Master's thesis

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Multiple Measurement of International Regime Effectiveness

Comparative Study of the International Ozone Depletion Regime and Climate Change Regime

Master of Science in Globalization: Global Politics and Culture
Trondheim, Spring 2011

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Abstract

The study of international environmental regime effectiveness is contextualized in globalization. In this classificatory and comparative study, the cases of the ozone depletion regime and climate change regime are evaluated for their level of effectiveness. Regime effectiveness is conceptualized in a three-fold indicator operationalization of "output," "outcome," and "impact." This multiple-measurement approach to regime effectiveness facilitates a robustness check of the levels of effectiveness of the ozone depletion regime and the climate change regime. The study employs an analytical framework based on the standards of collective optimum and goal attainment. The classification of regime effectiveness through this framework provides nuanced findings for each regime depending on which operationalization of effectiveness is applied. The comparison between the regimes finds that they are similar in terms of the outcome indicator, but vary significantly on the output and impact indicators, with the ozone regime scoring a high level of effectiveness and the climate regime ranking a low level of effectiveness. The findings emphasize areas of institutional design and scientific overlap between the regimes that could be used as a platform for a future explanatory study.

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From the: Snow Water Ice and Permafrost in the Arctic 2011 Executive Summary
Arctic Monitoring and Assessment Program (AMAP) Secretariat.

Acknowledgements

This thesis is the culmination of my academic adventure in Trondheim in the Master of Science in Globalization: Global Politics and Culture program. I would like to first and foremost thank Gunnar Fermann (Norwegian University of Science and Technology) for his fantastic skills as a guide on this journey. With thoughtful advice, patience, and understanding, Gunnar helped mold an initial curiosity and enthusiasm for the topic of international environmental policy into a structured piece of research. I have grown from the experience of working on this thesis with an advisor and it has certainly been the highlight of my degree. That being said, regardless of how good the guide may be, one can only summit a mountain on one's own legs. Thus, any weaknesses in the thesis – factual or interpretive – are my sole responsibility.

I would also like to acknowledge and thank my classmates from around the world in the Globalization program at NTNU. We have shared academic and cross-cultural experiences that are of unique value. These experiences may not be present in this thesis, but they are worth as much as the degree itself. In addition, recognition must be given to bluegrass music, Estenstadmarka, skiing, snow, sun, and importantly to the remarkable support of my friends (a special thanks to Line, Ragnhild, and Jo-Kristian for academic and personal support!) and "family" from Røros. I would not have done this without all of you.

Finally, I express my utmost gratitude to my family in Alaska for believing in me and supporting me throughout this process. A special thank you to my mom for final editing! And to Øistein, who inspired this journey to Trondheim, and for whom it was totally worth it.

This thesis is dedicated to the continued climbing of both metaphorical and physical summits.

Anna Theodora Barnwell

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List of Abbreviations and Acronyms

CO_2: Carbon dioxide

CDM: Clean Development Mechanism (Climate Regime)

CFC: Chlorofluorocarbons

COP: Conference of the Parties

CMP: Conference of the Meeting of the Parties

ETS: Emissions Trading System (Climate Regime)

FAR: IPCC Fourth Assessment Report 2007

GEF: Global Environmental Fund

GHG: Greenhouse Gas

GWP: Global Warming Potential

HCFC: Hydrochlorofluorocarbons

HFC: Hydro Fluoro Carbons

IPCC: Intergovernmental Panel on Climate Change

JI: Joint Implementation (Climate Regime)

LULUCF: Land Use and Land Use Change and Forestry

MeBr: Methyl Bromide

MLF: Multilateral Fund (Ozone Regime)

MRV: Monitoring, Reporting, Verification

ODP: Ozone Depletion Potential

ODS: Ozone Depleting Substance

SAP: Scientific Assessment Panel of Ozone Trends Panel

UNDP: United Nations Development Program

UNEP: United Nations Environmental Program

UNFCCC: United Nations Framework Convention on Climate Change

WMO: World Meteorological Organization

1. Introduction

1.1. Global Environmental Politics – A Crux of Globalization

Climate change and depletion of the ozone layer present humanity with evidence of globalization in both the nature of the problems and the political solutions needed to solve them. Climate change and ozone layer depletion are trans-boundary in that what is deposited into the atmosphere, regardless of its source, immediately becomes a part of the global commons. Thus, the scientific underpinnings of these two global problems highlight that ecological systems are inherently interconnected. Since the 1970s, humankind has begun to fully comprehend the level of global interconnection present on the planet, exemplified by the current era termed *globalization*. During this time, economic, social, and political aspects of human life have expanded and extended in an increasingly trans-boundary manner. This explosive growth in globalization has instigated activities that adversely affect the environment, particularly problems like climate change and ozone depletion. However, as the natural environment has changed, states and other actors have developed multilateral political mechanisms to address these global issues, such as international environmental regimes. Environmental problems such as climate change and the depletion of the ozone layer are collective problems that require cooperation on an unprecedented international scale. International environmental regimes coordinate solutions to these problems. In this thesis, the point of entry to the study of globalization is in the field of international environmental regimes, where economic, political, and environmental aspects of globalization intersect.

The study of international environmental regimes, the overarching field within which this thesis is placed, is contextualized in globalization. The problems these regimes strive to resolve are inextricably tied to increasingly long-range human economic activity of globalization and because the regime themselves operate on a global scale. The study of international regime *effectiveness* explores the quality and conditions of the institutions instrumental in managing collective action problems at the global level. Political science and economics offer the theoretical foundations for this field, because although globalization has called into question the relevance of boundaries and states, international regimes remain based on state centric politics.

Exploring international environmental regime effectiveness is central to scholars studying global environmental politics. The rise of environmental issues to the forefront of policy agenda setting in the 1970s gathered steam as international environmental agreements continued to grow throughout the 1980s (Zürn, 1998); there are currently more than two hundred major regimes in the field of international environmental protection alone (Gehring & Oberthür, 2004) . Global climate change and ozone layer depletion have remained politically pertinent as foci for the study of international politics since their introduction into the field since the mid-1980s (Zürn, 1998). The study of regime effectiveness has contributed to the field of international environmental politics by validating that institutions have the potential to be effective in the management of environmental problems. Numerous studies and research projects of the past decade have shown that international environmental regimes have the capacity to achieve positive improvements (Haas, Keohane, & Levy, 1993); (Miles et al., 2002); (Breitmeier, Young, & Zurn, 2006); the question is only a matter of *to what extent* the regime is effective, and what factors and mechanisms *condition* the extent of regime effectiveness. In the following section, this will be expanded upon.

1.2. Research Question and Justification of Research Interest

This thesis evaluates and compares the effectiveness of the ozone depletion and climate change international regimes. This study's research objective encompasses evaluation of politically and scientifically highly complex phenomena, yet despite complexity the research question is essentially straightforward:

How effective are the international ozone depletion and climate change regimes and how do these levels of effectiveness compare to each other?

This study aims to decisively and systematically answer this question. Through the evaluative process, the thesis utilizes a distinct analytical framework and determinate measurement of effectiveness from the perspective of political science. The thesis addresses whether these two regimes can be considered effective in managing the challenges and problems motivating their formation. The results serve as a fundamental platform for research aiming to explain regime effectiveness.

The classification of effectiveness is completed through applying a three-fold operationalization of regime effectiveness allowing for a systematic comparison between the two regimes. Regime effectiveness is conceptualized as institutional attributes of the regime ("output"), changes in states' emissions patterns ("outcome"), as well as environmental consequences of coordinated action ("impact"), as is described in detail in chapter two. A multiple-measurement approach to regime effectiveness facilitates a robustness check of the conventional wisdom that the ozone layer regime is more effective than the climate change regime. The study aims to provide nuanced findings depending on which operationalization of effectiveness is applied. This thesis' use of an applied analytical framework sets the present study apart from studies that evaluate regime effectiveness with less decisive and transparent methods of analysis.

The climate and ozone regimes share much in common, but also diverge in their differing success stories: the ozone regime is the near poster-child of international environmental regimes and is considered successful in several regards, which contrasts starkly with the troubled teenager of the climate change regime for which success at a substantial level is much more uncertain. From the perspective of environmental politics, these regimes are unique in that addressing atmospheric conflicts pose particular warrant for a response of collective action. The root of both problems – emissions of ozone depleting substances and greenhouse gasses – are global in scale, as are their adverse impacts. In grappling with such all-encompassing problems these regimes exist in a class of their own, possibly only rivaled by the continuing destruction of biological diversity at a global scale.

Research within the field of international environmental regime effectiveness is conducted with the ultimate aim of finding optimal solutions to environmental problems like these. The importance of evaluating regime effects lies in its relevance for understanding the strengths and weaknesses of regime's design and in the value of international environmental cooperation in general. Before being able to recommend suggestions for change, it is vital to have a concrete understanding of how regime effectiveness should be measured and evaluated. Such an understanding eventually leads to the ability to answer questions such as these: What *type* of regime is the *most* effective? How can differences in regime effectiveness *be explained?* Although this study – mainly because of limitations in time and space – is not designed to answer these highly relevant yet complex questions, it aims to provide the nuanced understanding of regime effectiveness necessary for further contemplation. After assessing the levels of regime effectiveness for the two cases, the study finds that in a comparison of the largely highly effective ozone regime and the largely low-effective climate regime, there are several areas that serve as foundation for future research.

1.3. Methodological Remarks and Research Design

In this section, the design and methodology of the study will be presented, by first discussing the methodological choices and analytical framework. The majority of the analytical framework – the essence of my methodology – lies in chapter two with the theoretical foundation upon which it lies. Regime effectiveness is challenging to operationalize and it is therefore of essence to carefully define the terms, indicators, and analytical framework of the project. In the following section the design and methods of study will be clarified for this purpose.

The study employs a descriptive and classificatory methodology at the international level of analysis. As will be clarified further in chapter two, this means that *regime effectiveness* is examined and operationalized on the an global, aggregate measurement in the form of the texts of protocols, conventions, or other legal product of the regime at the international level; aggregate emissions behavior; aggregate environmental quality impact (See 2.3 for details). A case study comparative approach is utilized that is in following with the bulk of research on regime effectiveness, which also employs qualitative methods, particularly the case study method (Breitmeier, et al., 2006, p. 9). This is largely because when striving to compare international environmental regimes, the number of cases from which to choose from is limited. Thus, the case method is ideal for a low-N study such as this.

In addition, another important consideration for evaluating regime effectiveness is the concept of time. A measurement of effectiveness can only refer to one particular point in time (Arild Underdal, 2002a). This is for several reasons, one being that both political (in the regime negotiations) and scientific (environmental degradation or improvement) changes are constantly occurring. As Underdal (2002b, p. 13) points out, it would be expected that the effectiveness of a regime increase with time in a curvilinear fashion, with eventual diminishment to obsolescence. Thus, it is important that when comparing two regime indicators, they are measured at the same stages in their life cycles. In the case that the stages cannot be synchronized, it is important to exert caution when comparing across regimes (Arild Underdal, 2002a). This was taken into consideration in the design in this study and controlled for, where possible.

This study's methods are articulated in the use of an analytical framework grounded in theory and research on regime effectiveness. The details for this framework are presented in chapter two, but will be briefly described here. The core of the framework is based on the use of three indicators that provide three complementary operationalizations of regime effectiveness, as is proposed by Underdal (2002a) and Mitchell (2008). Empirical findings are collected and mapped according to these indicators. In the analysis, each indicator is juxtaposed against a defined standard in order to classify that indicator's level of effectiveness. This allows for comparison of the results for each regime, allowing for the question of whether the variation in regime effectiveness across cases differs depending on what operationalization of regime effectiveness applied to be answered in the process. Of importance to the methods of this thesis is maintaining transparency in the application of the analytical framework to the empirical findings. In this study, this involves the critical *assessment* of regime effectiveness where standards are necessary. Here, it is important to clarify what the standards for the level of effectiveness, as it is important that the reader clearly understands how the author arrives at the given effectiveness conclusions (Arild Underdal & Young, 2004, p. 34). In particular, it is important to employ consistent terminology that can be compared across cases (Breitmeier, et al., 2006, p. 10). The reliability of the study lies in the transparency of the methods used and the highly detailed operationalization of the indicators. The standards and indicators will be operationalized and justified in chapter two.

To the extent of being transparent, assigning a score of effectiveness is a demanding aspect of the analysis. This study uses prose to describe the effectiveness classification score in attempt to avoid the rigidity of numerical scores, as previous research shows that the increased transparency gained from numerical assignment of effectiveness may lead to expressions of exactness with scant justification (Steinar Andresen & Wettestad, 2004, p. 63), reflecting the extremely political and complex nature of regime effectiveness. In the Miles et al. project (2002), such numerical scorings were attached, but not without criticism (Underdal 2002b). A multiple-measurement approach to regime effectiveness allows for a robustness check of the effectiveness scores that are assigned to each regime.

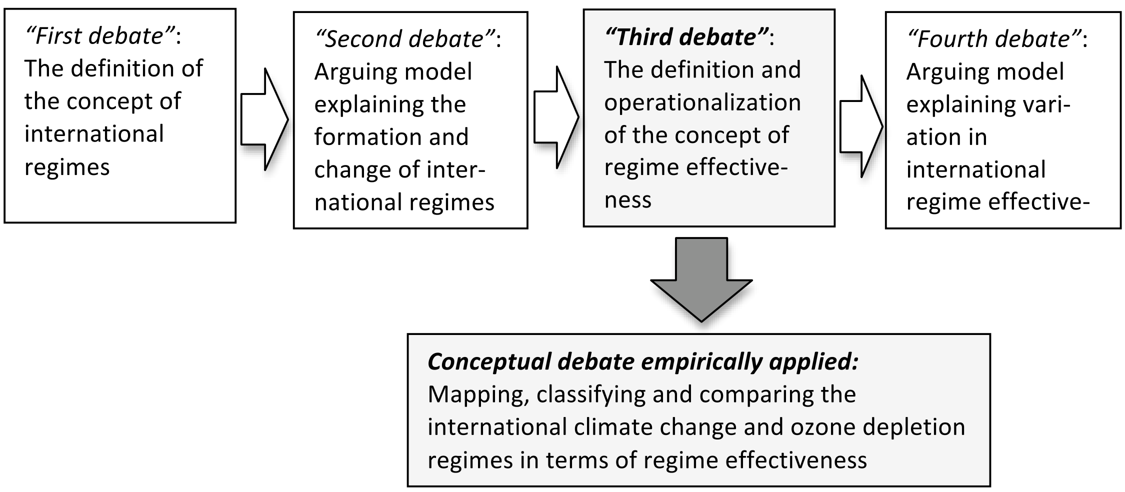
The data utilized for this study as organized in chapter three was collected using a variety of primary and secondary sources. For the historical accounts of regime formation and negotiation processes, I refer to official publications by the two secretariats, but also on secondary historical documentary accounts of the process. Data regarding the output of the regime, such as the conventions, protocols, control measures, annexes, etc. was collected through a review of original texts and officially published information. Data regarding the scientific advice for the solution of the problem, emissions trends, and the current status of the problem was attained through reading publications by the Intergovernmental Panel on Climate Change (IPCC) and the Ozone Trends Panel (OTM), as well as other peer-reviewed scientific research.

This introductory chapter has set the scene for the remainder of the thesis by first framing the relevance of the topic in the field of globalization and political science; presenting the research objective and question; and providing important information regarding the methodological choices of the study. The thesis is structured in the following manner. In chapter two the theoretical debates on international regimes will be presented in an effort to explain the informed conceptual framework chosen for analysis. In chapter three, the data necessary for the effectiveness classification is empirically mapped and presented. In chapter four, the analysis is the focus where regime effectiveness is classified. Additionally, the two regimes are compared. Finally, in chapter five, a discussion of results is briefly presented with closing remarks. In the next chapter, the methods of data analysis – the analytical framework – will be presented in depth after a review of the theoretical foundation of the field of international environmental regime effectiveness.

2. Theoretical Debates on International Regimes: Towards an Informed Conceptual Framework for Analysis

In the present chapter, I review relevant literature on international regimes in an effort to understand and draw upon the analytical debates related to (i) the conceptual understanding of the phenomena of international regimes and regime effectiveness, and (ii) the arguments underpinning the two well-established explanatory frameworks which shed light first on the conditions for regime-formation and change, and second on the conditions for regime effectiveness. This broader approach to the theoretical international regimes debate is chosen in an effort to clarify how the concept of regime effectiveness will be conceptually delimited, empirically measured, and fit into the broader picture of theoretical debates. As indicated in Figure 1, the main emphasis of the present chapter is to prepare the subsequent mapping, classification and comparison of the international climate change and ozone-depletion regimes in terms of regime effectiveness.

Figure 1: The Broader Theoretical Context and the Particular Application of the Regime Effectiveness Concept



The main analytical decision resulting from this review lies in the concept of regime effectiveness which will be defined, and subsequently operationalized along three dimensions related to the institutional attributes of the regime ("output"), changes in states' emissions patterns ("outcome"), as well as to environmental consequences of coordinated action (“impact”). Prior to this, the scholarly debates on the definition of international regimes and the explanation of regime-formation and change will be briefly reviewed. By presenting the relevant scholarly debates surrounding international regimes and regime effectiveness, the present chapter grounds the subsequent analytical consideration of how regime effectiveness is operationalized and eventually assessed in chapters three and four.

2.1. “First debate”: Defining the concept of “International Regimes”

International regimes, as the main concept and phenomenon of this study, must first be adequately defined and conceptualized. In the following section, the concept of the international regime will be reviewed starting from its beginnings in the field of political science. The origins of international regimes research can be considered a repercussion of globalization and interdependence on international relations and international political economy. It was in the 1970s that growing “complex interdependence” (Robert O. Keohane & Nye, 1977) characterized by transnational trade and finance relations, coalitions, and cross-border contacts, challenged the state-centric paradigm (Cohen, 2008). To grapple with increases in globalization and impediment on sovereignty, the study of international institutions or an alternate system of governance gained prominence.

The concept of the international regime was conceived in the late 1970s to early ’80s, through initiatives by scholars Robert O. Keohane and Stephen D. Krasner[1]. Conceptually the field of regimes offered scholars the ability to move beyond the study of formal organizations to understanding how international cooperation becomes coordinated and institutionalized (Cohen 2008). Despite the “wooly” nature of the concept of the international regime (Strange, 1982, p. 479); Cohen 2008), Krasner provides the academically accepted definition:

> Regimes can be defined as sets of implicit or explicit principles, norms, rules, and decision-making procedures around which actors' expectations converge in a given area of international relations. Principles are beliefs of fact, causation, and rectitude. Norms are standards of behavior defined in terms of rights and obligations. Rules are specific prescriptions or proscriptions for action. Decision-making procedures are prevailing practices for making and implementing collective choice (Krasner, 1982, p. 2)

Krasner’s consensus definition is the definition most largely used, mainly due to agreement about two particularly poignant aspects of an international regime. Krasner used the term *social institution* and *issue specific* (Levy, Young, & Zürn, 1994), terms that subsequently have been adopted into other definitions of the international regime (Seter, 2011). For

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[1] Largely via the journal *International Organization (1982).*
[2] The counterfactual presented by both Sprinz and Helm (2000; 1999) and Hovi et al. (2003) has foundations in

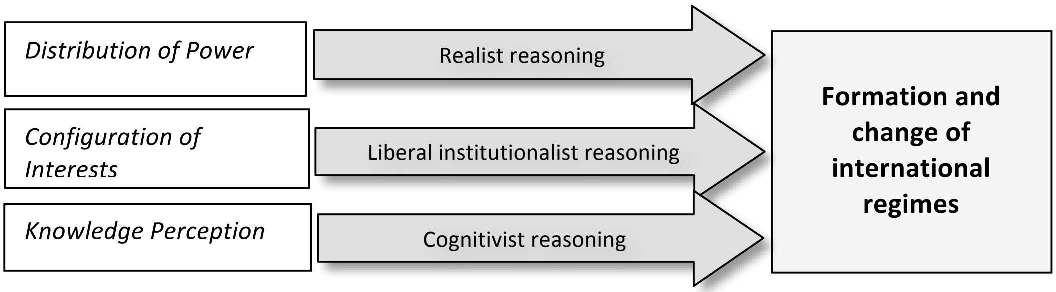
example, Young holds that regimes are social institutions governing the actions of those interested in or meaningful sets of activities (Young, 1980). Bringing in further nuances, Breitmeier states that "international regimes are social institutions created to respond to the demand for governance relating to specific issues" (Breitmeier, 2006).

Critique of the definition exists. These criticisms center on two particular points of Krasner's statement. The first criticism regards the exact meaning and relationship between the "principles," "norms," "rules," and "procedures." The terms representing four integral components of the regime are unfortunately quite difficult to distinguish from one another. A further criticism focuses on the formulation "around which actors' expectations converge" as what *area* of the issue the regime is formed around remains ambiguous (Hasenclaver, Mayer, & Rittberger, 1996). Despite these concerns about the absolute definition of an international regime, there remains a general agreement upon two important aspects of the concept, one being that international regimes are *social institutions* and secondly that they are issue-specific. Given this definition, international regimes are assumed to influence the behavior of states by facilitating cooperation on problems, challenges or opportunities which are too costly, complex, or wide in scope for any single country to solve, manage, or reap the benefits from on its own.

