

An Ethical Approach to Global Climate Change Mitigation

Prepared to meet the requirements for graduating with Honors standing from the Program in the Environment and Department of Philosophy at the University of Michigan, Ann Arbor.

Submitted by Kurt Muehmel
to the Program in the Environment
27 April 2006

Program in the Environment

Advisor:

Rosina Bierbaum
Dean and Professor, School of Natural Resources and Environment

Reader:

Edward Parson
Professor of Law, Law School
Associate Professor, School of Natural Resources and Environment

Department of Philosophy

Advisor:

Elizabeth Anderson
Professor of Philosophy; College of Literature, Science, and the Arts

Reader:

Peter Railton
Professor of Philosophy; College of Literature, Science, and the Arts

Acknowledgements

My most sincere thanks go to my advisors and readers for their genuine commitment to this project. My completion of this project would not have been possible without their guidance. I must also thank all of the people in my personal life who have supported me throughout this demanding process. My sanity is owed to them.

TABLE OF CONTENTS

<u>1. INTRODUCTION</u>	<u>2</u>
<u>2. THE PROBLEM OF GLOBAL CLIMATE CHANGE</u>	<u>5</u>
<u>3. WHAT TO DO ABOUT IT?</u>	<u>11</u>
<u>3.1 PROPOSALS FROM NATURAL, POLITICAL AND SOCIAL SCIENTISTS</u>	<u>13</u>
<u>3.2 PROPOSALS FROM ETHICISTS AND PHILOSOPHERS</u>	<u>17</u>
<u>3.3 EVALUATION OF EXISTENT PROPOSALS</u>	<u>24</u>
<u>3.3.1 PROCESS</u>	<u>25</u>
<u>3.3.2 CONSIDERATIONS OF OBLIGATION</u>	<u>29</u>
<u>RESPONSIBILITY</u>	<u>30</u>
<u>CAPABILITY</u>	<u>33</u>
<u>EQUAL PER CAPITA CAPPED EMISSIONS RIGHTS</u>	<u>39</u>
<u>3.4 PROPOSAL OF A NEW APPROACH</u>	<u>42</u>
<u>3.5 TECHNICAL CHOICES</u>	<u>44</u>
<u>3.5.1 A NOTE ON INDEXING</u>	<u>44</u>
<u>3.5.2 MEASURE OF RESPONSIBILITY</u>	<u>45</u>
<u>3.5.3 MEASURE OF CAPABILITY</u>	<u>52</u>
<u>3.6 CREATION OF THE OBLIGATION INDEX</u>	<u>57</u>
<u>4. INTO PRACTICE</u>	<u>60</u>
<u>4.1 CAP-AND-TRADE SYSTEMS</u>	<u>60</u>
<u>4.1.1 INITIAL ALLOCATION OF PERMITS</u>	<u>62</u>
<u>5. DISCUSSION</u>	<u>65</u>
<u>5.1 DATA</u>	<u>66</u>
<u>5.2 METHOD</u>	<u>68</u>
<u>5.3 PRACTICALITY</u>	<u>69</u>
<u>6. CONCLUSION</u>	<u>71</u>
<u>REFERENCES</u>	<u>73</u>

1. Introduction

The problem of global climate change (GCC) is one which requires a global response if it is to be adequately addressed. The issue itself is one which cuts across disciplines, capturing aspects of the natural sciences, the social sciences and the humanities. The interdisciplinary nature of GCC contributes to the difficulty in finding a response which is both effective and agreeable to the practitioners of the multiple disciplines (Gardiner 2004, p. 556). The result has been a mixed response from different disciplines. The natural and social sciences have taken the lead on the topic, exploring it in all of its physical, economic, and social complexity. Curiously, the attention of the ethicists has not been nearly as substantial as that from the other disciplines. Gardiner (2004) has made a considerable effort in summarizing the issue through an ethical lens and both Traxler (2002) and Singer (2002) have both proposed their own responses to the issue but there is little beyond these efforts.

