt, & J. Forster (Eds.), *Governing Climate Change: Polycentricity in Action?* (pp. 29-46). Cambridge: Cambridge University Press.

van der Hel, S., & Biermann, F. (2017). The authority of science in sustainability governance: A structured comparison of six science institutions engaged with the Sustainable Development Goals. *Environmental Science & Policy*. doi:http://dx.doi.org/10.1016/j.envsci.2017.03.008

Vanderheiden, S. (2008). *Atmospheric justice : a political theory of climate change / Steve Vanderheiden*. Oxford ; New York: Oxford University Press.

VCS. (2014). *VM0024 Methodology for Coastal Wetland Creation, Version 1.0, 30 Januray 2014, Sectoral Scope 14* Methodology developed by: Louisiana Coastal Protection and Restoration Authority (CPRA) for VCS <http://www.v-c-s.org/methodologies/find>

VCS. (2015). *VM0033: Methodology for Tidal Wetland and Seagrass Restoration. Version 1.0 20 November 2015 Sectoral Scope 14*. Methodology developed by Restore America's Estuaries and Silverstrum for VCS <http://www.v-c-s.org/methodologies/find>

Vierros, M. (2013). Communities and blue carbon: the role of traditional management systems in providing benefits for carbon storage, biodiversity conservation and livelihoods. *Climatic Change*, 1-12.

Wehrens, R. (2014). Beyond two communities – from research utilization and knowledge translation to co-production? *Public Health, 128*(6), 545-551. doi:http://dx.doi.org/10.1016/j.puhe.2014.02.004

Whatmore, S. (2002). *Hybrid Geographies: Nature Culture Spaces*. London; Thousand Oaks; New Delhi: SAGE Publications.

Whatmore, S. (2006). Materialist returns: practising cultural geography in and for a more-than-human world. *cultural geographies, 13*(4), 600-609. doi:10.1191/1474474006cgj377oa

WMO, ICSU & WMO (1986). *Report of the International conference of the Assessment of the role of carbon dioxide and of other greenhouse gases in climate variations and associated impacts* (9-15 October 1985; Villach, Austria). WMO Report No. 661.

Yusoff, K., & Gabrys, J. (2011). Climate change and the imagination. *Wiley Interdisciplinary Reviews: Climate Change, 2*(4), 516-534. doi:10.1002/wcc.117

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