2.2. "Second debate": Explaining the Formation of and Change in International Regimes

Having clarified the concept of international regimes and thereby establishing regimes as a potential dependent variable for study, the debate on international regimes progressed to addressing why and how international regimes are established in the first place. What are the conditions for regime-formation and change? These questions are best addressed through three academic schools of thought that approach the explanations to these questions from different angles and focus on different explanatory factors (Hasenclaver, et al., 1996), as is briefly described in Figure 2. The three schools - neorealist (the power based argument), the liberal institutionalist (the interest based argument) and the cognitivist (the knowledge based argument) - will be briefly described below.

Figure 2: Model for the Explanation of Regime Formation and Change



The neorealist approach explains regime formation and change from the view that state's self-interested and utility maximizing properties are an explanation for cooperation in the international regime (Hasenclaver, Mayer, & Rittberger, 2000a). The neorealist focuses on the role of a power structure that favors the formation of regimes. In this literature, discussion is centered on the existence of a hegemon. Kenneth Waltz (1979) formulated the two assumptions which characterize the neorealist school of thought: i) states are the main actors in international politics and that without a super national system of authority, conflict will occur, and ii) as the international system is characterized by anarchy, it is also characterized by self-help, and therefore has a collective action dilemma (Waltz, 1959). In such a system, neorealists use hegemonic stability theory (Kindelberger, 1973) to explain international regime formation and change through the behavior of a hegemon that establishes norms for conduct on several issue areas.

The liberal institutionalist approach takes configuration of state-interests as point of departure in explaining regime formation and change. This school is considered the most influential school in the field of environmental regimes (Vogler, 2003). Liberal institutionalists emphasize interest-based theories that focus on how international regimes help states realize common interests by reducing both uncertainty and transaction costs due to transparency and multilateral structure established by means of the regime (Hasenclaver, et al., 1996). To understand this school of thought's theoretical underpinnings, Mancur Olson's (1965) research on public goods provides a platform for exploration. Olson observed that despite the fact that groups of rational actors may have a common interest or objective, they may not act in order to achieve the objective (Olson, 1965). Olson concluded that these commonalities could be considered public goods, which can also be defined as "having benefits that cannot easily be confined to a single "buyer" (or set of buyers). Yet once they are provided, many can enjoy them for free (Kaul, Grunberg, & Stern, 1999). To illustrate the salience of the public goods in regime formation, liberal institutionalists utilize the concept of market failure, which refers to situations in which the outcomes of market-mediated interaction are sub-optimal (Keohane, 1982). The market's imperfection, as evidenced by market-failure, is similar to the imperfection of the international system, which has barriers for effective cooperation on global problems. In such a system, lacking institutions negative externalities are common (Seter, 2011). In order to reduce negative externalities and achieve a more optimal outcome states may decide to coordinate their behavior in a given area through collaboration in a regime (Krasner, 1982).

In the cognitivist approach regime-formation and change are explained in terms of social and consensual knowledge. Cognivists are skeptical towards rationalist theories of international politics particularly because interests are considered exogenously given. Cognitivists consider the interests of the state as an empirical question and as constantly evolving as states learn and change ideologically (Seter, 2011). States' interests may change over time also due to learning interactions between actors, for example during meetings of the international regime (Steinar Andresen, Skodvin, Underdal, & Wettestad, 2000). Although significant differences exist within the cognitivist school, the field is generally considered especially relevant in the field of international *environmental* regimes. Of particular note is research focused on epistemic communities, whereby communities of scientists and have been shown to play an important role in forming the interests of countries (Neumayer, 2001, p. 133). Cognitivists highlight that high levels of uncertainty characterize environmental problems, making correct scientific information vital in the decision making by states (Mitchell, 2010). The idea that interests can be adapted based on the variables of knowledge and ideas allows the cognitive approach space for explaining regime formation and change.

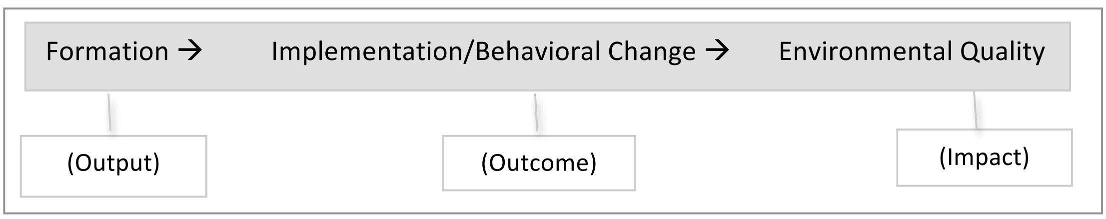
The approaches presented in this section highlight differences in explanation of formation and change in a regime. Whether power-distribution, configuration of interests, and epistemic communities/knowledge are seen as competing or complementary explanations of regime-formation varies through the literature. The accuracy of these arguments and the related schools of thought as presented above will not be further discussed in this study but provides a contextual background for better understanding the subsequent "third debate" on which my empirical study rests.

2.3. "Third debate": On the definition and operationalization of Regime Effectiveness

Having briefly reviewed the scholarly debate on the delimitation of the "international regime" and the model explaining regime-formation, this section defines and operationalizes regime effectiveness which is the key concept through which the international climate change and ozone-depletion regimes are to be described, classified and compared in this study. This is also a necessary precursor for students striving to *explain* regime effectiveness for which there are multiple avenues of research. The added analytical demands on an explanatory approach to regime effectiveness will be discussed in section 2.4, but will not be elaborated on empirically in the present thesis.

Regime effectiveness refers to the extent to which the international regime manages or solves the trans-boundary problem that originally inspired the establishment of the problem-solving regime. At its core, evaluation of regime effectiveness measures how the regime functions as a political tool in reaching its stated goals (Mohr, 1995; Seter, 2011). Doing this requires a clear understanding of what the regime's objectives are and what the success criterion of effectiveness is in the assessed case. In the present study, a multiple operationalization of regime effectiveness is applied in terms of "output," "outcome," and "impact" (Easton, 1965; Mitchell, 2010). The three indicators are all measurements of a regime product, but also importantly located at different stages of the effect-chain of the regime: "Output" can be associated with attributes of the regime formed; "outcome" to regime implementation/behavioral change; and "impact" to the state of environmental quality (Underdal, 2002b, p. 7). The use of indicators has implication for causality in that the shorter the causal chain linking a regime and its effects, the easier it is to demonstrate causality, this is shown in Figure 3 below. In the following sub-sections each indicator will be clarified in some depth.

Figure 3: Indicator Associations with the Regime Chain of Causality



2.3.1. First Indicator of Effectiveness: Output

Output is the first and fundamental effect of an international regime, as it refers to the created set of rules and regulations produced by the regime. It is productive to explore the dynamic institutional system of the regime through endogenous attributes, as the design of the regime will have important implications for effectiveness (Young, 2010). The output indicator can be analyzed at two levels of analysis: i) the norms, principles, and rules of the international regime, or ii) as measured by the laws, policies, and regulations that are adopted at the state level as a response to the requirements of the international regime (Mitchell, 2010, p. 148). Mainly for reasons of parsimony, the present study will focus on the level of the international regime. Such an analysis using these criteria can be completed by using data available in the official texts of the regimes, such as the Kyoto Protocol, UNFCCC and the Montreal Protocol.

The general principles for effective institutional governance have been established through numerous empirical studies on international environmental regimes (Dietz, 2003). Individual authors have established a variety of suggestions for how to conceptualize these attributes. Wettestad (1999, p. 9), for example, uses a framework whereby output is examined in terms of four aspects: the ambitiousness, the legal status, the specificity, and the differentiation between the diversity of parties of the agreement(s). Underdal proposes that the criterion for the output indicator can be: the stringency of rules and regulations, the extent to which the system of activities targeted is in fact brought under its jurisdiction or domain, and the level of collaboration established (Underdal, 2002b, p. 6). The criteria and parameters for output at the international level are operationalized in this study as following and are returned to in chapter four.

Within the output approach to regime-effectiveness, the assumption is that (i) the greater share of world emissions are accounted for in the agreement/the more states have ratified the treaty (Wettestad 1999, p. 10); (ii) the closer the abatement targets are aligned with scientific recommendations; (iii) the more legally binding and politically committing the treaty is (Ibid.); (iv) the better the funding mechanism; (v) the stronger the monitoring, reporting and verification of national policies are (Breitmeier, et al., 2006, p. 197); (vi) the existence of sanctioning mechanisms in case of implementation-failure (Ibid.); and (vii) the existence of a scientific body responsible for the systematic dissemination of data and reporting (Breitmeier, et al., 2006, p.195), the more effective the international regime in question is. This analysis of this indicator assigns sub-indicators equal weight in its contribution to effectiveness of the indicator. In Table 1, the output indicators for regime effectiveness are presented in the operationalized and vital form. This will be the basis so for the collection of empirical data and data analysis.

Table 1: Operationalization of the Output Indicator

Output Indicators for Regime Effectiveness
Ambitiousness ○ Share of world emissions accounted for in the agreement ○ How targets compare with scientific recommendations
Legal Status ○ Whether commitment declarations of intent are legally binding in international law? ○ Number of ratified countries
Differentiation (different targets and timetables that account for the various types of actors, taking into account variation in parties particular conditions)
Other Attributes of Institutional Design ○ Decision making rules ○ Funding mechanisms ○ Monitoring, reporting and verification mechanisms (e.g. review of national policies) ○ Sanctioning mechanisms to apply in case of implementation failure ○ Scientific body with systematic dissemination of data and reporting, scientific review mechanism

2.3.2. Second Indicator of Effectiveness: Outcome

The presence of an international regime does not guarantee the proper implementation of targets, principles, rules and action-strategies by the member states. This suggests a limitation on the validity of the output-indicator (Seter, 2011). In order to strengthen validity, one needs to account for the level of implementation of the regime's output by examining behavioral change following its implementation. This is the outcome indicator (C. Helm & D. Sprinz, 2000, p. 633). Although the quality and characteristics of the regime goals as codified in the treaty (output) arguably are necessary or contributing prerequisites for the regime's ability to influence the state's behavioral change, an alternate way to measure effectiveness is to measure implementation behavior (emission behavior) either at the level of the member-state, or at the aggregate level (collective emission-patterns) (Seter, 2011).

Using this indicator may have three advantages over the output and impact indicators, as highlighted by Mitchell (2008). First, behavioral change is essential for achieving goals of improved environmental quality, which is the primary target for most international environmental regimes (Underdal, 2004, p. 34). Secondly, the outcome indicator is closer in the causal chain to the institution than environmental quality. There are fewer explanations for behavioral change than environmental quality (Mitchell, 2008, p. 84). Thirdly, data on behavioral change is easy to accurately model and behavioral data is readily available and of higher caliber (Ibid.).

For reasons of parsimony, this study operationalizes outcome as change in emission behavior at the level of the aggregate measure accounting for the collective emission behavior of all members of the regime in question. In the case of the Climate Regime this entails changes in collective GHG emissions of parties to the Kyoto Protocol at 5percent below 1990 emissions levels, or a stabilization of emissions for Parties to the UNFCCC. For the Ozone Regime this entails the changes in or phasing out of emissions of the 96 regulated ODSs. In previous research the outcome indicator has been recommended and employed as an indicator of regime effectiveness by several scholars (Helm & Sprinz, 2000; Mitchell, 2004; Seter, 2011; Underdal & Young, 2004).

Table 2: Operationalization of the Outcome Indicator

Outcome Indicators for Regime Effectiveness
o Are emission trends in accordance to the regulatory framework (Convention and/or Protocol)?
o Have aggregate global emissions decreased subsequent to the formation of the regime?

2.3.3. Third Indicator of Effectiveness: Impact

After regulations have been created by the regime (output), and behavioral changes have been observed and translated to an aggregate change in collective emissions or use of destructive substances (outcome), the final evidence of a regime's effectiveness will be improvement in the environmental quality targeted for regulation. The impact indicator measures this aggregate improvement in biophysical conditions.

Use of the environmental impact indicator can be a particularly good measurement for measuring the regime effectiveness in the case where the environmental problem has an anthropogenic source, such as for ozone layer depletion and climate change (Mitchell 2008, p. 87). Thus, measuring the drivers of these problems (pollutants) can provide measurement for how well the regime performs. This is reflected in the targets of the regime as well, which may include environmental quality targets in regulatory framework (Mitchell 2008, p. 86). Even if targets are directed at behavioral changes instead of environmental changes (i.e. emissions vs. concentration level), the goal of the regime is inherently based in improving the environment.

A caveat to the use of this indicator is that environmental changes can be difficult to measure because of technical and scientific complications, and the time lag that exists between implementation and observed change (IPCC, 2007a). For climate change, the time-lag problem is particularly complex, as the slowing and ultimate reversal of anthropogenic climate change is related to the decomposition of carbon dioxide (CO_2) in the atmosphere which can take over 120 years (IPCC, 2007a). For more complex GHGs such as HFC-23 the process of can take 220 years (WMO, 2010). For the ozone regime, similar difficulties arise as the regulated chemicals are long lasting in the atmosphere and it may take decades for the ozone layer to be replenished to pre-1980 levels (Parson, 1993; WMO, 2010b).

The impact indicator in this study is operationalized in both regimes as the atmospheric concentration of i) chlorine and bromine or ii) CO_2 (for each respective regime). Both regime effectiveness classifications will utilize additional measurements to supplement the impact indicator evaluation. To measure the potential impact of the climate change regime, available data on the impacts of climate change will be presented in terms of observed change in atmospheric concentration of GHGs, change in global mean temperature, from the period of 1992-2008, or the most recent data available. The environmental impact of the ozone regime is measured via observed change in atmospheric concentration of ODS and change in the amount of ozone, such as in the size of the ozone hole in the Arctic and Antarctic from the period of 1987-2008, or the most recent data available.

Table 3: Operationalization of the Impact Indicator

Impact Indicators for Regime Effectiveness
o Concentration (ppm) of CO2-equivalent GHG in the atmosphere or chlorine/bromine (ppb) o Observation of change in environmental quality

2.4. "Fourth Debate": Explaining Variation in Regime Effectiveness

In this section, consideration is given to how regime effectiveness *can be explained*. The *evaluation of the level of* regime effectiveness begins as the stepping-stone for explanation of effectiveness. This thesis does not venture to explain the effectiveness of regimes, but for the sake of theoretical comprehensiveness a brief review of potential explanatory framework is presented below. The importance of this lies in the close relationship in previous academic research between assessment of effectiveness and explanation.

There have been several approaches to arguing explanatory variables of regime effectiveness. Ostrom (1990) early on identified that both institutional and non-institutional (exogenous) factors influence regime effectiveness. Haas, Keohane, and Levy (1993) identified three general factors as governmental concern, political and administrative capacity, and contractual environment (Keohane, et al.,1993). Breitmeier and colleagues concluded that discourse, legitimacy, and habit are important factors (Breitmeier, et al., 2006). However, the project by Miles et al. (2002) outlined the explanatory framework that will be briefly presented here. The approach is also utilized by the so-called Oslo-Potsdam solution (Hovi, Sprinz, & Underdal, 2003). Here, factors are grouped into three clusters: i) the nature of problem; ii) characteristics of the groups of parties; and iii) properties of the regime itself (Underdal, 2004, p. 40). The explanatory model will be elaborated on below.

2.4.1. Problem Severity

Given the breadth of problems addressed by international regimes, it is natural to expect a variety of problems that exist in varying levels of severity. The level of severity, described by Underdal as "benign" or "malign" (Underdal, 2004, p. 21), can also be classified within two dimensions: an intellectual dimension (scientific uncertainty) and a political dimension (deep-rooted conflicts) (Underdal, 2004). A benign problem is characterized by "scientific certainty, coordination, symmetry, and cross-cutting cleavages," while a malign problem is characterized by scientific uncertainty, incongruity, asymmetry, and cumulative cleavages" (Ibid.). It follows that the nature of the problem can theoretically dictate such factors as cost and vulnerability, thereby making the problem either easier or more difficult to solve (Mitchell, 2010, p.173).

2.4.2. Properties of the Regime Itself

Finally, regime effectiveness is also dependent on the problem-solving capacity of the regime (Fermann, 1997). Problem-solving capacity is operationalized by the following two factors: the institutional setting, and the amount of skill and technique that are available to politically engineer a cooperative solution (Seter, 2011; Underdal, 2002, p. 23). Although the institutional setting is composed of a number of factors, Underdal argues the most important determinants for an institutional setting are decision rules and procedures. Other factors of institutional setting can be both related to the protocol or rules of the convention, or how the institution operates (Seter, 2011; Underdal, 2004). Procedures, arenas, or facilities create space for parties to develop consensus, knowledge, and shared beliefs (Underdal, 2004, p.41). Institutional capacity can include instruments or mechanisms that bring parties into the process, and which may enhance cooperative decision making processes (Jørgen Wettestad, 2002, p. 165).

2.4.3. Characteristics of the Groups of Parties

A third set of variables explaining regime effectiveness relates to the idea that some groups of actors have a greater potential for collective action than others (Underdal, 2004, p.41). How actor's capacity is operationalized varies. Ostrom (1995) suggests that social capital may be important, while others focus on the formal organization, social relations within the group, and the distribution of power. In addition, instrumental leadership can facilitate regime formation and implementation, and the more availability to resources a leader has may enhance the ability of states to encourage others to comply with the regime (Aggarwal, 1983, p. 620; Underdal, 2002b, p. 35). The leadership may arise from a variety of sources: officers of intergovernmental organizations, conference or working group chairs, national delegates, transnational organization or informal networks (Underdal, 2002).

The reality of the researcher's situation is that explaining regime effectiveness requires a complex assortment of variables for which a specific and definite pattern may be difficult to discern. Most research in the field is therefore based on case studies, thus the categorization presented above should be considered a way to simplify an otherwise highly complex set of variables. In addition, recent research in the area of regime interaction and interplay has called into question how regimes affect each other's effectiveness, which adds further complexity to explaining effectiveness. Although *explaining* the level of regime effectiveness is the not the specific goal of this thesis, these concepts will be carried throughout the thesis in their importance for framing questions for future research frontiers. Thus far in chapter two we have addressed the four "debates" in addition to operationalizing the important indicators of regime effectiveness: output, outcome, and impact. We now leave discussion about *conditions* for regime effectiveness, and move to a review of *how* regime effectiveness can be assessed. To do this, I will review the *standards* by which one can determine whether a regime is *low, medium, or high* level of effectiveness.

2.5. Having Decided Upon Indicators of Regime Effectiveness, Which Standard of Success Can Be Applied to an Empirical Study?

In section 2.3, the indicators which operationalize effectiveness in this study were argued for and defined. Drawing upon this operationalization further, the current section reviews the scholarly debate on the methods through which one can *assign a level of effectiveness* within each one of the three indicators reasoned (output, outcome, impact). This section defines how the regime's indicators will be evaluated against a standard, or threshold of success. This section provides insight as to how the indicators of effectiveness (output, outcome, and impact) to how the level of effectiveness is classified with a standardized score (Underdal, 2002b, p.4). This section is split into two parts. A review of the literature on this topic presents an array of potential standards and their pros and cons in use. The second section presents the standards of effectiveness utilized in this study.

The indicators (output, outcome, impact) structure the collection of data by measuring three aspects of regime effectiveness. The question, however, is: how does one know when the indicator is indicating effectiveness? In order to assign a score of effectiveness, it is necessary to establish a standard of evaluation such that deviation along this standard can be classified. In this study, the term for this will be "standard," but is also referred to by Mitchell (2008) as the 'performance scale,' while Underdal (2004, p.37) applies the term "yardstick." According to Underdal (2004, p.37 and 2002, p.7) when designing the standard, it must have the two following attributes: i) a point of reference against which actual performance can be compared, and ii) a common metric of measurement that can be applied across a wide range of cases. In this section, the point of reference - or standard - will be discussed and determined for this study.

Addressing this standard of how to evaluate effectiveness within each one of the three indicators has been, in recent years, commonly approached from a normative perspective. As Young (2008, p.21) states: "There is an essential normative component in the assignment of standards to the question of performance that is not present in the question of causality." Three types of standards have been proposed by a variety of scholars (Hovi et al., 2003; Young, 2003; Breimeier et al., 2006; Helm & Sprinz 2000): 'goal attainment,' 'problem solving,' 'collective optimum,' or through the use of a counterfactual (Mitchell, 2008, p.88).

The *goal attainment* approach assesses progress made towards the institution's stated goals. Institution creators adopt standards that vary along a continuum of ambitious to unambitious, largely reliant upon factors discussed in the above section. However, an evaluation of whether the regime has managed to meet its own standards is interesting and relevant in and of itself. Institutional goals are the result of political compromise between the institution's actors, whose individual goals may have otherwise varied (Ibid.). The *problem solving approach*, on the other hand, assesses progress in the regime as the originators of the institution defined it, but not those implied in the institutional ambitions (Mitchell, 2008; Breitmeier, et al., 2006). The problem solving approach will not be utilized or discussed further in this study.