It is also surprising that those ethical theories which have been advanced are largely pragmatic in nature. They are often more concerned with what response will garner the widest support or result in the least likelihood of defection. I do not find these approaches satisfactory. Looking out into the sea of research that has been done on climate change, I do not see a marker for a *purely* ethical response, one unencumbered by the demands of practical necessity. I am not so naïve as to think that a purely ethical approach has a strong likelihood of being put into practice, but knowing what such an approach would look like would have considerable advantage for other approaches. The first advantage is that it sets a goalpost against which other approaches can be compared. If we continue to produce approaches which are made of some amount of ethics

measured against some degree of practicality it is difficult to know exactly how far from the shore of ethics we are if we have never laid eyes upon it. Having seen it, we can weigh a combined, practical-ethical approach and make an informed choice regarding the balance which it strikes.

This method of approach follows a traditional distinction in ethics between ideal and non-ideal theories.¹ The distinction, most simply stated, is between a theory which assumes ideal conditions such that all actors will act in a perfectly ethically manner. Practical considerations are not the concern of such a theory. The alternative is that which takes into consideration the practical concern of how to motivate the actors to comply with such a theory. Under this approach concessions to the ideal theory are made in consideration of the ethical imperfection of the actors.² Rawls (1971) comments on the usefulness of ideal theory, saying, “Obviously the problems of [non-ideal] theory are the pressing and urgent matters. These are the things that we are faced with in everyday life. The reason for beginning with ideal theory is that it provides, I believe, the only basis for the systematic grasp of these more pressing problems.” (p. 8)

The second motivation for creating a purely ethical or idealized approach is in response to the fatalism which is so frequently present when discussing our social, economic, and political institutions. There is a prevailing myth that, somehow, these creations of ours will themselves create the best outcome for humanity without our thoughtful intervention. We need not be slaves to the institutions that we create, we are

¹ This distinction goes by a number of different names. For example, Rawls (1971) uses the terms strict compliance theory and partial compliance theory (p. 8). I am using ideal and non-ideal as I feel they are the most clear for the non-specialist reader.

² More broadly, discussions of just punishment and war fall under the heading of non-ideal theory because in an idealized theory there is no need for such measures. For my purposes, however, the most useful distinction between the two approaches is in regard to motivation. An ideal theory, such as the one I am advancing, does not make concessions to how to motivate nations or individuals to respond to GCC. A non-ideal theory would consider how to justly motivate people or nations to address GCC.

their masters and we must decide for ourselves what is right and how we will bring about the best society. This claim is in no way revolutionary, it is merely meant to emphasize the agency that we hold over our social arrangements. All too often is there a systemic sense of despair when discussing social arrangements, a sense that nothing other than “what is” will ever be possible. An idea, perhaps a better term is an ideal, should not be hampered in its infancy by practical limitations. Of course, if there is any hope for its realization, practical considerations must be introduced at some point, but the value of ethical imagination, unencumbered by practical limitations, must be realized and appreciated. If we feel that the social system that is currently in place is not satisfying us, if it is not right according to our metric, we must be willing to imagine its alternatives if we ever want to move beyond it.

Ultimately, however, a non-ideal theory which deals with matters of compliance is needed as compliance is, perhaps, the single greatest hurdle in addressing GCC as the incentives are clearly set so as to encourage inaction. In agreement with the above quote from Rawls, however, an understanding of the ideal theory is needed before a reasonable account of non-ideal theory can be put into place. In my language, we need to see the shore to know how far we are from it.

The approach I take in my attempt at a purely ethical approach to addressing GCC is to first ask what it is we need to do and then to ask how it is we should go about doing that. It is a two stage process with the ultimate goal of developing a measure of obligation which can then be applied to a practical method of addressing GCC. The approach categorically favors simplicity over complexity. If there is a simple, intuitive solution to a

question, it is taken, with justification, to be correct until relevant information demands moving away from it.

This paper is, like the problem itself, interdisciplinary and seeks to be interesting and accessible to all readers, despite their background. Thus, specialized language is avoided where possible and defined where necessary.

Global climate change is not an easy problem to address, but the scope of the challenge does not warrant our aversion. There is an incredible challenge facing the world, one that will not only remain present but will get markedly worse if it is not addressed head on. Let us not be afraid of a problem which is of our own making.