The *collective optimum* approach is assessed by progress towards an "ideal" or "perfect" solution to the problem (Hovi, et al., 2003). This standard is based on the definition of the problem and what the optimal solution would be for the given problem (Mitchell, 2008, p.89). Mitchell suggests that using this form of standard has advantages because it allows assessment of the institution to be independent from the goals the institution's self-defined bounds. Also, the standard can be applied across institutions, as it does not depend on the individual institution (Mitchell, 2008, p.89). A challenge in using the collective optimum, however, calls into question: *who* defines the optimal resolution of the problem or the collective optimum (Mitchell, 2008, p. 89)? The inherent nature of politics is that academic analysts, scientists, policy makers, or non-governmental organizations will unlikely unanimously agree on the best possible solution.

Another standard for regime effectiveness is the use of a *counterfactual*, where the standard is a hypothetical state of what would otherwise have happened if the regime had not existed. The counterfactual and the collective optima differ in their points of departure. Using the counterfactual allows for assessment against a potentially 'poor' standard (the pre, non-regime situation – also termed in some research as Business As Usual), while the collective optimum measures not just improvement from a non-regime situation, but progress towards a perfect situation. Both require hypothetical projections: one of a world in which no regime existed, and the other deciding what the optimal solution looks like. For example, measuring the output indicator along the counterfactual standard will consistently yield positive scores as the presence of treaties, statues, regulations, etc. would not have occurred in the absence of the regime (Young, 2008, p. 19). For some, this makes the counterfactual less difficult to imagine. Breitmeier and colleagues (2006) for example, when measuring problem solving as a variable, chose to measure *relative improvements* from a counterfactual state instead of using a collective optimum because they were not able to codify the optimum (Breitmeier, et al., 2006, p.31).

One method that has been discussed heatedly in the field is what can be called the Oslo-Potsdam solution (Hovi, et al., 2003). This solution utilizes a scale that ranks the outcome that would have occurred in absence of the regime - the counterfactual (0) and between what is designated as the collective optimum (1). Regime effectiveness is rated relative to both standards in this approach (Hovi, et al., 2003). This makes the approach a synthesis of 'distance to the collective optimum' and 'relative improvement' (Wettestad, 1999, p.8). Although this solution is theoretically appealing, it will not be utilized in this study for two reasons: first, it has been debated in the field amongst a variety of scholars and has not been adopted as the optimal measurement of effectiveness, but rather as a second-best substitute for the perfect solution that does not exist (Hovi, et al., 2003; Young, 2003, p. 102). Second, in this study, the counterfactual is not utilized, as it is difficult to predict what would have happened in the absence of a regime[2] (Young, 2003, p.98; Hovi et al. 2003). In the following paragraphs, a description of the standards for regime effectiveness employed in this study will be presented. These standards will be utilized in the analytical framework and applied in chapter four.

In this study, the designed standard of effectiveness is three-fold and dependent on the indicator. This is due to reasons of parsimony and an evaluation of which dimension was the best fit for each indicator. The type of data included in each indicator is suitable to a specific form of standard. The justifications for why the indicators used in the analytical framework was presented previously in the chapter. The question at hand now is: *how does one know when the indicator presents a story of effectiveness*? This study utilizes two forms of standards discussed: the goal attainment standard and the collective optimum standard. The operationalizations of the standards for evaluation of output, outcome, and impact are different, yet the purpose of each standard is to complete an evaluation of effectiveness that stands against the most ambitious standards of meeting the best possible outcome for the planet. What is gained from using the most collectively optimal solution possible is twofold. First, it provides a common metric measurement enabling comparison between the two regimes. Second, the collective optimum inherently inspires a goal-setting perspective, inspiring future-looking consideration of the regime.

[2] The counterfactual presented by both Sprinz and Helm (2000; 1999) and Hovi et al. (2003) has foundations in the game theoretic method, which is admitted by even the authors themselves to not be an optimal method (Young 2003, p. 98). Although it is difficult to estimate counterfactuals, the Scientific Assessment Panel of the Ozone Trends Panel has come far in producing counterfactuals for what would have happened to ODS emissions had the Montreal Protocol not been present. These projections are useful, but in the case of this study, a similar counterfactual is lacking for the International Climate Change Regime and therefore is not a useful comparison.

As has been discussed above, the design of a collective optimum solution is a contested process, and cannot be utilized in all situations. Regardless of the difficulty of the task, designing a standard is necessary for inter-regime comparison – which is at the core of my two-case comparison of regime effectiveness. Underdal (2004, p.37) emphasizes that a cross-examination of multiple regime case studies remains a largely unscientific matter without the use of a "common unit of effectiveness." As mentioned in the introduction of this thesis, the important point is that it should be transparent as to how one arrives at the given conclusion (Ibid.). The specific standards for each indicator are clarified and defined below in seeking the goal of transparency.

First, **the output indicator** is measured against a standard of collective optimum that has been identified and operationalized in section 2.3.1. The standard was created based on theoretical and empirical findings from political science literature on regime effectiveness field from the past decades (see section 2.4). In chapter four, the empirical findings along this indicator are assessed according to the presence of the determined attributes of the regime. For each attribute deemed important, a score is assigned. This indicator is the most reliant on political science theory and academic research on institutional design. The indicator operationalization is reliant on previous explanatory research that has determined which aspects of the regime are significant in contributing to effectiveness.

Second, the **outcome indicator** is measured against the goal attainment standard. This will assess the level of implementation of the regime's output by examining *behavioral change subsequent* to regime formation against the *standard of the targets and goals set by the regime*. This sheds light on how the regime is meeting its self-described goals (Mitchell, 2008). This standard is founded in the political agreements of the regime itself, thereby drawing upon the collectively negotiated terms for what countries have deemed the best solution politically possible. The assessment of the outcome indicator can also be completed through measuring the current behavioral trends with those that are suggested by scientific research to be necessary in order to meet the most optimal environmental quality. For reasons of parsimony, the evaluation of level of ambition is included in the output effectiveness assessment, rather than in the outcome effectiveness evaluation.

Third, **the impact indicator** will be assessed against a standard consisting of the recommendations from the scientific assessments produced by the international academic community. This standard is firmly rooted in science and the idea that scientific knowledge has the ability to estimate the best possible situation for the planet .The recommended and scientific ideal quality of biophysical conditions serve as the best fit for a measurement against the current situation.

The figure below depicts how the analytical framework is utilized in this study. Phase I, which occurs in chapter three, is where empirical mapping of the data needed for analyzing regime effectiveness occurs. In Phase II (chapter four) each indicator is compared against the designated standards in completing a *classification of regime effectiveness for each indicator.* After this classification is completed, it is then possible for a comparison of regime effectiveness (Phase III), which occurs in chapter four. The standards presented in this section are an integral aspect of the analysis. This is shown in the figure below. In chapter three the empirical findings are investigated prior to the analysis in chapter four.

Figure 3: Analytical Framework and Process of Evaluating Regime Effectiveness

Phase I:
Empirical Findings, (as presented in Chapter 3) along the parameters of each Indicator (Output, Outcome, Impact)

Phase II:
Analysis of Regime Effectiveness according to each indicator; level of effectiveness assessed by distance on the standard. (Ch.4)

→

In Phase II, the **Analytical Framework** is employed, utilizing the **standards** presented in the above section (2.5) and which are depicted in this table:

Indicator	Standard by which Indicator is Assessed
Output	Ideal Institutional Design
Outcome	Goal Attainment
Impact	Scientific Advice

Phase III:
After each regime is classified in terms of Regime Effectiveness, a comparison between the two regimes' levels of effectiveness is possible. (Ch. 4)

3. Empirical Mapping: What is the Empirical Status of the International Regimes of Climate Change and Ozone Depletion?

In the present chapter, relevant data will be presented which will feed into the subsequent comparative, classificatory regime effectiveness analysis (chapter four). The two international environmental regimes of climate change and ozone layer share some similarities. Both regimes strive to solve problems in the atmosphere. Both solutions to these problems reside in preventing a specific set of anthropogenic chemicals or pollutants from being emitted and harming the atmosphere, and thereby the planet's inhabitants. The regimes both began with framework *conventions* that evolved by means of adding *protocols* and amendments. Finally, both regimes share a unique characteristic distinguishing them from other regimes in that the problems are exemplar of those of the global commons.

For each regime, the nature of the problem will first be briefly presented. Second, a summary of what the scientific and political community has recommended as being the most optimal solution for environmental quality will be presented. Third, the historical development of the regime will be presented by briefly describing the historical development of international regulation and cooperation and the subsequent formation of the regime, with a focus on the institutional attributes, norms, and principles of the regime. Fourth, the trends of emission behavior subsequent to the formation of the regime are presented. Finally, evidence of any changes in the environmental quality will presented, with focus of those subsequent to the regime formation in focus. Due to space and clarity, this chapter will review only the data vitally necessary for the analysis of regime effectiveness. Where possible, the sources for more information will be referred to for future research. This threefold *documentary* forms the basis for the threefold *evaluation* of regime-effectiveness (output, outcome, impact) in chapter four.

3.1. Ozone Depletion Regime: Problem Description, Regime Attributes, Emission Trends, and Environmental Change

3.1.1. The nature of the problem

Ozone is a molecule made of three oxygen atoms (O_3) in gaseous concentration that protects life on earth by absorbing harmful ultraviolet B radiation from the sun. Ninety percent of ozone resides in the stratosphere approximately 20-40km above the Earth's surface, the second layer of the atmosphere (above the troposphere) (Andersen, 2005). Without the ozone layer, UV-B radiation increases which has many adverse impacts such as increasing the chance of melanoma and non-melanoma skin cancers, more eye cataracts, weakened immune systems, reduced plant yields, damage to ocean ecosystems and reduced fishing yields, adverse effects on animals, and damage to plastics (UNEP, 2005).

It was first in the early 1970s that scientists hypothesized that a group of man-made chemicals called chlorofluorocarbons (CFCs) could deplete ozone (Rowland & Molina, 1975; Skodvin, 2000b).(Rowland & Molina, 1975; Skodvin, 2000b). CFCs are chemically stable and persist long enough in the troposphere to be able to diffuse across the boundary to the stratosphere. These chemicals are broken down by UV-B to release chlorine and bromine atoms that act as a catalyst in the destruction of ozone molecules in the atmosphere (Parson, 1993).

The chemicals are anthropogenic in their origin and purpose. They were designed in 1928 for commercial products such as coolants in air conditioning and electronic components, or for flexible and rigid foam increased by the mid 1970s. In 1974, aerosol propellants accounted for 70percent of the global amount of CFC production (Andersen, et al., 2005). In addition to CFCs, scientists later discovered other ozone depleting substances (ODS) such as halons (fire suppressant), carbon tetrachloride, methyl chloroform, and methyl bromide (Chasek, Downie, & Brown, 2010). More recently, research has shown that most ozone depleting substances (now regulated under the Montreal Protocol) are also greenhouse gasses with an often high global warming potential (GWP). Not only do ozone depleting substances contribute to climate change, but scientists today are also concerned about the impact of increasing temperatures on ozone depletion itself – it is relatively unknown what effects the changing climate will have on the atmosphere's operations. There is research showing that holes in the Arctic and Antarctic, for example, both currently respond to and contribute to changes in temperature and climate (WMO, 2011).

3.1.2. The Earth's Threshold for Ozone Depletion and Scientific Advice on the Solution to the Problem

When Molina and Rowland first estimated the extent of damage due to ozone layer depletion, they calculated that if CFC production were to rise at the (1974) rate of 10 percent a year until 1990 and then leveled off, that up to 50 percent of the ozone layer would be destroyed by 2050. They estimated that this would cause up to 80,000 additional cases of skin cancer per year in only the United States, as well as other effects to crop damage, climate change, and genetic mutations (Molina & Rowland, 1975). Initial research conducted in the United States concluded in a 1979 report that for populations susceptible to sunlight, the skin cancer rate would be higher in conditions where ozone was depleted. At this time it was expected that without action taken, the estimated 16percent reduction in ozone would translate to several thousand more cases of melanoma a year, some potentially fatal. Concern was also centered on reduced crop yields, negative effects on larval forms of seafood species and species at the base of the marine food chain, and climatic effects (Andersen, et al., 2005). In 1982 estimates were becoming more exact as research increased. At this point it was also observed that UV-B radiation had been demonstrated to cause immunological changes in animals and it was expected to potentially occur in humans. Radiation also results in stunted plant growth, cuts on total leaf area, reductions in production of dry matter, and can inhibit photosynthesis (Andersen, et al. 2005). Evidence of a growing hole in the Antarctic ozone layer was first noticed in 1981, but was not taken as anything more than erroneous data until 1982 (Gribbin, 1988) and was not published until 1985 (Andersen, et al., 2005).

In 1985, it was predicted that if CFC release rate were to become twice the amount of 1985 levels, there would be a 3-12 percent reduction of the ozone column, independent of other changes in carbon dioxide, nitrous oxide, and methane (Andersen, et al., 2005). By the time of the publication of the first Scientific Assessment Panel (SAP) in November 1989, enough evidence had been building that scientists were able to make more confident recommendations for what type of emissions reductions were needed in order to avoid the most drastic effects.

> "Even if control measures of the Montreal Protocol were to be implemented by all nations, today's atmospheric abundance of chlorine (about 3 parts per billion by volume) will at least double to triple in the next century. If the atmospheric abundance of chlorine reaches about 9 parts per billion by volume by 2050, ozone depletions of 0-4 percent in the tropics and 4-12 percent at high latitudes would be predicted, even without including the effects of heterogeneous chemical processes known to occur in polar regions." (UNEP, 1989, p. 6)

Based on this report, the SAP concluded that complete elimination of ODS emissions were what was needed to return the Antarctic ozone layer to levels of the pre-1970s, and hence to avoid the ozone dilution effect that the Antarctic ozone hole could have at other latitudes (UNEP, 1989). In this report, it was suggested that all fully halogenated CFCs, halons, carbon tetrachloride, methyl chloroform and a "careful consideration of the HCFC substitutes" should be considered for elimination of emissions (UNEP, 1989). The justification for this came in 1989 from specifics in the Environmental Effects Assessment Panel. In addition, the Technology Review Panel in 1989 concluded it was technically feasible to decrease the production and consumption of the five controlled CFCs, carbon tetrachloride, and methyl chloroform by at least 95 per cent (UNEP, 1989, p. 9). The concept and justification for phase-out of chemicals thus began in 1989. In the following section, how the international regime developed politically is reviewed.

3.1.3. Institutional Background: Formation and Structure of the Regime

International interest in the matter of ozone depletion escalated in the mid 1970s as scientific understanding of the CFC's potential to deplete the ozone layer grew. The formation of the regime started in the late 1970s in the form of international negotiations between groups of countries, but nothing was formally agreed upon until 1985[3]. During this time, evidence and research on the ozone regime fluctuated and grew, with it a variety of political interest and commitment on the matter as well (Parson, 1993). The Vienna Convention for the Protection of the Ozone Layer (1985) was signed into being by 20 countries plus the European Community (Wettestad, 2002). The Convention was a loose framework, the looseness of which was criticized by the ambitious countries that had hoped for a legally binding protocol. Shortly after the adoption of the Convention, however, UNEP convened negotiations for the following two years, eventually leading to the Montreal Protocol in 1987 (Wettestad, 2002). Regardless of the Protocol's ratification, the political structure and functioning bodies of the regime are dually reliant on both the Convention and the Protocol.

The targets of the Montreal Protocol were first negotiated from 1985 to 1987. In 1986, the United States' lead negotiating position was an immediate freeze in CFC consumption,

[3] The United States, Norway, Sweden and Canada banned nonessential use of CFCs in aerosols in the late 1970s (Parson 1993). The first international initiative took place in 1977 in the form of a United Nations Environmental Program (UNEP) meeting on ozone. The meeting resulted in a "World Plan of Action on the Ozone Layer" that coordinated research taken by national and international agencies through the "Coordinating Committee on the Ozone Layer" (CCOL), which until 1982 remained the governing body on the issue (Skodvin 2000b).

followed by phased reductions to zero, and scientific review to determine whether the cuts were adequate or not. Earlier in 1986, it had been announced that substitutes could be available within five years given the right market conditions, despite the fact that the substitutes would be two to five times more costly to produce (Parson, 1993). Despite slow progress due largely to dissent by the European Community, by April 1987 a draft text was produced as the basis for the Montreal Protocol (Parson, 1993). The final agreement consisted of 50 percent cuts from 1986 levels of production and consumption of the five principal CFCs by 1999; in addition to a freeze in 1990 and a 20 percent cut in 1994. Three halons were frozen at 1986 levels starting from 1993. The total production and consumption of CFCs and halons were determined by measuring each chemical by its ozone depleting potential (ODP) (The Montreal Protocol, 1987). The Montreal Protocol was to enter into force upon receiving eleven ratifications representing two-thirds of 1986 CFC consumption. This happened on January 1, 1989 with thirty parties representing 83 percent of global consumption (Parson, 1993).

The protocol distinguishes in multiple ways between countries and recognizes differences in level of consumption and production of ODSs. Developing countries operate under Article 5 of the Protocol, whereby countries whose annual consumption was less than 0.3 kg per capita received a ten-year grace period and other nations could increase production limits by 10 percent for export to meet these countries' "basic domestic needs" (The Montreal Protocol, Article 5, 1987). Countries producing less than 25,000 metric tons per year could transfer their production quotas to other parties for the purpose of industrial rationalization (UNEP, 2009, p. 6). In the 1990 London amendment, developing countries were further considered and measures that discriminated against them were revised (Parson, 1993). In addition, financial and technology transfer provisions were implemented in partial benefit for these countries, most notably the Multilateral Fund (UNEP, 2009; Parson 1993).

As with many international environmental regimes, science has an integral role in the regime (Haas, et al., 1993). The Conference of Parties (COP) to the Vienna Convention hosts a Meeting of Ozone Research Managers that meet every three years. The group, which is made up of government experts on atmospheric research, reviews relevant national and international research and monitoring and then produces a report to the COP. In addition, the Montreal Protocol established the Ozone Trends Panel which administers three panels of experts that meet at least one year prior to each assessment: a Scientific Assessment Panel, a Technology and Economics Assessment Panel, and an Environmental Effects Panel (WMO, 2010). Ad hoc groups on data and reporting and destruction technologies supplement these official panels (Wettestad, 2002, p.163).

At the time of regime formation, science and research was quickly advancing (Parson, 1993). Almost immediately after the Montreal Protocol was signed, new scientific information against CFCs was released, information that was channeled through the Ozone Trends Panel, the initial panel of the regime (Parson, 1993). Information in the WMO/UNEP *Scientific Assessment of Ozone Depletion* in 1989 on the status and expected future of the ozone hole was that the hole would fill when chlorine returned to 2 parts per billion, which – even with a global phase-out of CFCs - was not predicted to occur until 2060 (UNEP, 1989; Parson, 1993).

These 1989 recommendations were taken into consideration in 1990 at the second meeting of the parties (MOP-2) in London. Here, amendments were made to the original Protocol that strengthened control measures and timetables for CFCs, halons, carbon tetrachloride, methyl chloroform, and nonbinding resolutions were made on other halons and the substitute HCFC (UNEP, 2009, p.16). At the 1992 meeting in Copenhagen (MOP-4), the evidence for ozone-layer depletion was growing increasingly grim and existing phase-outs were accelerated and controls added on other chemicals – including methyl bromide, commonly used as an insecticide (Parson, 1993; UNEP, 2009).

Negotiations on methyl bromide (MeBr) would reoccur from this point forward as being controversial, largely because of its use in agriculture. The US and the EU advocated the acceleration of the phase-out of the chemical, but only within the context of a US loophole to the phase-out date of the chemical for critical use exemptions (CUE)[4] in agriculture (Gareau, 2010, p. 226). This issue returned in 2003 at the MOP-15 in which parties were not able to resolve disagreements on requests for critical use exemptions (CUEs) for MeBr. Negotiations were suspended and taken up at an Extraordinary MOP, where disagreement prevailed on the matter of long term CUE beyond 2005. The disagreements continued into the MOP-16 in 2004, where the US led a veto that culminated in deadlock. By the MOP-18 there were fewer CUEs requested and the decision was made to defer consideration of the controversial elements in order to progress elsewhere (Chasek et al., 2010, p.174).

At the MOP-9 in 1997 in Montreal, the phase-out date for MeBr was accelerated from 2030 to 2005 (for details see Annex I). At MOP-9 the issue of illegal trade of CFCs was also addressed. The MOP-11 in Bejing agreed to phase out the newly developed

[4] This is not to be confused with the Montreal Protocol's CFC "essential use exemption.""

bromochloromethane, and strengthened controls on MeBr. The Bejing amendment also banned trade in HCFCs with countries that did not ratify the Copenhagen amendment, but that had introduced the HCFC phase-out at home (Chasek et al., 2010, p.170). HCFCs were again addressed in the MOP-19 in Montreal (2007). The phase-out, originally scheduled for 2030, was moved forward to 2020, for developing countries from 2040 to 2030. The decision was influenced by the pertinence of HCFC for climate change, as well as ozone depletion (Chasek et al., 2010, p.170).

In the MOP in Doha, the Multilateral Fund for the Implementation of the Montreal Protocol was the subject of attention as developing countries needed assurance that the HCFC accelerated controls would be possible, as this was agreed upon in the MOP-19. The 2009 MOP addressed the issue of destruction of ODS that are stored as waste, which will continue to be on the agenda for MOPs in the future, particular as such storage in developing countries becomes more common place as developing countries begin to phase out more chemicals (Chasek et al. 2010, p.174).

Other Institutional Attributes of the Regime

Technology transfer was integral to the process of switching from ODS such as CFCs, to HCFCs (and later HFCs). In Article 10a of the Protocol, transfer of technology is defined only in brief, as being supported by the Multilateral Fund in order to ensure that substitutes are "expeditiously transferred" to Article 5 parties and that it occur in fair and favorable conditions (UNEP, 2009, p.21). By 2007, more than 240 sectors with products dependent on ODS halted most uses within 10 years and were satisfied with the performance of substitutes (Andersen et al., 2007, p.46). A "significant" part of technology transfer occurred voluntarily through multinational companies, industrial associations (Andersen et al., 2007,p.295). However, a large part of technology transfer is accredited to the MLF, which accounts for the finance and support of 5520 projects (USD 2.1 billion) as of 2007 to 143 developing countries (Andersen et al., 2007, p.31)

The compliance mechanisms of the Montreal Protocol are addressed in Article 7 which demands parties report statistical data on production, imports, and exports (or amount used for feedstock or recycled, depending on the substance) of the controlled substances within three months of when the given substance control goes into force for the respective party (The Montreal Protocol, Article 7, 1987). Developing countries operate under Article 5 of the Protocol and are required to submit data on the production, imports, exports, and consumption (use) by sector to the Secretariat (UNEP, 1999, p. 2).

In Article 8 of the Protocol it was recommended that at the first meeting of the Parties a non-compliance measure be determined, which now exists as the Non-Compliance Measure (UNEP, 2009, p.19). The Implementation Committee consisting of ten parties was established in 1990. At the Ninth Meeting in Montreal 1997, Parties recognized that the accurate, timely, and comprehensive reporting of data had emerged as a critical component of the Protocol and agreed to create a handbook that would assist parties in fulfilling their reporting obligations (Decision IX/28) (UNEP, 1999, p.1).

The procedure follows such that National Ozone Units (NOUs) report to the Secretariat and the Secretariat reports the data to the Meeting of the Parties. Based on this, compliance is assessed by the Implementation Committee under the Non-Compliance Procedure of the Protocol (UNEP, 1999, p.3). Consequences of non-compliance can result in three measures i) assistance where appropriate, such as in the data reporting phase, technical assistance, technology transfer, financial assistance, or information training; ii) "issuing cautions;" ii) suspension of specific rights and privileges under the Protocol, in accordance with rules of international law (UNEP, 2009, p.506-508).

The Montreal Protocol has evolved over time, facilitated in part by regime design. Evidence for this is the adjustment procedure for already controlled substances that does not require ratification process for some of the decisions made in the regime (Wettestad, 1999, p.159). Also, the Protocol demands review of regime regulations as stated in Article 6 of the Montreal Protocol: "Beginning in 1990, and at least every four years thereafter, the Parties shall assess the control measures provided for in Article 2 and Articles 2A to 2I on the basis of available scientific, environmental, technical and economic information" (The Montreal Protocol, Article 6, 1987)

To date, the Montreal Protocol controls ninety-six chemicals. Annex I shows the most recent version of timetables and control measures for the most relevant ODSs. In the industrialized countries the following chemicals have been phased out: halons, CFCs, carbon tetrachloride, methyl chloroform, hydrobromofuorocarbons, bromochloromethane, and methyl bromide (with exceptions). In developing countries hydrobromofluorocarbons, bromochloromethane, CFCs, halons, carbon tetrachloride have been phased out as of 2010, while methyl chloroform and methyl bromide will be by 2015, and HCFCs by 2030. In 2009, the Protocol celebrated the 196 parties that have ratified the Montreal Protocol, making it officially universal (UNEP, 2009). Table 4 below summarizes the design and attributes of the international ozone regime.

Table 4: Summary of Regime Design and Attributes of the International Ozone Regime

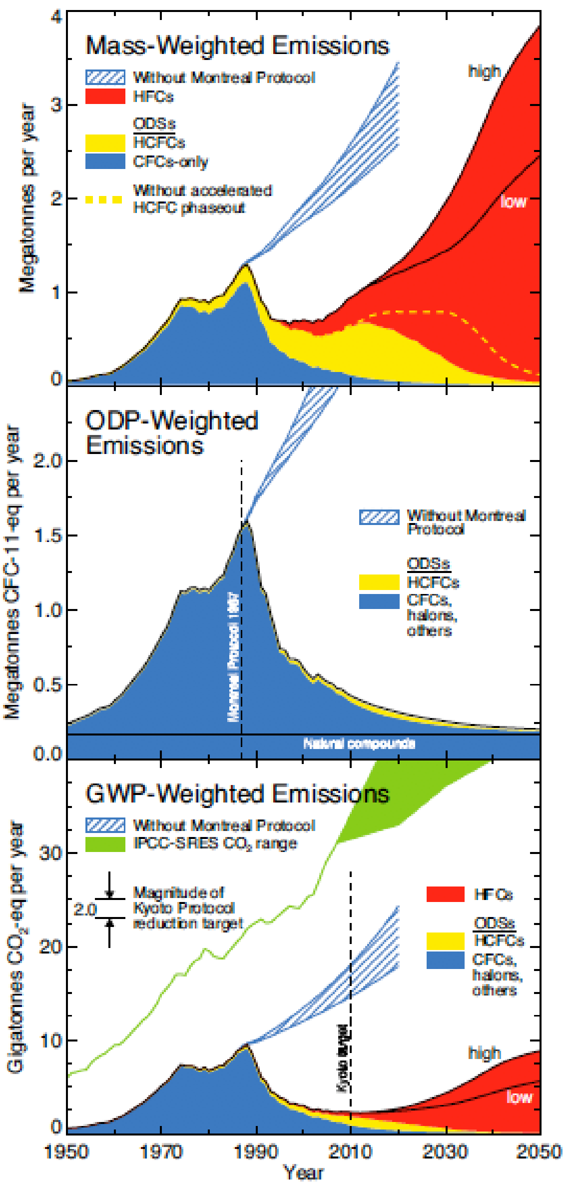
Form of output	**Vienna Convention (1985)**	**Montreal Protocol (1987, enforce 1989)**	**Amendments – current outcomes**
Number of countries ratified	196	196 Universal as of 2009	Varies, - 195, 192, 182, 167
Share of global emissions covered	N/A	Ratification by at least 2/3 of global consumption of ODS by 1986 In 1989 accounted for 83%	Information unavailable, see phase-out timetables in Annex I.
Mitigation commitments	No specific obligation – "The Parties shall take appropriate measures.. to protect human health and the environment against adverse effects resulting… from human activities which modify… the ozone layer" Article 1	Original: 8 chemicals regulated, a 50% reduction in CFCs from '86 baselevel by '99. Halons were to be frozen at '86 base year in '94.	96 chemicals regulated to date (See Table 1 for full details on control measures) MOP1 (1990)- all CFCs and original Halons phased out by 2000. Non-binding resolutions made on other halons and HCFCs.
Legal status	Not legally binding	Legally binding	Legally binding under the Montreal Protocol
Long term goals, timetables	Legal ability to create protocol and amendments	Allows for amendments to original timetables, See phase-out timetables in Table 1. Insert maximum years (original)	Acceleration of timetables for phase outs occur at COPs of the Montreal Protocol Insert maximum year(s)
Mechanisms for Technology transfer	Nothing specific	Outlined in Article 10a- reliant on the Multilateral Fund [1]	←
Mechanisms for Finance	Nothing specific	Multilateral Fund for the Implementation of the Montreal Protocol	←
Mechanisms for Compliance/Sanctioning	Nothing specific	Trade sanctions, reporting requirements, Implementation committee assess compliance based on reporting; *no penalties for non-compliance*	←

3.1.4. Emission trends subsequent to the formation of the ozone-layer protection-regime

In the following section, emissions activity that has occurred after the regime's outputs have been produced will be reviewed. A distinction between emissions and accumulation in the atmosphere is important. Emissions of chemicals focuses on behavior as the source point where as accumulation refers to the actual presence of the chemicals in the atmosphere.

Prior to 1987, emissions of Ozone Depleting Substances were increasing at a substantial rate (WMO 2010). Of these, 90percent of emissions in 1986 were in the OECD countries (Andersen et al., 2005, p. 278). As is clear from Figure 4, after 1987 and the enactment of the Montreal Protocol, emissions of major ODSs decreased 85percent by 2005 (Andersen et al. 2005). The worldwide production of CFCs fell from 1.1 million tons in 1986 to 35,000 tons in 2006 (Chasek et al., 2010, p.176). HCFC emissions increased more rapidly than expected while CFCs decreased more slowly than expected. The reason for a slower CFC decline is due likely to emissions from so called "banks" of CFCs in appliances that are already produced, such as refrigerators, air conditioners, and foams. Carbon tetrachloride emissions also declined slowly over the past decade (WMO, 2010, p.1).

Figure 4: Emissions of ODS and their Substitutes (WMO, 2010a, p. 3)



Emissions are increasing of the first CFC substitute developed, the HCFC, which has a shorter lifetime and ODP than CFCs. Emissions of HCFC-22, increased 50percent faster in 2007-2008 than in 2003-2004. HCFC-142b has increased about two times as fast. However, the total emissions of HCFCs are projected to begin to decline during the coming decade due to measures recently agreed to in the Montreal Protocol (WMO, 2010a, p. 2)

A non-chlorine substitute – the HFC – is currently being phased-in instead of HCFC (Wettestad, 2002). While HFCs are non-ozone depleting, they have a longer life span and a higher GWP than the HCFCs they are substituting. CO_2 equivalent emissions of HFCs are increasing by 8percent per year, which is expected to grow as HCFCs decline in the coming decade (WMO, 2010a, p. 2). HFC-23 (a byproduct of HCFC-22 production) has a particularly large GWP with a lifetime of about 220 years. It is regulated under the Montreal Protocol and the Kyoto Protocol's clean development mechanism (WMO, 2010a, p. 3). It is expected that HFC emissions will increase, largely by Article 5 countries following an assumption that trends will follow what has been observed in developed countries. The increase in emissions is not only because of their substitution for CFC/HCFCs regulated in the Montreal Protocol, but combined with economic growth and an increase in living standards (Daniel, et al., 2010, p. 28). In Figure 4, the differences between ODP and GWP of ODSs are displayed, along with projections for emissions of the future and the respective ODP/GWP effect.

3.1.5. Environmental Change Subsequent to the Formation of the Ozone Regime

1994-1995 was the peak of chlorine and bromine ODS species accumulation in the troposphere as is measured by equivalent chlorine (ECl), and a decline has been occurring since. This decrease is attributed to the decline of the short-lived methyl chloroform and somewhat to methyl bromide. At the time of the 2005 Assessment of Ozone Depletion, the abundance of ECl in the atmosphere had decreased 8percent from the maximum value seen in 1992 and 1994 (WMO, 2006). In the 2010 Assessment, total tropospheric chlorine had declined from 2005-2008, albeit at a slower rate [5] than in previous years, and two thirds more slowly than expected (WMO, 2010)[6]. The peak of tropospheric abundance of chlorine from ODS and methyl chloride of 3.7ppb, had declined by 2008 to 3.4ppb (WMO, 2010a, p. 1).

In addition, stratospheric levels of chlorine and bromine also declined during the period of 2005-2008 (WMO, 2010). As CFCs and halons have lifetimes of several decades to a few centuries, decline in stratospheric chlorine and bromine levels down to the values observed prior to 1980 will take decades to observe (WMO, 2010). This time lag is exemplified in the 14-20km layer of the Antarctic stratosphere where most of the ozone resides. Each year from late August to early October nearly all of the ozone is destroyed (WMO, 2010) despite apparent improvement mentioned above. Likewise, the Arctic ozone depletion often is highest during the spring of the past decades but is dependent on other factors such as atmospheric dynamics, transport, and temperature. In April 2011 the highest

[5] From 2007-2008 decreased at 14ppt, from 2003-2004 decreased at rate of 21ppt (Forster, 2010)
[6] This is likely due to the increasing HCFC and CFC banks emissions trends described in 3.1.3

recorded level of ozone column loss in the Arctic was recorded at 40percent (WMO, 2011). Thus, while chemical levels measured have slightly decreased, global ozone levels have not seen a substantial decrease or improvement since the minimum point in the mid-1990s (WMO, 2010).

The slower than expected declines in accumulation are likely because of increases in HCFC emissions, and partially due to CFC banks. The HCFC and HFC substitutes have posed new questions for research on the interaction between these chemicals and increases in temperature in the troposphere (WMO, 2010). This will be discussed further in chapter four.

3.1.6. Summary of the International Ozone Regime Empirical Findings

This presentation of the ozone layer depletion regime has encompassed the data necessary to assess regime effectiveness. The nature of ozone depletion has been portrayed as a problem first theorized about in the 1970s, and which was later proved to be occurring by the beginning of the 1980s. The science regarding ozone depletion was new at the time of regime formation, but new research provided evidence to both a growingly large emissions problem, and observations of the problem were confirmed (such as the presence of a hole in the ozone). In addition, research on potential impacts on human and natural ecosystems reiterated the importance of replenishing the ozone layer for life on earth. The holes in the ozone layer in the Antarctic and the Arctic have not decreased or increased in recent years.

At the time of adoption of the Montreal Protocol, the science was not year clear on what was needed to restrict further depletion. However, evolving research corresponded with subsequent amendments and accelerations to the original timetables, calling for phase-outs for some chemicals in some countries. In addition, ODSs have been added for regulation as evidence arises of their potency increasing the extent of the overall regime’s reach. The regime has also had to address substitutions for the regulated ninety-six chemicals. These substitutes are currently the focus of the regime, both in terms of their increasing emissions and their relevance for the climate regime. Although emissions of ODS have decreased, as is evidenced by decreases in accumulation in the atmosphere of chlorine and bromine, progress has not occurred as quickly as expected. The regime is universally ratified, and targets exist for all countries, although developing countries have been given flexibility in achieving their targets. After having reviewed the ozone regime, in the following section the same process will be completed for climate change.

3.2. Climate Change Regime: Problem Description, Regime Attributes, Emission Trends, and Environmental Change

3.2.1. The Nature of the Problem

The ‘greenhouse effect’ is the earth’s natural method of warming the planet that is vital for maintaining a livable climate for the planet’s inhabitants. Anthropogenic increases in emission of gasses (known as greenhouse gasses – GHG) intensify the greenhouse effect and this is causing an overall increase in the Earth’s temperature resulting in changes in climate. Scientists have found that even small increases in temperature can cause large changes in climate, changes that have already been observed and are expected to increase (Chasek et al., 2010; Le Treut et al., 2007). The Intergovernmental Panel on Climate Change defines climate change as a “change in the state of the climate that can be identified by change in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer” (Le Treut et al., 2007, p. 30).

Climate change is a complex phenomenon within an already complex and dynamic climate system whereby multiple factors beyond greenhouse gasses contribute to its behavior (Young 2010). The field of atmospheric and earth science has grown since the 1980s but modeling and predictions are of yet exact, enhancing uncertainties regarding the effects of climate change. Additionally, the anthropogenic causes of climate change are complex in that they derive from multiple sources of multiple types of pollutant. The GHGs that have increased considerably since 1750 are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). In addition, increases in halocarbons such as peroflourinated hydrocarbons (PFCs), hydroflourocarbons (HFCs), and sulphur hexafluorideas (SF_6), well as indirect greenhouse gasses such as SO_2, NOx, CO and NMVOC. These gasses have differing impacts on the green house effect, which is described as Global Warming Potential (GWP). For example, methane and hydroflourocarbons have a higher GWP than carbon dioxide. However, carbon dioxide is the largest threat for global warming because it is emitted in such huge quantities due to the (burning) of fossil fuels, other GHG are referred to in research with their GWP in terms of carbon dioxide equivalent (UNFCCC, 2004).

GHG emissions from the burning of fossil fuels accounts for 77 percent of all GHGs, while deforestation and methane emissions account for most of the remaining GHG emitted (Le Treut et al., 2007). Since the pre-industrial era, CO_2 has increased in the atmosphere by 30 percent, from 275 ppm to 369 ppm in 2008. Seventy-six percent of the world’s emissions of GHG originate from 20 countries (Bernstein et al., 2007, p. 37).

3.2.2. The Earth's Threshold for Climate Change and Scientific Advice on the Solution to the Problem

Determining levels of what is dangerous for the Earth is based often on normative judgment rather than on science; however, this does not mean that science does not have ways of estimating, predicting, and modeling how the Earth will respond to anthropogenic change. There are two ways that the IPCC and policymakers generally operationalize the effects of climate change in the sense of earth's capacity – one is concentration of GHG in the atmosphere (as presented in CO_2 equivalent measurement) and the second is via temperature change. In the following section I will briefly review political and scientific recommendations for the threshold of these two effects before undesirable impacts of climate change occur.

In the beginning of the climate regime in the late 1980s[7], the available scientific information suggested that a 2 degree Celsius increase would be the maximum temperature before the risks for the most detrimental climate change effects would increase rapidly (IPCC, 2007b, p. 99). In 2006, renowned climate scientist James Hansen concluded that warming of more than 1° C (relative to 2000) and a maximum CO_2 at 450ppm would be "dangerous" in context of sea level rise and extermination of species (Hansen et al., 2006). In 2008, Hansen and colleagues updated their recommendation suggesting CO_2 be reduced from the current 385ppm (growing at 2ppm/year) to 350ppm in order to avoid irreversible ice sheet and species loss (Hansen et al., 2008). 350ppm is quickly becoming the targeted number by scientists and climate mitigation advocates. Most scientists certainly agree that it is critical that we prevent concentrations of GHG from rising above 540ppm, which is two times that of preindustrial levels (Young 2010, p. 83; Steffen et al., 2004). Variations on the number depend on calculations of the climate system's slower feed back mechanisms, modeling decisions, and definition of the concept of "danger" for the Earth's ecosystems and climate.

Recommendations from an economic perspective can differ, even within the field. The Stern Review (Stern, 2006) argues that concentrations of GHG need to be stabilized below 550ppm CO_2 equivalent. Other authors have argued decisions regarding the cost benefit analysis of climate change are reliant upon decision on a particular discount rate (Nordhaus 2007 (Nordhaus, 2007), thereby rendering policy decisions on what type of policy, to what cost, and timeframe of policy complex.

[7] These initial groups were the WMO, International Council of Scientific Unions (ICSU), UNEP, and the Advisory Group on Greenhouse Gasses (AGGG).

The 2007 report estimates that, if 2000 emissions were held constant, the best estimate for temperature rise by the year 2090-2099 would be between 0.3-0.9 C. Given six models of change in GHG emissions, however, the range of potential temperature changes (relative to temperatures from 1980 -1999) would be from 1.1 C (best estimate at low scenario end) to 6.4 C (at the high scenario end) (Meehl et al., 2007, p. 5). The IPCC indicates that a 50-85 percent decrease in emissions (base year of 2000) is needed to prevent concentrations of GHG in the atmosphere from increasing above 450ppm and temperature increase of 2 degrees by 2050 (IPCC, 2007b, p. 15; Young, 2010). Whether the climate regime has included these recommendations and empirical evidence on the current emissions behavior and environmental quality will be presented in the following sections.

3.2.3. Institutional Background: Formation and Structure of the Regime

The UN Conference on Human Development in Stockholm in 1972 is generally regarded as the first introduction of international efforts towards understanding how humans affect the global climate (Skodvin, 2000a). It was not until 1979 at the World Climate Conference when the World Climate Program was first organized. From 1979 until the late 1980s (see Annex I for a detailed chronology), a movement gathered as international organizations became increasingly interested in negotiating a solution.

The IPCC was the first intergovernmental institution to be established in 1988 in order to fill the gap for an internationally coordinated scientific assessment of climate change. The first session began in November 1988 with the goals of synthesizing and i) assessing the scientific information related to the issue and the information needed to evaluate the environmental and socioeconomic consequences, and ii) to formulate response measures for how to manage the issue (UNFCCC, 2004, p. 12; UNGA, 1988).

The IPCC produces the most comprehensive scientific reports of synthesized peer reviewed research on the climate change issue. The Assessment Reports have been produced in 1990, 1995, 2001, and 2007. Research on the fifth assessment report is currently underway. The origin of the UNFCCC and the Kyoto Protocol both correspond with the timing of the release of assessments (IPCC, 2011). In 1990, when the first assessment was submitted, governments realized that the problem was serious. The assessment reported that if nothing was done, global mean temperature would increase by 0.3 degrees Celsius per decade, causing melting in the polar ice caps and a rise in sea level, which was predicted to be up to 65 centimeters by the end of the 21^{st} century (IPCC, 1990). The report emphasized that preventing the problem would require stabilizing the concentration of GHG in the atmosphere to 1990 levels, translating to a 60percent reduction in emissions (IPCC, 1990).

Discussions aimed at designing a convention began in December 1990[8] and formal negotiations for a climate convention were underway in February 1991 (Chasek et al., 2010, p.184). The leading coalition of states[9] ideally wanted to ideally organize a framework convention and a protocol to control emissions to 1990 levels by 2000. The United States and the Soviet Union, however, rejected the idea of setting a target and timetable for controlling emissions in a future climate regime. One year after discussions had begun there was no resolution on the issue. Entering into 1992, US participation at the United Nations Conference on Environment and Development (UNCED) Earth Summit in Rio de Janeiro was contingent upon the UNFCCC draft text containing no binding commitment to control GHG levels (Chasek et al., 2010, p.185). Participation of the United States was preferable, and thus the text did contain a binding commitment.