2. The Problem of Global Climate Change

The near consensus in the scientific community is that humans are having a direct and significant influence on the climate systems of the earth. The changes which are predicted to result from global climate change have the potential to harm multitudes of people in myriad ways. While an increase in mean surface air temperature by 2°C sounds innocuous, this increase is likely to disrupt precariously balanced natural systems in ways that pose the greatest danger to humans. Sea levels will rise as a result of thermal expansion and run-off from ice caps,³ inundating coastal regions, submerging entire island nations and depriving people of their land (IPCC 2001a, p. 667). As climate patterns change there is the likelihood for massive crop failures as the climate becomes unsuitable for the traditional crops grown in a region (IPCC 2001b, p. 253). Disease-carrying insects will be able to survive in new regions, bringing their dengue fever,

³ A more significant and less predictable cause for sea-level rise is the collapse of polar ice sheets and shelves.

malaria and schistosomiasis to human populations that do not have a history of resistance to the disease and do not have the knowledge or means to respond to such a situation (Hopp and Foley 2001). The process was originally referred to as “global warming.” But it is much more than that: it is a disruption to some of the earth’s most fundamental natural systems⁴ which will, in turn, lead to significant disruptions to the human systems which inhabit the earth. While certain authors may argue for attention to be given to GCC on the grounds of protecting the intrinsic value of these natural systems, here I am making no such claim. GCC is a humanitarian crisis which will further stress the people of the world who are already bent over by the heavy burden of low development.

GCC presents a double threat to the least developed countries (LDCs) of the world. First, there is empirical evidence that the inhabitants of LDCs fare worse in response to natural disasters, other factors held equal (Kahn 2005, p. 283). Second, the impacts of GCC are likely to be most severe in the tropics where many LDCs are located while temperate climes and their well-developed inhabitants are likely to receive a less severe blow (Gardiner 2004, p. 563). The implications of this situation are staggering. GCC threatens to undo the progress of the past and impede the progress of the future in bringing the LCDs up to a respectable level of development. Simply put, it is a catastrophe waiting to happen, a crisis on which we have predicted and now have the opportunity to act or to simply ignore.

If GCC does pose a significant threat of creating or exacerbating humanitarian crises in the future (a condition widely supported in the scientific literature), then an

⁴ These systems include the water resources, agricultural capabilities, terrestrial and freshwater resources, and other systems which have been deemed vulnerable to the impacts of GCC. For an exhaustive review of these impacts, see the IPCC report from Working Group II (2001b), especially its summary for policy makers.

intervention on these basic humanitarian grounds finds almost universal support among ethicists. Regardless of what an ethicist may think about the claims of international justice, there is a basic humanitarian duty to prevent catastrophe when possible and provide aid when needed. Thomas Nagel, in “The Problem of Global Justice,” remarks:

[J]ustice may be a side issue. Whatever view one takes of the applicability or inapplicability of the standards of justice to [the income disparity present in the world], it is clearly a disaster from a more broadly humanitarian point of view. I assume there is some minimal concern we owe to fellow human beings threatened with starvation or severe malnutrition and early death from easily preventable disease, as all these people in dire poverty are (118).

The duty to address GCC is uncontroversial from a moral perspective. If we know, with relative certainty, that a situation is going to greatly threaten the basic well-being of any person (in this case, many persons) then there is a clear moral duty to act to prevent that situation. This duty is based on the *minimal* concern which is owed to our fellow humans. If nothing else, it is plainly wrong to allow a person to starve, die of a disease, or drown when there is the opportunity to prevent it, especially when the cost of that prevention is relatively small. Simply put, the duty to do something about GCC is not a matter of justice, but a matter of humanitarian assistance.

It is important to recognize that the humanitarian crisis of GCC is of a particular sort which makes for an even stronger case to address it directly and forcefully. Certain crises are the result of natural disasters which are clearly not caused by human actions,⁵

⁵ Though, at times, human activities can exacerbate the harm caused by natural disasters. For example, cutting corners when engineering buildings on or near geologic faults can greatly increase the damage

while others are the direct result of human actions. There is a distinction drawn between the responses to each. Responding to the purely natural disaster implies “positive duties” to the people suffering the crisis whereas responding to the anthropogenic crisis simply implies “negative duties” to the people suffering.⁶ Whereas some critics are skeptical about the existence of any positive duties, no one who holds any ethical framework denies the existence of negative duties to not do harm. The duty to address climate change is ethically fundamental, finding support in even the most austere ethical theories.

A relevant distinction to be made between GCC and other humanitarian crises is that the most severe impacts of GCC have yet to be felt.⁷ Whereas the response to famine and disease is largely reactive, responding to the problem after the point at which it is plainly a problem, there is a question of whether to respond to GCC proactively or reactively. In truth, we have already committed ourselves to some degree of climate change and its ensuing impacts and thus any response to climate change will have to include some amount of reaction to the problems once they occur. In the parlance of climate change, reaction to the impacts is dubbed “adaptation” and proactive measures to minimize such impacts are dubbed “mitigation.”

As Gardiner (2004) observes, the debate to adapt or mitigate is largely based around questions of cost, questioning which approach will be the least cost option. The modeling required to make such estimates of cost is extremely sensitive to the

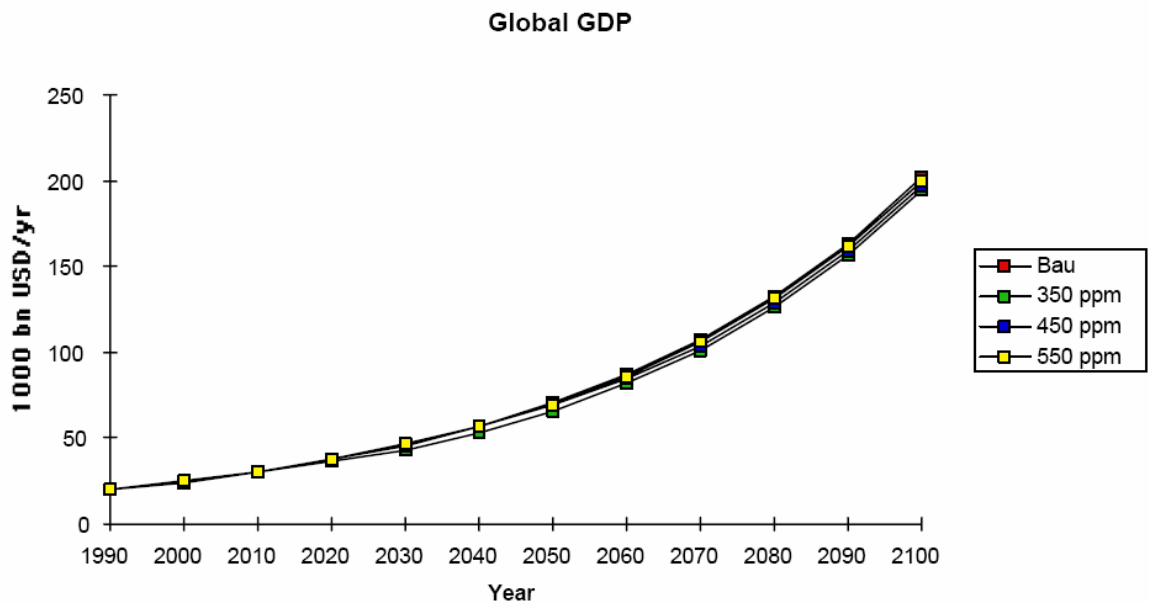
caused by natural disasters. These situations also call for attention of the sort which I am advocating for GCC.

⁶ A positive duty to a person is one which requires others to do something for that person, simply on the grounds that they are in need, without consideration of why they are suffering. A negative duty simply requires that you do not harm that person. Thus a negative duty is constructed in the negative form, “Do not harm,” whereas the positive duty is constructed as, “Provide assistance to those in need.”