The United Nations Framework Convention on Climate Change was finally adopted on May 9 1992, with the 'framework' text negotiated as best possible, and the leading countries left with hope of setting the stage for later more stringent actions (UNFCCC 2004). The convention was opened for signature at the Earth Summit in June 1992; 154 states and the European Community signed the convention. The convention entered into force when it received fifty ratifications on 21 March 1994 (UNFCCC, 2004). Today, there are 190 countries that are Party to the Convention (UNFCCC, 2004).

The United Nations Framework Convention on Climate Change (UNFCCC)

The convention regulates greenhouse gasses that are not regulated by the Montreal Protocol (see Part I of this chapter). The primary gasses of concern are carbon dioxide (CO_2), methane (CH4), nitrous oxide (N2O), peroflourinated hydrocarbons (PFCs), hydroflourocarbons (HFCs), and sulphur hexafluoride (SF6). The convention divides countries into three groups according to their differing commitments. Annex I parties (41 countries) include the industrialized countries that were members of the OECD in 1992 and

[8] Initial coalition of states: Finland, Netherlands, Norway, Sweden v. United States. The leading states wanted to organize a framework convention and a protocol controlling emissions, to be completed no later than one year after. The US only wanted talks on a framework convention with no negotiation on protocols, arguing that regulating carbon releases would require too massive of changes. Finally, Japan broke ranks with US and Soviet Union and committed itself to stabilizing GHG emissions to 1990 levels by 2000. Only US and Soviet Union remained in rejecting a target and timetable for controlling emissions in a future climate regime (Chasek et al., 2010, p.185).

[9] The EC, Australia, Austria, Denmark, Germany, Japan, the Netherlands, and New Zealand

countries with economies in transition (EIT) (14 countries), such as the Russian Federation, the Baltic states, and several Central and Eastern European States (UNFCCC, 2011d). These parties aim to return their emissions by 2000 to earlier levels (1990 chosen by the EC) (UNFCCC, 2004). Specifics regarding timetables for targets, or emissions reduction targets after 2000 were not addressed. Countries are not legally committed to hold themselves to the targets. Parties are required to submit reports on the implementation of the convention, particularly policies and measures taken on the state level to reduce GHG emissions (UNFCCC, 2004).

Annex II parties (24 developed countries) are a subset of Annex I. They are the OECD members from Annex I, but do not include the EIT Parties. Annex II parties are required to provide financial resources to enable developing countries to adapt and mitigate climate change effects. In addition, they should "take all practicable steps" to promote technology transfer to EIT and developing countries, funneled through the Convention's mechanisms (UNFCCC, 2011d).

Finally, Non-Annex I Parties are primarily developing countries. These are states with the Non-Annex I countries that are considered especially vulnerable to climate change, in particular low-lying coastal areas, those prone to desertification, or drought. Other countries in this group may rely on income from fossil fuel (production and commerce) and may be vulnerable to the economic effects of climate change. There are 49 parties classified as least developed countries (LDCs) by the United Nations. These parties are given special consideration by the convention due to their limited capacity in being able to respond to climate change's adverse effects (UNFCCC, 2011d). They are required to follow general commitments to respond to climate change, but they have fewer specific obligations and can rely on external support in order to meet their goals. They are required to "provide a general description of steps taken or envisaged in order to implement the Convention and estimate emissions of GHG" (UNFCCC, 2004).

The UNFCCC is the framework around which the regime's structures are based. All Parties to the convention meet annually at the Conference of the Parties (COP). In addition, the Convention's text established important norms and principles for the regime to follow. Of note was the "common but differentiated responsibilities" (Article 3, United Nations Framework Convention on Climate Change, 1992). This principle backed the aforementioned country differentiations by recognizing differing levels of economic development, vulnerabilities, and assigning commitments based on this classification.

The Kyoto Protocol

Movement towards a protocol started to be negotiated shortly after the EC community signed the Convention, despite remaining lack of interest by the US and Russia. At the first Conference of the Parties (COP) to the UNFCCC in March 1995, it was decided that quantitative limits on GHG emissions beyond 2000 would be negotiated by 1997 (Chasek et al., 2010, p.185-187). As negotiations continued through COP-2 and progressed until COP-3 (1997), differences between the leading states and the veto states were large. A point of contention was that the U.S. delegation would not accept any emissions reduction unless developing countries also formally agreed to control their emissions, which was not acceptable for the developing countries (Ibid.).

The Kyoto Protocol was regardless negotiated at the COP-3 in 1997. It requires industrialized-country parties to Annex B to reduce their *collective* emissions of six different GHG (listed in Annex A) by at least 5percent below their 1990 levels between 2008 and 2012. Exceptions were made for some country targets, for example there are distinguishable differences between targets of the veto states and the EU. Australia, for example, lobbied for a decreased reduction target (8 percent) due to particularly large reliance on fossil fuel exports in the economy. The US accepted a target of 7 percent[10] reduction from base year of 1995 (as opposed to 1990) (Kyoto Protocol, Annex B). The EU received an 8 percent reduction. An agreement (voluntary or binding) for developing countries (Non-Annex I) was not included in the Kyoto Protocol (The Kyoto Protocol, 1997).

The Kyoto Protocol expects that countries meet their reduction targets primarily through national measures. To this aim, the Protocol includes "flexibility mechanisms" that are market based and which would assist in the process (UNFCCC, 2011c). The mechanisms (Emissions Trading, the Clean Development Mechanism (CDM), and Joint Implementation (JI) have multiple goals: they should instigate sustainable development through technology transfer and investment, they should assist with reduction of carbon in atmosphere in a cost-effective manner, and would encourage the private sector and developing countries to contribute to emission reduction efforts (UNFCCC, 2011c).

The mechanism of emissions trading, as described in Article 17, created what is now known as the carbon market (UNFCCC, 2011c). It functions such that Annex I parties with excess emissions credits can sell its credits to an Annex B Party that is unable to meet its commitments. Carbon Development Mechanism, as described in Article 12, is a procedure

[10] Note that the US is a signatory to the Protocol but has not ratified.

through which developed countries can finance or invest in projects that avoid or help reduce GHG emissions in developing countries. In return the investing country receives credits that can be applied towards meeting limits on their own emission (UNFCCC, 2011a). Joint implementation (JI) as described in Article 6, is similar to the CDM, only in that it is between industrialized countries and economies in transition (the former Soviet bloc). Joint implementation projects must result in emission reduction or removals that are greater than what would have otherwise occurred.

The Kyoto Protocol could enter into force after at 55 parties to the convention accounting for at least 55 percent of the CO_2 emissions in 1990 ratified it. Most developing and small island state nations ratified immediately, but Annex I countries used subsequent COP meetings to address remaining issues – such as exact operationalization of the flexibility mechanisms until COP-7 in 2001 (Morocco) (Chasek et al, 2010). At that time, it was questioned whether the Protocol would be ratified. The United States announced familiar opposition to the Protocol on grounds that it did not include large economies like China and India as members of the non-Annex I group. The Protocol could be ratified without the US, but the US decision had ability to alter the decisions of other economically powerful countries.

By 2004, 120 countries had ratified the protocol and 44 percent of 1990 emissions were represented. The focus was on recruiting Russia to ratify, as it represented 17.4 percent of 1990 emissions thereby allowing for the needed 55 percent of emissions. Incentives for Russia were numbered as it was assumed that they would benefit from the flexibility mechanisms. On November 18, 2004 they ratified, and the Kyoto Protocol officially entered into force on February 16, 2005 (Henry & Sundstrom, 2007, p. 47). By 2009, there were 188 countries and the European Community that had ratified the Kyoto Protocol. The US remains the only Annex I Party to the UNFCCC Convention that has not ratified the Kyoto Protocol.

The compliance system of the Kyoto Protocol is based on the general compliance mechanism of the Convention and the UNFCCC says it is one of the most rigorous found in international treaties (UNFCCC, 2004, p. 85). The Compliance Committee is "facilitative" rather than punitive, with two branches, one Facilitative Branch and one Enforcement Branch each having separate responsibilities. The Enforcement branch is responsible for non-compliance by parties that i) do not on GHG inventories, ii) not meeting emissions targets, or iii) eligibility requirements under the mechanisms. In the case of non-compliance with targets, measures such as deduction of emissions at a rate of 1.3 times the amount of excess emissions from the Party's emissions in the second commitment phase, suspension from eligibility to participate in the emissions trading, or preparation of a compliance action plan (UNFCCC, 2004, p.86). Currently, there are four countries that have been issued questions of implementation: Croatia, Bulgaria, Canada, and Greece which have been questioned for several different reasons – regarding emissions trading quotas, reporting, national system implementation. The stated repercussions are that the country will submit a plan to address the non-compliance in three months, and that it cannot participate in CDM or alternatively emissions trading (UNFCCC, 2011b).

Decision making in the Kyoto Protocol is grounded in the consensual approach established from early on in the UNFCCC. The Convention stated that parties should make every effort to reach agreement on any proposed amendment or annex to the Convention by consensus. If all efforts were to be exhausted, then the amendment could be adopted at a three-quarters majority vote (Article 15 of UNFCCC and 20 of Kyoto Protocol). The consensus-based decision-making makes it difficult to come to agreement, but is at the same time important for UN platform. After a consensus has been arrived at, there are guidelines for amendments. Article 20 and 21 of the Kyoto Protocol states that amendments to the Protocol will enter into force for those regime members that provide a written consent This means that members can easily opt out of adjustments and targets (Young, 2010, p. 99).

Post 2012-Framework

As soon as the Kyoto Protocol entered into force, attention turned to negotiating the second commitment period after the first 2008-2012 period. Article 3 of the Kyoto Protocol states that the parties will use the COP of the UNFCCC to negotiate and consider subsequent commitments, but no detail is provided about whether the post-2012 commitment would be negotiated as an extension of the Kyoto Protocol or as a new agreement under the larger UNFCCC framework (Article 3.9, The Kyoto Protocol). At the Montreal COP11 in 2005, it was determined that COPs would consist of two parallel tracks associated with the two related agreements - the Protocol and the Convention. Montreal was the 11th Conference of the Parties (COP11) to the UNFCCC, and also the 1st Meeting of the Parties (CMP1) to the Kyoto Protocol. It is considered vital for the continuation of the regime that the processes run parallel to each other in order for the non-parties of the Kyoto Protocol (developing countries and the United States) to maintain their participation in the regime.

Given the complexity of negotiating the second commitment period, it was important to set a path for the process. Climate analysts believed it was important to avoid a post-2012 gap between the Kyoto Protocol and any subsequent policy that could potentially cause uncertainty for economic and political order and a further fragmented system (Chasek et al., 2010, p. 194). It was decided that at COP13 (2007) in Bali, Indonesia, a plan for negotiating post-2012 would be set. Thus, the Bali Action Plan was to provide guidance for the next two years leading up to the COP15/CMP5 in Copenhagen, Denmark where it was hoped a post-2012 framework would be adopted.

The Bali Action Plan accounted for both of the parallel tracks – the UNFCCC track (Ad Hoc Working Group on Long-term Cooperative Action) and the Protocol track (Ad Hoc Working Group on Further Commitments for Annex I Parties under the Protocol). The Bali Action Plan agenda included discussing national and international action on mitigation for developed and developing countries, adaptation, technology transfer, financial support, and investment, in addition to options for emissions reduction targets for the Annex I parties and potential commitments for post-2012. At the 2008 COP14 in Poznan, Poland these agenda items set by the Bali Action Plan were not thoroughly negotiated[11] (Chasek et al., 2010, p. 198). Progressing towards the Copenhagen meeting questions remained unanswered about the post-2012 framework. Would the next agreement be a continuation of Kyoto Protocol or something new entirely? Would it be binding vs. voluntary commitments, short term v. long term, total emissions vs. sources of emissions, mechanisms to assist developing countries, focus on adaption vs. mitigation?

The COP15 in Copenhagen was expected to be the meeting during which the post-2012 framework would be negotiated. However, as COP14 had foreshadowed, concerns about global financial crisis and recession on the horizon weakened hopes for political dedication to the matter. In addition, the United States, considered a necessary player for successful negotiations, was unable to domestically address climate change while national politics were focused on other politically heated topics (Bang, Froyn, & Hovi, 2009).

The result of the COP15 was the Copenhagen Accord. The Accord was the product of a small group of heads of state - the United States, China, India, and Brazil. It was not formally adopted at the COP and has no formal standing in the U.N. negotiations. 130 countries have associated themselves with the Accord and 80 have submitted specific mitigation pledges, as is suggested to be done voluntarily by the Accord (Pew, 2010). The Copenhagen Accord included a constructive start for negotiating a financing mechanism, and

[11] The COP14 outcome was likely influenced by the global financial crisis that reduced focus on climate change and increased worries that economic issues would overshadow emission reductions. In addition, the presidential election in the US created political uncertainty regarding the American position in 2009. The validity of these explanations, however, are not further addressed in this thesis.

provided progress on discussions regarding forestry and technology transfer and theoretically signified cooperation between the world's largest polluters. However, the political aftermath of the COP/CMP was skepticism of the international regime's ability to negotiate a solution for climate change (Dimitrov, 2010).

The following COP16/CMP6 in Cancun, Mexico resulted in the "Cancun Agreements." The Agreements did not resolve the remaining issue of how to continue with the Kyoto Protocol or a binding agreement post 2012, as the divide between developing and developed countries remained insurmountable. Specific mitigation pledges were not changed or particularly addressed in the Cancun Agreements, but were referenced in both the convention decisions and the Kyoto decisions. In the Convention-track decision developing countries agreed to take nationally appropriate mitigation actions (NAMAs) while being supported by technology and finance with the goal of some reduction by 2020. Developed countries are encouraged to increase their level of ambition to consistent with the "level consistent with the Fourth Assessment Report of the Intergovernmental Panel on Climate Change" (UNFCCC, 2011 -b).

Cancun Agreements further defined mechanisms introduced in the Copenhagen Accord: the Green Climate Fund, mechanisms on adaptation, technology, forestry, and monitoring, reporting, and verification (MRV) (Pew, 2010). For finance, the convention track decision uses the financial goals of the Copenhagen Accord which was $30 billion in fast-start finance for developing countries in 2010-12, and by 2020 $100 billion a year in public and private finance for mitigation actions and transparency on implementation. In Cancun, parties decided to establish a Green Climate Fund under the guidance of the COP, which will be governed by 24 members from developed and developing countries (Pew, 2010). This is a new development, because until this point, the regime has relied on the Global Environmental Facility (GEF) to provide the funding needed by non-Annex I countries in order to implement development strategies that are less energy intensive (Young, 2010, p.96). The GEF operates outside the realm of climate change and is susceptible to the influence of other institutions like the World Bank, UNDP and UNEP (Young, 2010, p. 97). The regime relies on Article 11 of the UNFCCC, which refers to the establishment of a "mechanism for the provision of financial resources on a grant or concessional basis" and requires that it include equitable representation of all Parties in transparent system (Article 11, UNFCCC 1992). In the Article countries are obligated to provide "new and additional financial resources to meet the agreed full costs incurred by developing country Parties" (Article 11, Kyoto Protocol 1997).

Closely related to the financing mechanism, another area of progress from recent negotiations has been in the area of technology transfer. Technology transfer under the Convention requires that developed country Parties and other developed Parties in Annex II shall take all steps possible to promote, facilitate, and finance as appropriate the transfer of, or access to, environmentally sound technologies and know-how to other Parties, especially developing countries (Article 4.5, UNFCCC 1992). At COP16 a Technology Mechanism was designed, which consists of a Technology Executive Committee (TEC) and a Climate Technology Centre and Network (CTCN) in replacement of the Expert Group on Technology Transfer (EGTT) (UNFCCC, 2011f).

Both the Copenhagen Accord and the Cancun Convention-track decision set a goal of limiting average global warming to below 2°C above pre-industrial levels, and asked for periodic review of this long-term goal, with an option for strengthening the goal to 1.5 degrees. A timeframe does not currently exist, but it is recommended that at COP17, parties suggest a timeframe for the peak of global emissions and an emissions goal for 2050 (Pew, 2010).

The agenda for the remaining part of 2011 leading to COP17 is large and includes addressing the legal form of a future climate agreement and a review of country mitigation commitments (UNFCCC, 2011e). As this thesis goes to print, the most recent round of negotiations in Bangkok, Thailand in early April was the first meeting after Cancun where negotiators addressed the Cancun Agreements in preparation for the COP17 in Durban, South Africa where the post-2012 framework will again be addressed. Developing countries made it again clear in Bangkok that they want a continuation of the Kyoto Protocol and it is unclear how flexible developed countries will be (UNFCCC, 2011e). In Table 5 below, the summary of the regime attributes and legal products to date is presented.

Table 5: Summary of Regime Design and Attributes of the International Climate Change Regime

Form of output	UNFCCC (1992 [1994])	Kyoto Protocol (1997 [2005])	Amendments – current outcomes
Number of ratified countries	195	193 Parties, 37 to Annex B, 63.7% of Annex I countries are parties	Copenhagen Accord (not adopted or ratified)
Share of emissions covered	N/A	55% of total Annex I CO_2 emissions for 1990	N/A
Mitigation commitments	"Stabilization of GHG concentrations…that would prevent dangerous anthropogenic interference with the climate system.." (Article 2, UNFCCC)	Parties to Protocol amount to 55% of global emissions Annex I Parties follow reductions in Annex A gasses (GHG) to the given amount in Annex B (-8% to +10%), with view to reduce overall emissions by at least 5% below 1990 levels from period 2008-2012.	Cancun – recognizes Annex I countries should need 25-40% below 1990 levels by 2020 16 Annex I countries have provided emission reduction targets for 2020
Legal status	Not legally binding	Legally binding during commitment period of 2008-2012	Not legally binding – part of negotiations for post 2012
Long term goals, Ambition for timetables	(None)	Mitigation targets are for 2008 – 2012	Suggested a 2° maximum temp rise, above pre-industrial base, with an option for review and alter to 1.5° (date not stated) National targets for 2020 voluntarily suggested
Mechanisms for Technology transfer	TT:Clear (website) Technology Framework, designed/imple. 2001 Expert Group on Technology Transfer (EGTT)	CDM, JI, improve technology transfer Subsidiary Body for Scientific and Technological Advice (SBSTA)	Technology Executive Committee (TEC) Climate Technology Center and Network (CTCN)
Mechanisms for Finance	COP guidance to GEF which can provides support to projects	The Adaptation Fund is financed from proceeds on CDM activities and other sources of funding. Amounts to 2% of certified emission reductions (CERs) issued for a CDM project.	Green Climate Fund – $30 billion 2010-2012, $100 billion by 2020
Mechanisms for Compliance/Sanctioning	(Minimal) Reporting of GHG inventories. Subsidiary Body of Implementation reviews effectiveness.	Compliance Committee reviews national reporting and system for GHG inventories. The Enforcement Branch determines compliance. Punitive measures: emissions reductions in 2nd commitment period, suspension from ETS, compliance plan.	Reporting system by Annex I and non-Annex I countries of mitigation efforts, and (for Annex I) data on finance, technology, and capacity support. No punitive measures in response.

3.2.4. Emission trends subsequent to the formation of the climate change regime

In the following section, greenhouse gas emission trends are reviewed, as this is the primary source of anthropogenic climate change. In this section, emissions trends are measured by emissions from anthropogenic sources of greenhouse gases only.

Greenhouse gas emissions have been rising since pre-industrial times, particularly since the 1970s. The IPCC uses two databases to measure emission trends, and both of which show that since 1970, the global warming potential (GWP) weighted emissions of GHGs[12] have increased by 70percent (or 24percent since 1990) (Rogner et al., 2007, p. 102). Carbon dioxide is the largest source of anthropogenic emissions (77percent), having grown 80percent since 1970, and 28percent since 1990 (Ibid.). The largest source of GHG emission originates from the power generation and road transport sectors, which from 1970 to 2004 grew by over 145 percent and 120 percent respectively, largely in the form of CO_2 emissions. There has also been growth in GHG emissions in the industrial (65 percent), residential and commercial sector (26 percent), Land use Land-use Change and Forestry (LULUCF) (40 percent), and the agriculture sector (27 percent) from 1970 to 2004 (Ibid.). The growing emission trends are summarized in Table 6, through growth from 1970, and growth subsequent to regime formation.

Table 6: Emissions trends from 1970 and subsequent to regime formation

Emissions growth in chosen GHG, from 1970 – 2004 and 1990 – 2004. (Data from IPCC 2007)		
	Growth in emissions 1970 - 2004	Growth in emissions 1990 - 2004
Global Warming Potential weighted GHG emissions	~70%	24%
Carbon dioxide (CO_2) from the combustion of fossil fuels	80%	28%
Methane (CH4)	40%	11%
N2O[13]	50%	11%

Aggregated global emissions have therefore *increased*. Although this study bases its assessment on aggregate measurements, regional data is of relevance for the climate regime

[12] Not including ODS, which are controlled by the Montreal Protocol
[13] Increase use of fertilizer and aggregate growth of agriculture

because both the Convention and Protocol differentiate between countries in their targets. North America, Asia, and the Middle East have led the rise in emissions since 1972 (Rogner, et al., 2007). While Annex I (developed countries) hold a 20 percent share of world population, they account for 46.4 percent of global the GHG emissions. Non-Annex I countries (developing countries) host 80 percent of the world population and account for 53 percent of GHG emissions (Ibid.). Twenty-five countries accounted for 85 percent of global emissions, and the same 25 countries account for 87 percent of global GDP (Baumert, Herzog, & Pershing, 2005, p. 11). An additional difference is that Annex I countries have a lower energy intensity per unit of economic production process than the non-Annex I countries (Rogner et al., 2007).