⁷ There is suspicion, reported widely in the popular media, that the abnormally intense 2005 hurricane season is a result of GCC. Thus, a resident of the United States Gulf Coast may understandably object to this statement.

assumptions which are built into it. Bjorn Lomborg, inspired by the modeling work of William Nordhaus and an ardent opponent to mitigation, holds that the expense of mitigation can be better spent on other causes. Gardiner describes the Nordhaus model which Lombord sites as “controversial,” in its estimates, others have been far less kind. Stephen Schneider (1993) remarks that the estimates used to calculate the cost of reduction are “draconian.” Schneider, with Christian Azar (2001), conclude that “even the most pessimistic economic model results also support the conclusion that substantial reductions in carbon emissions *and several fold increases in economic welfare are compatible targets* (original emphasis).” Figure 1 illustrates the difference in global GDP under a “business as usual” (BAU) atmospheric carbon stabilization schemes of

Figure 1: Global income trajectories under business as usual (BAU) and in the case of stabilizing the atmosphere at 350ppm, 450ppm, and 550ppm. (Source: Azar and Schneider 2002)



increasing concentrations. According to this more respected approach, the economic consequences of mitigation, even at the conservative level of 350ppm⁸, are certainly not

⁸ This level has been recently made impossible to achieve as present concentrations are now above this mark.

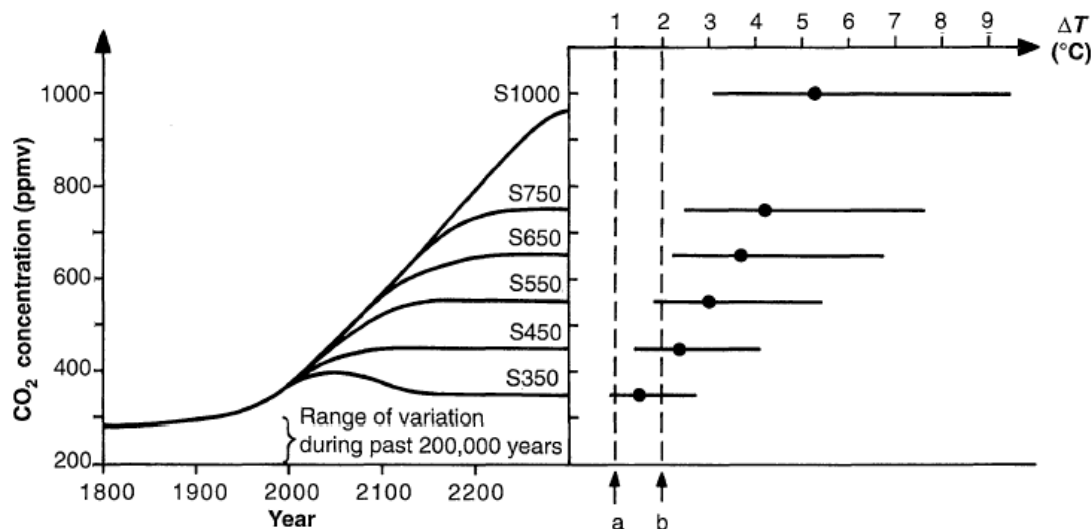
prohibitive to the economic expansion which is so vitally important to both politicians and their constituents.

Gardiner also makes the observation that that adapting to the incremental economic changes imposed by mitigation is to be preferred to adapting to the highly unpredictable and unevenly distributed of GCC left unchecked. We can do nothing and respond on the consequences wrought by Mother Nature at the time and place of her choosing, or we can attempt to mitigate such impacts via the mechanism of our choosing, dividing the burdens as we choose. This is a cogent point which captures both the practical and economic advantages of mitigation over adaptation. What does it take to mitigate the consequences of climate change? The simple answer is a reduction of greenhouse gas emissions. Due to the nature of the climate system, however, it is not as simple as may first seem to be the case. In order to choose a mitigation pathway, it is necessary to first choose a final atmospheric concentration of CO₂. This choice is governed by what range of predicted temperature increase is acceptable. In order to avoid “dangerous anthropogenic interference” with the climate system which is the stated purpose of these attempts (UNFCCC 1992)⁹, studies have shown that something around a 2°C increase in mean surface temperature is the upper limit of what can be tolerated¹⁰ (e.g. Schneider and Mastrandrea 2005). In order to commit ourselves to no more than a 2°C increase, further studies have shown that stabilizing atmospheric concentrations of CO₂ at or around 550ppm is necessary (e.g. Eickhout et al. 2003, p. 41). Stabilization at that concentration does not follow a simple linear approach, but an approach which

⁹ “Article 2, Objective: 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.”

¹⁰ The 2°C upper limit is also what has been adopted by the European Union for their purposes in GCC mitigation.

Figure 2: Stabilization scenarios for atmospheric CO₂ and the corresponding equilibrium changes in global mean temperature as compared to pre-industrial times (Source: Azar and Rodhe 1997)



increases and then stabilizes, as shown in Figure 2. Thus, at different points on the progression toward stabilization, different amounts of greenhouse gases can be emitted globally.

3. What to Do About It?

While the claim that we must do something about GCC may be ethically uncontroversial, deciding how to address GCC is quite the opposite. Even narrowing the focus to mitigation does little to quiet the debate. It would seem that the number of proposals on how to mitigate is as numerous as the people who have thought about the issue.¹¹ The proposals have come from both ethicists and social scientists capturing both the arguments from moral duty and those from practical necessity. The conditions which can be imagined in an ethically ideal world are seldom aligned with the political,

¹¹ Of course, my writing of this paper only goes to further support this assertion.

economic and social reality of our inhabited world. Thus, there is a sense that the moral perspectives are irrelevant and ought to be written off for being simply impractical. As I have stated above, I firmly believe this is not the case and we must not dissuade ourselves from a moral arrangement simply because it would be difficult to achieve. If this position is naïve, then so be it, I am certain that it is necessary for there to be any progress in our global human systems.

To begin, I will briefly review proposals for mitigation systems which are relevant to my discussion. Daniel Bodansky's review, *International Climate Efforts Beyond 2012: A Survey of Approaches* has been an indispensable resource for this section and, naturally, provides a far more thorough review of more than 40 approaches. I have selected a few which characterize the broad categories of approaches. In discussing these examples I am primarily interested in how they divide the burdens of mitigation among the people of the world. Many have a significant focus on the policy mechanisms required to enact their proposal and the methods necessary for its implementation and enforcement. This, however, is not my primary concern; I am principally concerned with the division of burdens entailed with mitigation of climate change impacts. I have attempted to distinguish those proposals which are coming from an ethical perspective and those which are coming from a scientific or political perspective, though there is some overlap where others from both disciplines have proposed the same or similar approaches (e.g. equal per capita burden sharing). For those which have been advanced from both perspectives I will remark on their shared support and place them in what I take to be the most appropriate category. In this section I will simply be describing the

approaches as objectively as possible, leaving analysis of their positive and negative attributes for a later section.

3.1 Proposals from social, political, and natural scientists

The **Kyoto Protocol** to the Framework Convention on Climate Change is at once celebrated for what it has accomplished and denigrated for what it has left unfinished. Created at the third Conference of Parties (COP-3) in Kyoto, Japan, the Protocol aimed to set specific commitments for the nations of the developed world (the members of its Annex B). The process which created the Protocol is what Bodansky categorizes as a top-down multilateral negotiation with an ad hoc division of commitments. The Protocol is celebrated for being the first agreement with specific commitments for various nations. Unfortunately for the Protocol, the praise stops shortly thereafter. Though it is a significant first step in the process, showing that nations can come to *some* agreement on emission reductions, it is widely criticized on many fronts. Robert Stavins (forthcoming) summarizes the current debate on the Protocol well, saying:

Because the Kyoto Protocol's ambitious targets apply only to the short term (2008-2012) and only to industrialized nations, the agreement will impose relatively high costs and generate only modest short-term benefits while failing to provide a real solution (Joseph E. Aldy et al. 2003). For these reasons, most economists see the agreement as deeply flawed (Richard N. Cooper 1998; David G. Victor 2001; Warwick J. McKibbin and Peter J. Wilcoxon 2002), although some see it as an acceptable first

step (Axel Michaelowa 2003). Virtually all agree, however, that the Protocol is not sufficient to the overall challenge.