Aggregate emissions have increased, but *some countries are decreasing emissions*. The 37 countries and the European Community party to the Annex B of the Kyoto Protocol are projected to aggregately decrease emissions by a projected 11 percent by 2012, which is more than the required 5 percent for the commitment period 2008-2012 that is required by the Protocol (UNFCCC United Nations Framework Convention on Climate Change, 2011 -a). As already presented in 3.2.3, the Kyoto Protocol does not regulate global emissions, particularly the 35 percent of global annual CO2 emissions produced by the United States and China (Congressional Research Service, 2008).

In the absence of regulation, the current estimations by the International Energy Authority and the US Energy Information Administration are that ― global growth will be more than 55 percent from 2006 levels of energy-related CO_2 emissions, with a growth rate of 1.7 percent (IEA) to 2 percent (US EIA) per year until 2030. These estimates are 40-110 percent higher than in 2000; 25 to 75 percent of this would belong to non-Annex I countries (Rogner et al. 2007, p.109). GHG emissions are projected at a 25-90 percent increase from base year of 2000 (IPCC, 2007, p. 97). Scenarios that account for the climate policies currently under discussion show GHG emissions increasing for many decades. The IPCC reports that emissions at or above current rates would induce changes that would be likely larger than those already observed during the 20th century (Meehl et al., 2007, 10.3).

3.2.5. Environmental Impact Subsequent to the Formation of International Climate Change Regime

In this section, the environmental impact subsequent to the formation of the climate change regime will be presented. In the climate regime the institution that analyzes and presents assessments on the scientific and anthropogenic effects and causes of climate change is the IPCC. The IPCC Fourth Assessment Report (2007) or the most recent data available will be utilized in this study. For climate change, the appropriate measurements of environmental changes chosen are those evidenced in the concentration of GHG in the atmosphere, as well as biophysical changes on the earth.

Atmospheric CO_2 concentrations have increased by almost 100ppm in comparison to preindustrial level of 280ppm reaching 379ppm in 2005 (IPCC, 2007a, p. 37). For April 2011, the data registered for atmospheric CO_2 was at 393.18ppm (NOAA, 2011).The total CO_2 equivalent concentration of all long lived GHGs, is currently estimated to be at 455 ppm CO_2-eq, but with land use-change and other air pollutants included decreases that level to somewhere between 311 and 435 ppm CO_2-eq (IPCC, 2007, p. 97). From 1995 to 2005 the annual CO_2 concentration growth has been larger (1.9ppm) than it was since the beginning of continuous direct atmospheric measurements from 1960 to 2005 (average of 1.4ppm per year) (P. Forster et al., 2007). The 350ppm target would need to be attained within the next few decades in order to avoid the most adverse effects of climate change (Hansen et al, 2008). The earth has not been below 350ppm since 1988, which was prior to the formation of the regime (NOAA, 2011).

The IPCC estimates that from 1901-2005 the increase in temperature *per decade* was 0.069-0.017, while from 1979-2005 it was 0.188-0.069 (Trenberth et al., 2007). The linear warming trend[14] from 1965 to 2005 is almost twice what it was from 1906 to 2005 (Trenberth, et al., 2007). Arctic temperatures rose on average almost twice the global rate in the past 100 years. During the period 1995-2006, eleven of these ranked among the twelve warmest years in instrumental record of the global surface since 1850. Model experiments estimate that even if all radiative forcing agents were held constant at the year 2000 levels, warming would continue at rate of 0.1 C per decade (Trenberth et al., 2007 , 9.4). It is very likely that Northern Hemisphere temperatures during the second half of the 20th century were higher than any other 50-year period in the past 500 years, and likely that it was the highest in the past 1300 years (Jansen et al., 2007).

As a result of climate change, sea level has risen at a rate of 1.8mm per year from 1961 – 2003. From 1993-2003 the rate is faster, at 3.1mm per year. This is due to thermal expansion of the oceans (57 percent) and decreases in glaciers and ice caps (28 percent), with the remaining amount from melting of the polar ice caps (Lemke et al., 2007, pp. 6-8). Arctic sea ice has shrunk by 2.7 percent per decade with decreases in the summer at 7.4 percent. In

[14] Linear warming trend 1965-2005: 0.13[0.10 to 0.16] degrees C per decade

addition, mountain glaciers and snow declined in both hemispheres – the extent of seasonally frozen ground has decreased by about 7 percent in the Northern Hemisphere since 1900. Temperatures at the top of the permafrost layer have generally increased since the 1980s in the arctic by up to 3 degrees Celcius (Bindoff et al., 2007; P. Forster, et al., 2007; Lemke, et al., 2007). As measured by the indicators of environmental impact and change of climate change, concentrations of GHG are increasing, temperature rise has accelerated, and other changes such as sea level rise and decreasing ice extent have been observed. For other relevant changes that have occurred as a result of climate change, see Appendix III.

3.2.6. International Climate Change Regime: Summary of Empirical Findings

This review of the climate change regime has provided this study with the data necessary to assess effectiveness. The nature of the problem has been presented as being highly complex, both because of its drivers, the climate system at large, and the multiple consequences related to human-induced climate change. Uncertainty remains, but the Intergovernmental Panel on Climate Change and other academic research since the 1980s has shown that the impacts of warming temperatures are already causing observable changes on Earth. Although assigning a threshold for Earth's capacity to adapt to these changes is a more difficult task than modeling and observing the changes, science has shown that a CO_2 level of 540ppm is at the upper reaches of what is tolerable, and current research maintains that 350ppm is what is necessary to maintain stability in the climate system.

The formation and structure of the regime has its origins from 1972, but it was in 1992 that the UNFCCC was adopted, and 1994 when it entered into force. Due to its lack of specific mitigation targets and lack of a legally binding mechanism, work towards a Protocol started shortly thereafter. After negotiating for years, and the addition of multiple flexibility mechanisms that made it ultimately easier for countries to comply with targets, the Kyoto Protocol was adopted in 1997, and entered into force in 2005. The Kyoto Protocol is a legally binding treaty, which requires countries to reduce their emissions based on 1990 GHG emission levels from the first commitment period of 2008-2012. Although the countries party to targets in the Annex B of the Protocol are estimated to have reduced emissions by 11 percent in the 2008-2012 commitment period, *global* emissions have increased since pre-industrial times, since the 1970s, since 1990, and since 2000. Concentration of CO_2-equivalent GHG in the atmosphere has also increased. In addition, changes have been observed due to climate changes.

4. How Effective are the International Climate Change and Ozone Depletion Regimes in Terms of Output, Outcome and Impact? Case-internal and Comparative Classificatory Analyses

This chapter is the culmination of this thesis's quest to explore regime effectiveness, classify two cases in terms of regime effectiveness, and then compare them in this regard. The goal of this chapter is to present a structured evaluation of effectiveness of the climate and ozone regime, with as much transparency as possible. In order to do this, the chapter will be split into three sections. The first is an intra-regime classification of effectiveness for each regime individually along the three indicators – output, outcome, and impact. Assessment of the regime's effectiveness is conducted via comparison with standards that include elements of the collective optimal solution for each indicator. In using these standards, the theoretical underpinnings and framework presented in Chapter 2 is necessary. In that chapter, indicators were selected and justified. Also, the decision made regarding the standard to which the indicators would be compared was described in detail (see 2.5). Assigning a level of effectiveness to a regime is related to the difficulties of assigning levels of tolerance to changes in the physical environment. Such an evaluation of what constitutes danger cannot only be delegated to science, but involves normative and thus political judgment. When Parties agree to reach an agreement, the agreement will reflect a synthesis of what impacts are deemed tolerable from the perspectives of the human and natural systems. In this chapter, assessment of regime effectiveness is completed through a combination of scientific and political judgments reflected in each standard, resulting in a hopefully robust description of effectiveness.

Following the classification, a summary for each regime's effectiveness is presented with the scores assigned. This is a necessary precursor to the subsequent comparison of regimes in terms of effectiveness. The rating of effectiveness scores will be given in prose at the ordinal level in the form of "high," "medium," and "low," a scale that has also been utilized by Wettestad (1999:12). Transparency is maintained throughout this section and the study by using selected indicators, thorough empirical mapping of the data the indicators consist of, and clear description of the standard against which the indicator is being evaluated (see chapter two for details on the analytical framework). Finally, a comparative analysis and areas of interplay between the two regimes will conclude the chapter.

4.1. The Regime Effectiveness of the Ozone Layer Depletion Regime

4.1.1. Output Effectiveness

To measure effectiveness along the output indicator, I return to the operationalization of output as the norms, principles, and rules of the regime. In this section, empirical data as mapped in chapter three is compared against the ideal of an effective regime in terms of output that was defined in chapter 2.3.1. This indicator is expressed as the Montreal Protocol, which is the universally ratified primary agreement of the regime. The output indicator is evaluated in terms of three sub-indicators: ambition of targets and legal status; differentiation; and other attributes of institutional design.

Ambition of Targets and Legal Status

An important factor in determining output effectiveness is the measurement of ambition of targets. The measurement of ambition that best reflects the concept of collective optimum (see 2.5) explores how adaptive the regime is to science, the share of global emissions accounted for in the regime, the number of countries ratified, and the legal status of agreements.

When the Montreal Protocol was adopted, policymakers were not aware of either the full consequences of the problem, nor the optimal mitigation solution. When the first Scientific Assessment Panel presented the first comprehensive report on ozone depletion, however, the regime began a pattern of amending the Protocol through dynamically adapting to new scientific information. This included adding control measures for new chemicals or accelerating timetables for phase-outs of others. This tight match between scientific advice and target negotiation offers a picture of effectiveness.

Output effectiveness for this regime would not, however, be complete without reference to two chemicals for which regulation was not at the optimal level of meeting scientific advice and ambition: HCFCs and Methyl Bromide (MeBr). Of particular note is the discussion of substitutes for CFCs – which involves HCFCs and HFCs. The innovation of substitutes can be interpreted as a consequence of the ambitious targets set for CFCs. The targets were successful in creating a stable market that stimulated a response from industry to create substitute chemicals. Substitutes have played a large role in countries ability to phase out CFCs, evidenced by increasing emissions of HCFCs. When new scientific research showed that HCFCs, while having a smaller ODP than CFCs, had a high GWP and for this reason the phase-out for HCFC was accelerated in 2007. This created an additional round of industry reaction in the design of a new substitute - the HFC. The HFC has an even higher global warming potential than the HCFC, although its ODP is nearly zero. HFCs are currently *not* regulated under the Montreal Protocol, but are in the 'basket' of greenhouse gasses included in Annex A of the Kyoto Protocol. Scientists project that although increased emissions of HFCs will not be destructive to the ozone layer, they will contribute to climate change.

This is indicative of the ozone regime having targeted the ozone depleting substances, but not the purposes for which the substances are used. Thus, although overall ozone depletion is being mitigated via targets and timetables (as evidenced by lower emissions and production – see following section) an alternate environmental impact (climate change) is occurring as a consequence of the regime. To conclude, the example of substitutes in the Montreal Protocol is one that can be considered to have both facilitated and restricted effectiveness of the regime. On the one hand, targets have been complied to with the use of substitutes, on the other, the use of substitutes has not absolved ozone depletion, nor has it removed the source of the problem. In addition targets appear to have alternate effects on another atmospheric problem: climate change. Thus, the example of HCFCs and HFCs does not take away from the ambition of the targets, but provides a reason for concern for the future of this effectiveness.

In addition to substitutes, another chemical has proven to be challenging for the Montreal Protocol to regulate. Since the 1990s, methyl bromide had been suggested for rapid phase-out because of its threat to human health as a toxic pesticide and its ozone depletion potential (Chasek et al. 2010:169). The US and the EU had taken measures to control it domestically, but internationally the US managed to have a loophole approved that allowed for "critical use" (see chapter three). The treatment of MeBr therefore differs from the treatment of CFCs in the Protocol, both language in the clauses and target setting are less stringent (Gareau 2010: 210). In 1997 the phase-out for methyl bromide was finally negotiated, but with delay and lack of ambition that is noted as an anomaly in documentaries of the ozone regime history. However, in as much as it is an anomaly, it exemplifies that the regime has faced conflict, and points to exogenous factors that may have played a role.[15] In addition, delay in regulating MeBr may attest to the extreme importance of substitutes in the regulation of other ODS (Gareau, 2010). Of the industry and companies involved in producing ODSs, the methyl bromide industry is the only remaining camp that claims alternatives and substitutes do not exist to this chemical (Andersen et al., 2005). The argument by industry is that MeBr cannot be regulated because of this. It was the first chemical to be commercialized in 1900 and the last to be added to the Protocol in 1992 (Andersen et al., 2005). The example of MeBr casts a shadow on the effective score of output effectiveness through evidence of lacking ambition in grappling with this chemical. If MeBr was as prominent as CFCs, for example, the regime might not have managed to attain such a high level of effectiveness.

Although there are exceptions to the level of ambition in target setting for all chemicals in the Montreal Protocol, the regime has shown a pattern of developing control measures based on scientific knowledge and advice and subsequent ambitious target and goal setting. Based on the level of ambition, the regime is at the outset highly effective. In the remaining review of *output effectiveness* for the ozone regime, other institutional attributes will be reviewed in order to complete a score for effectiveness.

Differentiation

The Montreal Protocol's now universal ratification means that it accounts for all emissions in its control measures. However, Article 5 allows for differentiation between the countries' timetables for control measures. In the ozone regime 'differentiation' means countries are subject to regulation, but they are offered a grace period of ten years for fulfilling commitments. This attribute of the legal framework of the regime has contributed to stark regional differences in behavioral trends, where developed countries have decreased emissions and developing countries have increased (see section below on outcome). Although the countries are differentiated, *all countries are accounted for in the Protocol.* The explanation for this will not be explored here, but are founded in the following section on institutional design. The important point is that, on the sub-indicator of differentiation, the ozone regime is highly effective as it enabled differentiation between countries (ensuring fairness), but still managed to incorporate developing countries into the regulatory scheme (Barrett, 2003, pp. 346-351).

[15] Exogenous factors (such as heavy lobby interest of the agricultural industry and countries which are represent these interests) that can explain the lack of ambition are not of discussed in this study.

Other Attributes of Institutional Design

There are several institutional mechanisms that reflect output effectiveness of the regime. The presence of a funding mechanism, The Multilateral Fund, assured countries that they could afford the implementation of the Protocol's regulations. Secondly, the restrictions on trade with non-parties preventing non-party countries to gain a competitive advantage over those party to the Protocol. Finally, the presence of a compliance mechanism dictated by Article 7 which requires that parties submit reports regarding emissions trends. The presence of these mechanisms result in an effective regime, as measured on the output indicator.

The formal Non-Compliance measure was adopted in order to handle cases whereby reporting did not occur, or when the standard wasn't met. Reporting problems have occurred (see 3.1.3.) The Multilateral Fund, one of the methods through which non-compliance is reconciled, is meant to act as assistance for implementation. In the 1990s it did not function as it was originally intended, but in more recent years has functioned well and is considered a positive attribute of the regime (Oberthür, 2001). The effectiveness of the compliance mechanism of the Montreal Protocol has been high.

In conclusion, output effectiveness for the ozone regime has been high. The Montreal Protocol, following the initially low ambition of the Vienna Convention, provided a legally binding ambitious Protocol, in the face of scientific uncertainty. When science provided insight into the repercussions of ozone depletion and what was needed to prevent them, negotiators strengthened amendments and targets were tightened.

4.1.2. Outcome Effectiveness

To attain goals set by the ozone layer depletion regime means to meet the targets and timetables of the Montreal Protocol. This includes the control measures (emissions and production regulation), control of trade with non-Parties, and reporting under Articles 7 and 9. Compliance has generally been good (Wettestad, 1999, p. 131). Instances of non-compliance to the Montreal Protocol have occurred in the reporting data, but since 2001 compliance has been observed (Andersen et al., 2005).

Emissions and production of ozone depleting substances have decreased by 85 percent (as of 2001) since the Montreal Protocol was adopted in 1987 (see 3.1.2). Current assessments by the SAP estimate that emissions would have continued to rise at 6 percent a year without the Montreal Protocol (WMO, 2010).

Due to the decreases in CFC consumption and production, emissions trends of the past decade highlight a sharp increase in the emissions of HCFC, the substitute for CFC (see *output effectiveness).* In 2010, HCFC emissions were larger than what was projected in 2006, and it is estimated that emissions of HFC (the substitute for HCFCs) will follow a similar upwards trend as HCFCs. This is connected to economic growth and subsequent increased emissions in the Article 5 countries, where the grace period for phase-outs allows for larger emissions for a longer period of time (see 3.1.3). This trend is reason for caution in the assessment of effectiveness on this sub-indicator. However, as this thesis assesses the regime only at the current point in time, concerns about future trends do not contribute to the score.

As measured against the standard of the regime's political agreements (goal attainment), the ozone regime's effectiveness according to the outcome indicator is highly effective. As stated in the Scientific Assessment Panel:

> "The success of the Montreal Protocol and its subsequent Amendments and Adjustments is evident from the large decreases in the production of ODSs since their peak at the end of the 1980s, from the large decreases in emissions, and from decreases in mid-latitude EESC (equivalent effective stratospheric chlorine) since the middle of the 1990s that are expected to continue throughout the 21st century" (WMO, 2010, p. 5:33).

4.1.3. Impact Effectiveness

There are several ways to operationalize the impact indicator for ozone layer depletion, one of which is mentioned in the above quote. The method determined for this study was the one most compatible for both regimes as a common metric. This is the concentration in the atmosphere of, for the ozone regime, chlorine and bromine in the troposphere and stratosphere [16] or for the climate regime, CO_2-equivalents. This measurement has a closer association to emissions trends, and is thereby closer to measuring the causal mechanism between the regime and environmental improvement. An alternate method for measuring impact of the ozone regime is by measuring the amount of ozone (or amount of ozone depletion) present in the atmosphere. The ozone layer regime will be assessed on both of these measurements in this section.

Scientists measure "improvement" by using a baseline of 1980. The year 1980 is used as representative of the time before major stratospheric ozone losses occurred due to halocarbons (WMO, 2010, p. 10). In the 2010 Assessment, it was projected that returning to 1980 levels of equivalent effective stratospheric chlorine would occur in the year 2014-15,

[16] Chlorine and bromine are the byproducts of ozone depletion in the atmosphere by ozone depleting substances. Refer to chapter three for more info.

which is one year less than projected during the previous Scientific Assessment[17]. Despite the progress evidenced by declining chlorine and bromine in the atmosphere, the 2010 Assessment reported that decreases in tropospheric chlorine were slower during 2005-2008 than in earlier years and compared to what was projected during the baseline scenario of the 2006 Assessment. In addition, the SAP 2010 contends that the there was an underestimation of CFC emissions from banks in 2006 (see 3.1.5). Regardless of minor setbacks, combined with the data of chlorine and bromine concentrations are evidence of an improving environmental quality towards the scientific goal of pre-1980 levels and a therefore medium effective regime.

The second measurement of the impact indicator for the ozone regime is operationalized by the amount of ozone. The global level of ozone, while being 2.5-3.5 percent less than pre-1980 levels, has remained relatively constant since 1999 (minimum was approximately 1994) (WMO, 2010). This may be due to the long lifetime of the chemicals regulated in the regime (CFCs range from 45-100 years) which means that despite decreases in recent emissions, the effect will not be noticed in the ozone layer for decades (Parson, 2003; Andersen, 2005).

In conclusion, the impact indicator - as assessed against scientific recommendations as the collectively optimal solution for the planet – provides evidence of a slight decrease in atmospheric concentration of chlorine and bromine towards the goal of returning to pre-intensive ODS emissions era. This operationalization of impact shows a more optimistic view of the regime's impact than measuring levels of ozone. Actual levels of ozone remain depleted, as well as the holes above the Antarctic and Arctic, but have not regressed since the mid 1990s, which the scientific panel assessment attributes to a well functioning regime. Given these data at this moment in time the regime is determined to be effective in improving the environmental quality, but has not yet attained the ideal scientific goal in either instance of indicator operationalization.

4.1.4. International Ozone Depletion Regime – Overall Effectiveness Summary

At this moment in time, the international ozone depletion regime scores as a highly effective international environmental regime, as measured along the three indicators of

[17] The assessment importantly notes that this is an estimation. If the estimation were only reliant on anthropogenic sources of chlorine than it might be more accurate.

output, outcome, and impact. This analysis has also presented evidence showing that although the regime is highly effective, there are signs of imperfection that serve as reservations for the

The ozone regime provides ample evidence of effectiveness in the output indicator along the parameters of ambition; and medium effectiveness along parameters of differentiation and other attributes of institutional design. The ambition and comprehensiveness of the Montreal Protocol attest to the regime's willingness to follow the advice of the research community on the matter. Recently, the regime has also included scientific research on the global warming potential of some ODS and ambition in this regard as well. The two instances of HCFCs and Methyl Bromide exemplify situations in which the Protocol's institutional capacity was not as flexible and responsive in adopting more stringent regulations. However, despite delay, the Protocol managed to account for these chemicals in recent amendments.