Regarding the process followed to come to the reduction commitments listed in Annex B of the document Najam (1998) describes it as a combination of, “political horse-trading, power asymmetries at the negotiating table and the desire to obtain commitments from all Annex-I parties.¹²” It is this process which leads Bodansky to categorize the division of commitments as “ad hoc”. The alternative in his summary is the “rational design of commitments” whereby commitments would not be divided through negotiation, but according to some relevant criteria instead.

The end result of the Kyoto Protocol was a set of commitments among Annex-I countries which varied from nation to nation. For example, the United States committed itself to reducing its carbon emissions to 93% of its 1990 emissions during the 2008-2012 commitment period. Many of the member states to the European Union agreed to reductions of 92% of their 1990 levels, while other nations were allowed and agreed to increase their emissions. Australia has set a limit of 108% of 1990 emissions and Iceland has set a limit at 110% of 1990 emissions.

The **Brazilian Proposal** was a proposed change to the Kyoto Protocol brought by the Brazilian delegation during the COP-3 negotiations. The Brazilian Proposal aimed to accomplish two tasks. The first was to formalize the process by which non-Annex-I

¹² The references to nations as belonging to different Annexes can easily become confusing. The distinction originated in the UNFCCC (1992) with its listing of nations in its Annex I and Annex II. Nations listed in Annex I are the developed nations of the world, including those nations in transition to a market economy (primarily the newly-independent states of the former Soviet Union). The list of Annex II nations starts with the nations on the Annex I list and removes the nations with transitional economies. Discussion of Annex B nations refers to Annex B of the Kyoto Protocol (1997) which lists the nations with specific reduction commitments under the Protocol. This list is nearly interchangeable with the Annex I list from the original UNFCCC.

nations would be included in the Kyoto process. The second was an attempt to distribute commitments based on each nation's historical emissions and, later, each nation's contribution to mean surface temperature increase. Thus, it is an example of Bodansky's rational design of commitments.

The Brazilian Proposal was not adopted during the COP-3 negotiations, but it has become noteworthy because it is "the sole climate regime for differentiation of commitments, with formal discussion and documentation status within UNFCCC" (Den Elzen 2005, p. 278). Since the original proposal was brought in 1997, numerous expert meetings have occurred to weigh the scientific methods and ability to support the calculations required by the proposal. Throughout these meetings numerous indicators of responsibility were discussed and subsequent studies have determined that the level of uncertainty is acceptably low among Annex-I countries for the Brazilian Proposal to be implemented (Den Elzen 2002, p. 66). A more full discussion of the Brazilian Proposal and its considerations occurs later in this paper.

An alternative to dividing commitments according to a nation's historical contribution to GCC, as is the case in the Brazilian Proposal, is to divide commitments according to each nation's **Ability to Pay**. Under the system proposed by Jacoby et al. (Bodansky 2004), nations would be divided into different classes based on per capita GDP. Each class of nations would then have commitments of varying strictness which they would be expected to meet (Bodansky 2004). This approach is similar to the Brazilian Proposal in many ways. It can also be considered a method of rational design of commitments. The primary difference between this approach and that outlined in the Brazilian Proposal is that this method is "forward-looking," whereas the Brazilian

Proposal is “backward-looking”. It is a difference of who is responsible for causing the problem and who is best suited to resolve the problem. This difference is of particular concern to the ethicists below.

The **Bottom-Up** approach eschews not only the rational design of commitments but the international negotiation process as well. This alternative approach would allow states to define for themselves their commitments and the means by which they would meet their commitments. Nations could then engage in bilateral or multilateral negotiations in order to determine a package of actions which would be acceptable to all members party to the negotiation. The central aim of this approach is to give the individual nations the opportunity to design for themselves what is most practical given their social, political, economic and environmental needs. This approach was proposed by Robert A. Reinstein in 2004 (Bodansky 2004).

A far more comprehensive approach is constructed in the **South-North Dialogue on Equity in the Greenhouse**. This team-based approach sought to draw from previous proposals to come to one approach which would adequately and equitably address GCC. The team defines an adequate response to GCC to be preventing any increase in global mean surface temperature greater than 2°C. Defining equity is a bit more complicated, as is often the case. The team defines four broad themes of equity in GCC: the division of burdens brought on by mitigation, the impacts of climate change and the need to adapt equitably, the capacity of nations to engage politically in the discussions and negotiations surrounding GCC, and the way in which intranational inequity reflects international inequity in regards to GCC (Ott et al. 2004).