The Montreal Protocol has presence of institutional design attributes that reflect an effective regime. These include financial mechanisms, compliance measures, and technology transfer. These attributes are particularly relevant for Article 5 members of the regime, which rely on such mechanisms for complying with the regime's demands. Article 5 of the Protocol is both reason for effectiveness and ineffectiveness. While developing countries present a challenge because of increasing emissions behavior, they are regardless legally bound within the Protocol such phase-outs will occur, after the grace period.

The ozone regime has attained its goals of regulating ozone-depleting substances and is therefore highly effective on the outcome indicator. While ODS emissions trends have decreased and provide evidence of an effective regime, a worrisome trend is increases in the substitutes for ODS which are also GHG. These trends show that although ODS may be phased out, the purposes for which they are needed have not been. As developing countries continue to experience economic growth, the increases in substitute emissions may become more relevant to the regime. However, for the time being the outcome indicator shows evidence of a highly effective regime.

Measuring the impact indicator shows improvement in environmental quality and offers evidence of an effective regime. As mentioned above, impact is not yet the most complete indicator of effectiveness, as the effect of current policies on the natural environment will not occur for years. This is true when examining actual ozone levels as an indicator, which does not show any substantial change, but for which there has not been regression in conditions either. The ozone layer will likely not be able to recover for at least another 6 years, if not longer. Thus, on the measurement of this indicator, the ozone regime is effective: signs exist that improvement (or at least stabilization) has occurred, but it is yet too early to see whether the regime will be able to optimally solve the problem at hand. In the Based on the discussions in this section, in Table 7 the regime effectiveness results are presented for each indicator.

Table 7: International Ozone Regime Effectiveness Scores for the Output, Outcome, and Impact Indicators*

Output Indicators for Regime Effectiveness	**Output Effectiveness Score**	**Overall Score**
Ambition of targets • Share of world emissions accounted for in the agreement • How targets compare with scientific recommendations	High (w/ differentiation) High	*High*
Legal Status • Whether commitment declarations of intent are legally binding in international law? • Number of ratified countries	High High	
Differentiation (different targets and timetables that account for the various types of actors, taking into account variation in parties particular conditions)	High	
Other aspects of Institutional Design ○ Funding mechanism ○ Monitoring, reporting and verification mechanisms/review of national policies ○ Sanctioning mechanisms to apply in case of implementation failure ○ Scientific body with systematic dissemination of data and reporting	High Medium Medium/Low High	
Outcome Indicator	**Outcome Effectiveness Score**	**Overall Score**
○ Have emissions of ozone depleting substances decreased or been phased out in accordance to the goals set by the most recent amendments ratified? ○ Has aggregate global emissions decreased subsequent to the formation of the regime?	High High	*High*
Impact	**Impact Effectiveness Score**	**Overall Score**
○ Concentration of chlorine and bromine in atmosphere ○ Level of ozone in atmosphere	High (slight decrease) Neutral (stabilization)	*Medium-High*

* *For operationalization of the indicators and scoring scales, see chapter two. For empirical findings see chapter three.*

4.2. The Effectiveness of the International Climate Change Regime

4.2.1. Output Effectiveness

To measure effectiveness along the output indicator, I return to the operationalization of output as the norms, principles, and rules presented in chapter two. In this section, empirical data as mapped in chapter three is compared against the ideal of an effective regime in terms of output that was defined in chapter two. To evaluate regime effectiveness for the indicator of output one must examine the two main texts of the regime, the UNFCCC (1992) and the Kyoto Protocol (1997). This is because the Kyoto Protocol does not encompass all members of the convention. There are 195 countries party to the UNFCCC. There are 193 parties to the Kyoto Protocol, but only 37 countries plus the European Community are parties to Annex B. The regime operates on the philosophy that if non-Protocol ratified members can participate on some level that in the future a legally binding agreement could be made universal. The output indicator is evaluated in terms of three sub-indicators: ambition of targets and legal status; differentiation; and other attributes of institutional design.

Ambition of Targets

The adoption of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 was a loose framework that did not include legally binding mitigation targets. The Article 2 text describes the objectives of the UNFCCC:

> "The ultimate objective of this Convention …is to achieve… *stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.* Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."

The UNFCCC is not legally binding and is therefore not an ambitious product of the regime. In addition, the vague and unambitious mitigation target of stabilization is not specific and does not imply decreases in emissions. The UNFCCC while attesting to some level of political cooperation, results in a low score of effectiveness for this indicator.

The adoption of the Kyoto Protocol in 1997 showed improvement in level of ambition. The Protocol set legally binding mitigation targets for each country that was party to the Protocol, with the collective target of 5 percent decrease in emissions from 1990. The first commitment period was limited to 2008-2012. While the Protocol defines targets, the share of emissions regulated is small. In addition, lack of a long-term timetable lessens its ambitiousness.

How do the mitigation targets of the Kyoto Protocol compare with what is scientifically recommended? Current research and estimations for what is needed in terms of emissions reduction is dependent on what "climate goal" (i.e. the desired level of climate change) is used in the modeling. In section 3.2.2 it was reviewed the various thresholds the Earth is estimated to be able sustain of climate change.[18] An ambitious target could utilize the data presented by setting targets of *maximum temperature change, parts per million carbon dioxide, or emissions reductions.* Neither the Kyoto Protocol nor the Convention meets any of the suggested operationalizations of an ambitious target. Therefore, in its current form, the climate regime measures at a low level of effectiveness based on its level of ambition.

Differentiation

The lack of global participation in the Kyoto Protocol is a significant weakness of the Protocol. This is also a reflection on the UNFCCC, where the Annex I and Non-Annex I grouping has its origins (See 3.2.3). Non-Annex I countries are not legally bound under the Kyoto Protocol to any emissions reductions. This differentiation between countries is grounded in one of the central principles of the climate regime: the idea of "common but differentiated responsibilities" articulated in Article 3 of the UNFCCC. Because emissions of GHGs are not uniform across all regions and countries, this is a crucial aspect for assessing the ambitiousness of the climate regime. A very small number of countries produce the majority of global GHG emissions (see 3.2.4). This means that any agreement must somehow accommodate for variation in share of responsibility of the problem. Taking this into account in the targets, however, has had repercussions on the ambitiousness of the Protocol in that only Annex I countries are party to Annex B. Although the Kyoto Protocol could not enter into force without 55 percent of the Annex I emissions ratified and represented, the emissions limited by Kyoto represent only 32 percent of global emissions (Pew, 2005). Thus, differentiation in the climate change regime results in a score of low-effectiveness in this sub-indicator.

[18] See 3.2.2 for more information. Examples include: Emissions frozen at base-year of 2000 for 0.3-0.9 degree Celsius increase (IPCC); 60-80 percent decrease in emissions in order to prevent 450ppm.

Other Attributes of Institutional Design

The Kyoto Protocol included several mechanisms designed to enhance participation and cooperation globally (particularly for developing countries), encourage compliance, and assist in mitigating the problem. In practice, the presence of many of the mechanisms is indicative of effectiveness, but in practice many have not been as useful. This thesis does not go into depth on the success of the mechanisms and their consequences, however, has briefly presented the attributes of the institution and to what extent they represent regime effectiveness.

The *flexibility mechanisms* (the ETS, CDM, and JI – see 3.2.3) do not add to a greater level of success in the regime. They were introduced as ways to enhance abatement efforts, increase participation, technology transfer (UNFCCC, 2011c), and to decrease marginal costs differences of climate change abatement projects in Annex I and non-Annex I countries (Barrett 2003: 381). The flexibility mechanisms have generated confusion and have not always been utilized in the ways they were created. Because of this, it is argued that although they hold potential to do so, they reflect low- effectiveness.

In regards to the *finance mechanism* and closely related *technology transfer,* an effective design has not yet been implemented. Recent negotiations at COP15 and COP16 signal progress in this area. As technology transfer is largely based on the financing mechanism, the GEF has been the main actor involved in technology transfer projects mandated by the regime. The inadequacies of the funding mechanism affect technology transfer. Recent changes and report requests by the COP/CMP since COP13 reflect an interest by the regime to improve a less than effective system (UNFCCC United Nations Framework Convention on Climate Change, 2008). From what is currently ratified, technology transfer and the financial mechanism of the UNFCCC and Kyoto Protocol does not present evidence of regime effectiveness.

The compliance mechanism of the Kyoto Protocol is evidence of high regime effectiveness. According to the UNFCCC it is a rigorous system that is on par with the best of international treaties (UNFCCC, 2004, p.85). Currently, the compliance mechanism for the Kyoto Protocol manages non-compliance with the emissions targets has not been enforced yet, as the commitment period ends in 2012. The current cases of non-compliance are in regards to not implementing national systems (see 3.2.3). The compliance system is therefore well planned and well functioning, but the larger issue is that the Protocol’s lacking ambition makes compliance easier and non-compliance much less relevant.

The output indicator on the whole sends mixed signals as to how effective the regime is based on this measurement. The Kyoto Protocol was negotiated with several mechanisms that are considered innovative. However, without ambitious and encompassing targets, theoretically effective mechanisms cannot make up for the low effectiveness in other areas. The IPCC sums it up: “The numerous mitigation measures that have been undertaken by many Parties to the UNFCCC and the entry into force of the Kyoto Protocol in February 2005 are inadequate for reversing overall GHG emission trends” (IPCC, 2007b, p. 97).

4.2.2. Outcome Effectiveness

Measurement of the outcome indicator, as with the output indicator, must be measured against both the UNFCCC and the Kyoto Protocol. As is discussed above, the Convention does not set specific mitigation targets and is not legally binding (section 4.2.1), thus whether one has attained the target is rather subjective. However, the one feature of Article 2 that can be used as the standard is the goal of “stabilization” of emissions. Thus, one can question: have trends stabilized? Current data show that from 1970 to 2004 there was a 70 percent increase in GWP weighted GHG emissions, and a 24 percent increase since 1990, with mean annual growth rates from 2000-2005 higher than those in the 1990s (see 3.2.4). The IPCC states: “from an emissions perspective, we are not on track for meeting the objectives of UNFCCC Article 2” (Rogner et al., 2007, p.111). Thus, the goal set by the UNFCCC has not been attained; the regime is assessed at low-effectiveness for this sub-indicator.

The second goal of the regime is the Kyoto Protocol which sets clear mitigation targets and is legally binding and is therefore a standard by which we can compare current emissions trends (outcome) against. The Protocol required the parties to Annex B to regulate Annex A gasses to a level of 5 percent below a base-year of 1990. Current projection by the UNFCCC is that the overall reduction in this group of countries will be 11 percent (UNFCCC, 2011 -a). Thus, by the standard of the Kyoto Protocol as the goal, emissions trends are on track for meeting the targets operationalized and goal attainment. When operationalized in this manner, the regime is highly effective.

Thus, there are two different versions of the output indicator when accounting for both the Kyoto Protocol and the UNFCCC. While the effectiveness score for this indicator meets the requirements, it must be taken in combination with the output indicator score. There is a fundamental discrepancy rooted in the ambition of the Protocol’s targets and the goal attainment. This project does not seek to explain the assigned levels of effectiveness, however, for the sake of comprehensiveness, it is relevant to note that both endogenous institutional factors (lack of ambition) and exogenous factors (EIT countries significant reductions in emissions accounts for aggregate reduction) explain the regime's effectiveness as measured by meeting targets (Seter, 2011). A more demanding standard than goal attainment would allow for the conclusion that although the climate change regime has slowed growth in emissions in some countries, it has not kept them from increasing on a global scale. For this study, however, along the goal attainment standard, the regime presents a score of medium effectiveness.

4.2.3. Impact Effectiveness

As with the ozone regime, using indicator of impact for climate change can be operationalized in multiple ways. As was determined in chapter two, concentration of CO_2 ppm in the atmosphere will be utilized here as the common metric which enables comparison across the regimes. Accumulation of CO_2 in the atmosphere is a one-step removed measurement of anthropogenic *driver* of climate change (emissions behavior), but is not an *effect* of climate change. To measure climate change directly, the operationalization includes temperature change, sea level rise, diminishing icecaps, and changes in climate systems, etc. can be used (see 3.2.4). The operationalization used in target setting for policy makers as "yardsticks" are temperature change and parts per million of CO_2 concentrations in the atmosphere.

As is clearly indicated in section 3.2.5, atmospheric concentrations of CO_2-equivalent have increased since pre-industrial era, and have only accelerated since the formation of the regime. This increase in concentrations subsequent to the formation of the regime is evidence of a low level of effectiveness of the regime, or even a negative-effectiveness as the trend is in blatant opposition to any measurement of improvement on the issue.

The use of temperature increase can also be a measurement of the impact indicator, but it is not as direct of a measurement of the regime's impact as current concentrations of CO_2. In 2007 the IPCC reports that the linear warming trend for the globe has been in the range of 0.069 ±0.017 from 1901-2005 while from 1979-2005 it was 0.188±0.069 (P. Forster, et al., 2007). This increasing trend, even subsequent to the formation of the regime, is in opposition to what is recommended by scientists in order to avoid detrimental impacts of climate change. This aggregate regression in biophysical conditions reflects a planet that is, thus far, unaffected by the presence of the international climate change regime, rendering the regime at a low level of effectiveness.

4.2.4. International Climate Change Regime – Overall Effectiveness Summary

The international climate change regime's effectiveness as measured by the output, outcome, and impact indicators, shows an overall picture of an ineffective international environmental regime. Despite this discouraging overall score, the individual indicator scores provide more subtle information, some of which is optimistic. Following is a summary of regime effectiveness for the international climate change regime.

The climate regime provides evidence of low effectiveness when measured on the output indicator along the standard of what ideal regime attributes are present in institutional design. The indicator, while being overall negative, does present some mixed messages. Along the parameter of ambition the regime is definitively low in effectiveness. Along the parameter of differentiation the regime ranks both low and medium, as differentiating is important due to the pattern of emissions, but has contributed to the unambitious and ineffective small share of emissions accounted for. Other institutional attributes of the regime are ranked low with an inclination towards medium. There is evidence of improvement on several mechanisms, the presence of a compliance mechanism and the flexibility mechanisms show potential, however, the lack of ambitious targets and timetables restrict these mechanisms from functioning to this potential. Ultimately, the UNFCCC and the Kyoto Protocol fail to meet a level of ambition that matches what is necessary for mitigating climate change.

Along the indicator of outcome, the climate regime is expected to attain the aggregate target set by the Kyoto Protocol for the first commitment period, implying an effective regime. Regime effectiveness as measured on the outcome indicator gives a confused message that can only interpreted in the context of the output indicator as well. It is difficult to use the Convention as a standard because of the lack of specificity in the targets. However, when measuring trends against the objective of "stabilization" the conclusion is that this goal has not been attained and the regime ranks at low-effectiveness.

An assessment of the impact indicator shows an aggregate decline in global environmental quality resulting in a score of low effectiveness, if not negative. This indicator was measured at two levels: one indicator being closer to behavioral change (concentration) and the other as the effect of increased concentrations (temperature). Neither indicator shows sign of improvement, thus neither indicate effectiveness. While the impact indicator is not an adequate measurement yet of regime effectiveness as environmental changes have a long time lag it is regardless an important indicator to measure. This will be discussed further in the conclusion. In Table 8, the scores from the above discussions are summarized.

Table 8: International Climate Regime Effectiveness Scores for the Output, Outcome, and Impact Indicators*

Output Indicators for Regime Effectiveness	**Output effectiveness Score**	**Overall Score**
Ambitiousness • Share of world emissions accounted for in the agreement • How targets compare with scientific recommendations	Low Low	*Medium-Low*
Legal Status • Whether commitment declarations of intent are legally binding in international law? • Number of ratified countries	Yes Medium	
Differentiation (different targets and timetables that account for the various types of actors, taking into account variation in parties particular conditions)	Low/Medium	
Mechanisms o Funding mechanism o Monitoring, reporting and verification mechanisms/review of national policies o Compliance mechanism o Scientific body with systematic dissemination of data and reporting	Low (current negotiating) Medium High High	
Outcome Indicators for Regime Effectiveness	**Outcome Effectiveness Score**	**Overall Score**
o Have emissions of greenhouse gasses stabilized in accordance to the UNFCCC? o Have emissions decreased in accordance to the Kyoto Protocol? o Have aggregate global emissions decreased subsequent to the formation of the regime?	Low High Low	*Low*
Impact Indicators for Regime Effectiveness	**Impact Effectiveness Score**	**Overall Score**
o Concentration (ppm) of CO2-equivalent GHG in the atmosphere? o Temperature rise	Low (Negative) Low (Negative)	*Low*

* *For operationalization of the score see chapter two, for empirical findings see chapter three*

4.3. Comparison of regime effectiveness between the International Climate Change and Ozone Depletion Regimes

In this last, crucial, main section of the empirical analysis chapter, I will compare the effectiveness of the two regimes along each indicator. The following table, along with the more detailed Table 7 and Table 8 in the above sections provide an overview of the main findings of the study until this point. In the following comparative analysis, the ozone regime and the climate regime will be compared along the parameters of output, outcome, and impact.

Table 9: Classification of Regime Effectiveness

Classification of Regime Effectiveness			
Indicator of Regime Effectiveness	**Operationalization of standard** *(see chapter 2 for details)*	**Ozone Layer** (Using most recent legally binding regime output)	**Climate Change** (Using most recent legally binding regime output)
Output	Ideal output for an effective regime – literature based optimum	High	Low
Outcome	Goal attainment – how has behavior met standards set by the regime?	High	Medium
Impact	What environmental improvement has been observed?	Medium	Low - negative

4.3.1. Comparing Effectiveness in Terms of Output

On the output indictor, the ozone and climate regimes vary significantly. This is despite the fact that the Kyoto Protocol was designed based on the Montreal Protocol, a function of similarity on the issue areas and timing. The Montreal Protocol is the model in this relationship. As Oberthür (2001, p. 360) notes, there is very little of the Kyoto Protocol that cannot be attributed to the Montreal Protocol. In particular, the development of convention to protocol was one first and fundamental decision. A comparison between the regimes' designs is presented in the following, in the understanding that although attempts were made to streamline these regimes by the original designers, in practice they have large differences. In doing this, the following regime attributes and norms will be compared: ambitiousness of targets, differentiation, flexibility and funding mechanism.

The most obvious variance when comparing the ozone and climate regime is on the parameter of ambition of targets. This is in regard to specificity of targets and share of emissions. In terms of the specificity of the targets, the Montreal Protocol has permanent emissions limits, while the Kyoto Protocol requires minimal reduction of emissions on a short-term time period. The Montreal Protocol has negotiated targets in response to scientific recommendations and newly developed research, while the climate regime has not shown capacity to respond with targets that resonate with what science recommends.

The difference in ambition extends to another key area of variance in the level of differentiation. Both regimes take into consideration differences in levels of economic development and emissions burden shares between regions and countries. This is an important when solving a problem of the global commons and was established as a norm in the ozone regime. However, accepting differing targets between developing and developed countries has multiple consequences. On the one hand, matters of fairness and equity must be taken into consideration in order to enhance participation on the part of developing countries and enhance regime accountability. On the other hand, on the long-term perspective, comprehensiveness in terms of share of emissions can be lost.

The ozone regime managed to allow for differences, while also regulating future emissions of the developing countries. The Montreal Protocol provides a grace period to developing countries, accounting for developing country emissions in control measures. The Kyoto Protocol, however, does not include developing countries in any form of regulation. In this sense the ozone regime's share of regulated emissions is universal, while the climate regime currently accounts for the emissions of only 37 countries.

One can wonder what explains why the negotiators of the Kyoto Protocol decided that the Kyoto Protocol was a tolerable consensus. The answer to this question is not within the scope of this study; however, of relevance to this matter is a discussion of institutional attributes that may have contributed to the lack of ambition. When the Kyoto Protocol was negotiated, it was believed that the development of the regime would follow the pattern of the ozone regime. The Montreal Protocol has evolved on a near annual basis. If the first version of the Montreal Protocol were the version in existence today - it would not have been scored highly effective. Flexibility was built into the Montreal Protocol, allowing it to adapt to new knowledge, make change or add amendments over time (Barrett, 2003) partially due to a built in flexibility mechanism in Article 6. The Kyoto Protocol has always been viewed as a first-step; negotiators believed that they could adapt the Protocol later, the way the Montreal Protocol had been able to (Young, 2010). However, partially due to regime design differences, the climate regime does not have the capacity to make adjustments the way the ozone regime has been able to.

While these design attributes are of relevance in this discussion, there are determinedly exogenous factors that are not addressed in the scope of this study that contribute to the variance between the regimes on this point. Both regimes began with discussions about the problem solving of the respective issues in the mid to late 1980s. The ozone regime's Vienna Convention was adopted in 1985. The UN Framework Convention on Climate Change was adopted in 1992. From this point on, it is clear that the climate regime has faced significant stagnation in comparison to the ozone regime. The Montreal Protocol entered into force four years after the adoption of the Vienna Convention. The Kyoto Protocol entered into force thirteen years after the UNFCCC was adopted. Thus, it is obvious that even if the Kyoto Protocol did allow for more flexibility, the regime faces additional obstacles in comparison to the Montreal Protocol.

There are several other institutional attributes where the regimes also differ. One is on the matter of funding. Although the two most recent meetings of the climate regime, the COP15 and 16 have shown progress on this matter, until this point, the Kyoto Protocol and the UNFCCC do not have a funding mechanism that is as effective as the ozone regime's Multilateral Fund (Young, 2010, p. 96). This affects other aspects of the regime, such as technology transfer and developing country participation, which are limited by lacking funding for these activities. Both regimes faced similar barriers when it comes to technology transfer, but the Montreal Protocol has been more effective at addressing them (Andersen et al., 2007). Where the climate regime lacks in a funding mechanism (to date), the presence of the flexibility mechanisms in the climate regime are not present in the ozone regime. These mechanisms do not contribute to a higher score of effectiveness for the regime. Overall, it would seem that while the climate regime attempted to use the ozone regime as a model, the progress of the regime has been slow in comparison, despite innovative measures such as the flexibility mechanisms. This leads one to question whether the ozone regime was the best model for solving the problem of climate change, an idea also shared by Barrett (2003) and Young (2010).

4.3.2. Comparing Effectiveness in Terms of Outcome

When comparing the two regimes on the indicator of outcome effectiveness by a standard of goal attainment the regimes do not differ as drastically as they do along the other parameters of effectiveness. As should be expected given the review of output effectiveness for the climate regime, the Kyoto Protocol's lack of ambition increases the chances of countries party to Annex B being able to achieve the goals set. Given the terms set by the Kyoto Protocol, the climate change regime will be meeting its goals. Similarly, the ozone regime has also met its goals set by the Montreal Protocol. The comparison along this indicator is meaningful as an attest to the compliance trends of both Protocols. However, as is discussed in the climate effectiveness section, this result can only be interpreted in light of the output effectiveness score as well.

A caveat to the use of this indicator for both regimes is that neither regime has begun regulation of emissions by developing countries (the Montreal Protocol first phase-outs for developing countries started in 2010, thus this study is not able to evaluate yet whether those goals have been met). Thus, as global emissions are currently not accounted for in either regime, this indicator's measurement on an aggregate level is somewhat irrelevant. In addition, trends of increasing emissions of CFC substitutes and from banks foreshadow that ODS emissions have not been fully eliminated and will need to be carefully watched in the future. As this study is concerned with aggregate emissions, using the emissions behavior of only the developed countries is a limited perspective of effectiveness for both regimes. This is particularly the case for the climate regime, for which it is obvious that although the goal has been achieved, global progress has not been substantial.

4.3.3. Comparing Effectiveness in Terms of Impact

The regimes vary in impact effectiveness as assessed by the collective optimum ideal of environmental quality as defined by scientific advice. Atmospheric concentration is the common metric operationalization chosen for the impact indicator. This indicator shows that the ozone regime has *improved* environmental quality, while the climate regime has *not had an impact*. The use of atmospheric concentrations also provides an alternate[19] measurement of emissions behavior than the goal attainment standard utilized in this study. In either usage of this data, the two regime scores differ greatly – the ozone regime being highly effective, and the climate regime measuring at a low level of effectiveness.

An alternate measurement of regime impact effectiveness was assessed by examining observations of change in the environment. For the ozone regime, this presents a picture that is less effective than using concentrations, because ozone is not increasing. For the climate

[19] Measuring behavioral change is not the standard way of measuring outcome because concentrations do not distinguish between countries and may include GHG or ODS from natural origins, not only anthropogenic (or those under the jurisdiction of the regime).

regime, the effectiveness classification is the same: observations of climate change and temperature have increased regardless of the regime's presence.

Both ODS and GHG have long lifetimes, thus concentrations and the subsequent changes in the environment are the result of several decades of emissions. This reflects the overall uncertainty of both the ozone depletion and climate change problem. Scientists, while increasing their understanding of earth science on a nearly daily basis, are still uncertain about the time frames for either problem. Thus, using estimations for replenishment of ozone, temperature increase, and atmospheric concentrations may be measurements that provide incomplete estimates on the impacts the respective problems. This questions the use of *impact* as an indicator of *regime effect.* While the indicator may not reflect regime consequences, it frames the importance of maintaining scientific goals in the regime that reflect *the environmental impact* solution to the problem. Despite its weaknesses, environmental impact remains the most ideal evidence of solving the problem, thus it is relevant in this analysis particularly as the study has focused on utilizing the collective optimum standard.

4.3.4. Areas of Synergy: Comparison Conclusion

The current comparative analysis has reviewed how the levels of effectiveness of the ozone and climate compare with one another. These comparisons are classificatory, but highlight areas of variance that serve as the platform for explanatory questions as well as highlighting points of *interaction.* As Gehring and Oberthür (2004) discuss, the concept of interaction is intended to refer to a causal relationship. In this thesis the concept is used in a descriptive manner. Interaction is relevant in a comparison between the climate regime and ozone regime because it draws on several aspects of the comparative analysis.

There are scientific similarities between the issues of ozone depletion and anthropogenic climate change. The biological feedback effects exist in several directions, as both positive and negative feedback, and on each of the indicators. In regards to *impact*, increased UV radiation from ozone depletion harms plants and marine species like phytoplankton, in turn reducing their ability to sequester carbon dioxide, thereby enhancing anthropogenic climate change (Oberthür, 2001). Likewise, increased temperatures in the atmosphere may adversely affect ozone replenishment and enhance ozone depletion, as evidenced by the holes in the Arctic and Antarctic ozone layer, which are dependent on climate trends in the region. In addition to these effects, ozone depletion substances are also greenhouse gases, adding complexity to the regulation of those gases that exist as both.

In regards to the *output* indicator, the policies of the regimes can influence one another. Neither regime refers to the other in their textual objectives of the regime. The Kyoto Protocol refers to gases that are not regulated by the Montreal Protocol; connections are mostly in basket of gases/chemicals regulated. For example, regulating HCFCs through the Montreal Protocol mitigates climate change. However, the Montreal Protocol can also have a *negative* effect on climate: increased emissions in HFCs could offset 30 percent of overall radiative forcing avoided under the Montreal Protocol by 2010 (WMO, 2010, p. 35). Likewise, as HFC is a gas listed in Annex A of the Kyoto Protocol, regulation of HFC is of consequence for ozone depletion, as this may make it more difficult to utilize as a substitute for CFCs/HCFCs. The ozone secretariat is well aware of these interconnections, and the 2010 Assessment was based on researching how ozone and climate interact. These output considerations stimulate changes in emission behavior or *outcome* in multidirectional ways.

To conclude, it is clear that while each regime has an individual score for regime effectiveness that has been compared to the other, the overlapping points highlight that the many areas of synergy between the regimes are anything but straightforward. The potential use of these insights in future research will be discussed, along with the recapitulations of the thesis, in the following concluding chapter.

5. Conclusion

In this final chapter I first summarize the research question and objective, the analytical framework underpinning the study, and the main findings of the thesis. Second, I will review areas for further study and prospects for political engineering in the field of international environmental regimes. Finally, in culmination of the thesis, concluding remarks on effectiveness of the ozone and climate regime are presented.

5.1. Summary and Main Findings

The research objective of this study was to classify regime effectiveness in the international ozone depletion regime and the international climate change regime through a transparent analytical framework allowing for a robust and nuanced assignment of regime effectiveness. The research questions were explicit: How effective are the international ozone depletion and climate change regimes and how do these levels of effectiveness compare to one another? In answering this question, the analysis sought to also consider: how do classifications differ depending on the operationalization of effectiveness?

In order to answer these questions, the study began with a presentation of the theoretical framework grounding the study of international environmental regimes in chapter two. Four debates were introduced: i) the definition of the concept of international regimes; ii) the explanation of the formation and change of international regimes; iii) the definition and operationalization of the concept of regime effectiveness; and iv) the explanation for explaining variation in international environmental regimes. Of these debates, the third one firmly grounds the study at hand.

Theoretical choices made throughout this study have influenced the results and findings. Of particular importance here are the choices regarding indicators of effectiveness: output, outcome, and impact. These three indicators were chosen based on previous studies and theory grounded in political science. The second critical decision was taken when designing the standards by which each indicator would be evaluated against. The choices to use conceptual standards based on the collective optimal solution and goal attainment have shaped what level of effectiveness is assigned. These operationalizations of *effectiveness* and the *standards* by which effectiveness level is determined provided the analytical framework for the data analysis.

After presenting the theoretical underpinnings and analytical framework in chapter two, chapter three presented the two cases in terms of the empirical findings. This chapter objectively mapped the data necessary for analysis in preparation for the classificatory assessment of regime effectiveness and the comparison between the two regimes.

In chapter four, the analytical framework was applied to the empirical data provided in chapter three. The ozone and climate regimes were assigned a level of effectiveness in a low, medium, or high scale along the parameters of output, outcome, and impact effectiveness. The decision for scoring each indicator was made through assessment against standards based on the collective optimum and goal attainment. After having completed an evaluation of regime effectiveness for each regime, the two cases were compared along each indicator. There are three main findings of this study which will be briefly summarized: i) level of effectiveness for the ozone regime; ii) level of effectiveness of the climate regime; and iii) the comparison between the two.

The study confirmed that the international ozone depletion regime is a highly effective regime. When measuring the indicators of output and outcome the regime was assessed at high-effectiveness. The regime has not been as effective when measured on the impact indicator, likely due to the time-lag issue. However, these results and the associated discussion warn against dismissing the ozone depletion problem as being completely and optimally solved.

The evaluation of the international climate change regime has confirmed that the regime can be treated with some amount of skepticism based off of its low level of effectiveness on all three indicators used in this study. On the output indicator there are some areas of optimism, but lacking ambition and country participation overshadow the ability of the mechanisms to work to their potential. On the outcome indicator, the goals of the Kyoto Protocol are likely going to be attained, however, overall behavioral trends are not headed in the direction of effectiveness, or even stabilization as called for by the UNFCCC. Therefore, although this indicator includes a “high” score on one measurement, the overall result is low-effectiveness. Finally, the impact indicator presented an image of low-effectiveness as both sub-indicators show declines in environmental quality. This indicator questions the relevance of the climate regime’s effect entirely.

In conclusion, the study completed a comparison of the two regimes. While they differed greatly in their level of effectiveness on the output and impact indicator, they were similar on the outcome indicator, which was explained by the poor ‘goal’ used in the standard for the climate regime. While their differences are large, there are also similarities. This is because the climate regime was modeled on the ozone regime development, thus many institutional attributes are similar, in addition to the global nature of the problems. Other similarities discovered in comparing the two regimes were presented in the end within the concept of *interaction*. In the final section, these areas of interaction, particularly along the impact and output indicators, were presented as a final comparison between the regimes.

The study provided a multiple-measurement assessment of regime effectiveness for the ozone and climate regimes. In doing this, the results are robust and show that depending the type of indicator and *standard* utilized to measure the regime, the score of effectiveness can vary. The relevance of this for policy-making is high in an area where, particularly for climate change, international cooperation can be casually dismissed as ineffective. This multiple measurement of effectiveness provides a holistic interpretation of regime effectiveness, and even in the case of the ozone regime, sheds light on the importance of maintaining goals that adequately reflect the most ambitious solution to the problem.

5.2. Prospects for Political Engineering in the Global Arena and Further Study

This study on the effectiveness of international environmental regimes contributes to policymaking by providing nuanced set of regime effectiveness scores based on a multiple-measurement analytical framework. In this section I will first provide some suggestions for how the results of this can be relevant for political engineering and policymaking. Second, some ideas for future research are proposed.

This thesis provides several areas where the regimes could focus energy in order to improve aspects for increasing effectiveness. The future ozone regime should prepare for enhanced matters of interaction with both climate change and the climate *regime*, as well as for potential changes in aggregate emissions trends and compliance as Article 5 countries emerge from the grace period. The matter of HFCs being an ODS substitute and significant GHG must be addressed by the Montreal Protocol. In addition, should accelerations of timetables occur, emphasis could be on enhancing targets for Article 5 countries. Finally, the methyl bromide "critical use exemptions" should be reviewed again, with the aim of a complete phase-out.

The climate change regime has yet to maintain the stability seen in the ozone regime. There are many steps that need to be taken, particularly in looking towards the post-2012 period. The regime is currently negotiating a revised financial mechanism as well as several other mechanisms that will likely benefit the future regime Progress on the financial mechanism will help facilitate technology transfer and alleviate concerns of non-Annex I countries. . One particular point that arose from the comparative analysis is the lack of flexibility in making amendments to the Protocol. This could be addressed in the next commitment period. In addition to increasing the ambition and specificity of targets, legally binding targets should be extended to as many countries as possible – including those currently differentiated – in order to accommodate a larger share of emissions. The ozone regime, at the very least, provides an example of providing extensions for developing countries while still accounting for them within the legal framework.

The natural progression of this study would be to use it for exploring potential causal mechanisms of regime consequences. Further ideas for future study are now presented, with emphasis on changes that could be made to the methodology employed in this study. One future area of research for the international climate change and ozone depletion regimes will likely be in the areas in which they interact. This also applies for evaluating regime effectiveness. For example, had I assessed impact and outcome effectiveness for the ozone regime by a standard of decreases in GHG (not ODS), the Montreal Protocol would be more effective at decreasing GHG emissions than the Kyoto Protocol to date. The Montreal Protocol is estimated to have contributed to GHG mitigation efforts to an extent that is six times greater than the reduction target of the first commitment period of the Kyoto Protocol (The Montreal Protocol having decreased 10-12 $GtCO_2$-eq by 2010) (WMO, 2010, p. 35). Thus, in the future, an assessment of the climate and ozone regime effectiveness could include an assessment of not only how the regime solves the problem that inspired its own formation, but could also include assessments of the regime's effect on the other regime. This is already been taken into consideration for the ozone regime's effect on climate change, as evidenced by the Ozone Trends Panel focus on climate change in the 2010 Scientific Assessment.

In addition, future studies using a similar design could change the level of analysis. This study was designed to evaluate effectiveness from the international level of analysis, in order to assess how effective the regimes were on a *global* scale. However, the study could have also been completed at the national level of analysis. For example, recent research has found that aggregate climate change mitigation policy is increasing, but on local and national scales (Dimitrov, 2010). Using a standard focused on national or sub-national policy developments would provide an alternate version of effectiveness in the climate regime. Within the international goal of 5 percent reduction of Annex I emissions by 1990, the Protocol assumes these goals will be met through national mitigation systems and targets, thus national legislation is conducive for a study on the national level of analysis.

5.3. Concluding Remarks

"In an interconnected and constrained world, in which we have a symbiotic relationship with the planet, environmental sustainability is a precondition for poverty eradication, economic development, and social justice."

(3rd Nobel Laureate Symposium on Global Sustainability, 2011)

This thesis began from the perspective of globalization. Throughout the study the globalization thread has continued to frame the research. As the above quote describes, our globalized planet must tackle environmental problems requiring collective action in the context of the simultaneous challenges faced by the human population. This thesis focuses on a form of governing the global commons in order to serve this challenge. The relevance of this field of study will only continue to grow as the world continues to both be interconnected and constrained. The two regimes studied struggle to meet the challenges posed by globalization, both of the past and the imminent future. Economic growth and associated projections of greenhouse gasses and ozone depleting substances emissions from developing countries, combined with the extent to which developed countries carry the burden of past emissions has been, and will remain, the focal point of future regime decisions.

Governing the atmospheric global commons in the context of ozone depletion and climate change is referred to as the biggest challenge of humankind. The study at hand has provided an evaluation of how well we are meeting these challenges thus far through international cooperation. The results provide both reasons for optimism and pessimism depending on the interpretation and the analytical perspective chosen. One thing is certain: although there is room for improvement, there is no time for despair.

Annexes

Annex I: Controls for Chemicals under the Montreal Protocol[20]

Chemicals	Developed Countries Phase out Schedule	Developing Countries Phase out Schedule
Chlorofourocarbons (CFCs)	Phase out by 1996	Phase out by 2010
Halons	Phase out by 1994	Phase out by 2010
Carbon tetrachloride	Phase out by 1996	Phase out by 2010
Methyl chloroform	Phase out by 1996	Freeze by 2003 at average 1998-2000 levels, reduce by 30 percent by 2005 and by 70 percent by 2010, and phase out by 2015
Hydrobromoflurocarbons (HBFCs)	Phase out by 1996	Phase out by 1996
Hydrochlorofluorocarbons (HCFCs)	Reduce by 35% by 2004 75% by 2010 90% 2015 Phase out 2020 with 0.5% servicing from 2020-30	Freeze by 2013 at 2009-10 levels, 10% by 2015 35% 2020 67.5% 2025 Phase out by 2030, 2.5 servicing 2030-40
Methyl bromide (CH3Br)	Phase out by 2005	Freeze by 2002 at average 1995-1998 levels, reduce by 20% by 2005, phase out by 2015
Bromochloromethane (BCM)	Phase out by 2002	Phase out by 2002

Annex II: Chronology of Major Events and Recent Developments of the International Climate Change Regime

Year	Organization/Meeting and associated development
1972	UN Conference on Human Development – Stockholm, Sweden
1979	World Climate Conference: development of the World Climate Program (WCP)
1985	WCP, WMO, UNEP, International Council of Scientific Unions - Villach, Austria: declared global warming a possibility
1986	The Advisory Group on Greenhouse Gasses (AGGG) established under the WMO, UNEP, ICSU
1988	Toronto Conference on the Changing Atmosphere: policy recommendation for a 20% decline in emissions from 1988 levels by 2005
1988	Intergovernmental Panel on Climate Change established
1990	IPCC - First Assessment Report
1990	Discussions for a convention began
1991	Within structure of the Intergovernmental Negotiating Committee (INC) negotiations for the UN Framework Convention on Climate Change (UNFCCC) began under the United Nations General Assembly
1992	United Nations Conference on Environment and Development (UNCED) Earth Summit, Rio de Janeiro: UNFCCC adopted and opened for signatures

[20] Data accessible from the Scientific Assessment Report 2010 (WMO 2010)

1994	The UNFCCC enters into force after receiving 50 ratifications.
1993	US President Bill Clinton enters into office and the US was able to reverse the George H. W. Bush policy in opposition to negotiations, progressing international ability to discuss the matter of protocol further.
1995	First Conference of the Parties (COP1) to the UNFCCC
1996	
1997	COP3 – The Kyoto Protocol negotiated (see table in text for details)
1998	COP4 – Buenos Aires, plan and 2 year deadline for when Kyoto would enter into force
2001	COP7 – Morocco. After negotiations on mechanisms dominating, KP operationalization finally agreed upon.
2004	Russia ratifies the Kyoto Protocol, officially accounting for the necessary 55% of emissions
2005	February 16: Kyoto Protocol enters into force of its first commitment period, 2008-2012
2005	COP11, CMP1: Montreal. Sights set for COP13 where a plan would be developed for post 2012
2007	COP13: Bali Action Plan negotiated, laying a plan for preparing for COP15/CMP5
2008	COP14: Poznan. Lack of progress on Bali Action Plan
2009	COP15/CMP5: Copenhagen Accord, non-adopted non-legally binding political agreement. Failure to negotiate post-2012 framework.
2010	COP16: Cancun Agreements - set goals and pathway for COP17 and hopeful post-2012 framework

Annex III: Highlights of Climate Change Observations from the IPCC Fourth Assessment Report

Highlights of Climate Change Observations from the IPCC Fourth Assessment Report (2007)

From 1900 to 2005, **long term trends of increased precipitation** have been observed in eastern parts of North and South America, northern Europe, and central Europe, whereas precipitation declined in the Sahel, the Mediterranean, southern Africa, and parts of southern Asia. In addition, it is very likely that cold days, cold nights, and frosts have become less frequent, while hot days and hot nights have become more common since 1970 (Trenberth et al., 2007).

Tropical cyclone activity in the North Atlantic has increased since 1970 (IPCC Intergovernmental Panel on Climate Change, 2007b)

The IPCC has documented not only evidence of the drivers of climate change (i.e. atmospheric concentrations and temperature change) but also changes on earth that are the ***result of*** **climate change,** but only a few will be highlighted here. There is, for example, "high confidence" of a trend of **earlier greening of vegetation** in the spring linked to longer thermal growing seasons (WGII 1.3, 8.2, 14.2). Terrestrial biological systems are experiences **changes such as in bird migration, egg-laying, and upward shifts in plant and animal species**. There is high confidence that changes in marine and freshwater biological systems, such as **shifts in algal, plankton, and fish abundance** in high latitude and high-altitude lakes, range changes and earlier fish migrations in rivers, are associated with rising water temperatures, change in ice cover, salinity, oxygen levels, and circulation (IPCC Intergovernmental Panel on Climate Change, 2007c)

Changes in managed and human systems, with medium confidence as a result of climate change have been observed. These **changes are in agricultural and forestry management** at Northern Hemisphere higher latitudes, human health (infectious disease vectors, or earlier onset of allergenic pollen), and human activities in the Arctic, such as hunting in tundra areas, and recreational activities on snow (IPCC, 2007c).

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