The South-North Dialogue is particularly noteworthy because of its scope and breadth. It attempts to address not only the commitments required by each nation but the process used to determine those commitments. The main push of the proposal is to place nations into one of six categories; Annex-I countries, Annex-I but not Annex-II countries (i.e., nations undergoing a transition to a market economy), newly industrialized countries, rapidly industrializing countries, other developing countries, and least developed countries. The member states of each category would then have varying commitments to mitigate and to provide adaptive assistance. The team of experts assessed each nation according to three parameters: responsibility for GCC, capability to mitigate, and potential to mitigate. Responsibility for GCC is measured via cumulative carbon emissions from 1990 until 2000, capability is measured via the Human Development Index (HDI) and per capita GDP, and potential to mitigate is defined via a combination of emissions per unit GDP, emissions per capita, and emissions growth rate¹³ (Ott et al. 2004, p. 3; Bodansky 2004).

3.2 Proposals from philosophers and ethicists

One important remark before reviewing these approaches is that there has not been a considerable amount of focus on GCC specifically as an issue of ethics. Gardiner (2004) remarks at the close of his essay, “Philosophical clarity [on the issue] is urgently needed,” calling the current state of understanding “a call to arms” for moral philosophers. Despite the relatively short supply of philosophical and ethical proposals specifically relating to GCC, there is no shortage of material written on matters of

¹³ This approach to measuring mitigative potential seeks to capture three measures of current emissions. Emissions per unit GDP is a measure of economic efficiency, emissions per capita would indicate unsustainable consumption patterns, and the rate of emissions growth would indicate if emissions have already been curbed or can be expected to increase in the near future.

distributional justice in general at both intra- and international levels. Thus, some of the reviews below are in response to the authors' original work on the subject, whereas others are my interpretation of a more general theory as applied to the distribution of burdens in GCC.

Beginning with the proposals which address GCC specifically, Martino Traxler (2002) has advocated for a division of burdens among **equally burdensome shares**. Traxler defines "equally burdensome" as having equal opportunity costs in terms of human welfare. The motivation for Traxler's proposal is to counter the sentiments of some developed nations, whereby they would only reduce their emissions if developing nations committed to reductions as well.¹⁴ Traxler emphasizes the distinction made by Henry Shue (1993) between "luxury" and "subsistence" emissions. It is a fact of our current infrastructure that a certain amount of carbon must be emitted for the basic processes of survival (growing crops, purifying water, distributing goods, etc...) This distinction motivates Traxler to favor a measure of human welfare opportunity cost rather than traditional financial opportunity cost. Whereas a calculation of equally burdensome shares according to standard financial opportunity would be relatively easy (emphasis on "relatively") it could lead to nations being required to reduce subsistence emissions while other nations were permitted to continue their luxury emissions. A problem which Traxler acknowledges is that the calculations of human welfare opportunity cost are much more difficult to determine than are traditional financial opportunity costs.

¹⁴ United States President George W. Bush is quoted as saying, "I'll tell you one thing I'm not going to do is I'm not going to let the United States carry the burden for cleaning up the world's air, like the Kyoto treaty would have done. China and India were exempted from that treaty. I think we need to be more even-handed." (Singer 2002)

A second distinction on which Traxler focuses is between forward-looking and backward-looking approaches. The approach which he ultimately proposes purposefully avoids any measure of historical responsibility which would be included in a backward-looking approach. He commits himself to a purely forward-looking approach out of a practical worry that responsible nations would not agree to, or would defect from a scheme which included a backward-looking component. Traxler uses a somewhat unconventional terminology, denoting backward-looking approaches as ones that address “justice” and forward-looking approaches as ones that address “fairness.” Traxler recognizes the ethical limitation of his approach, remarking, “...a fully moral treatment of this question would take account of both fairness and justice....” Further preventing his inclusion of measures of “justice” (backward-looking measures) is the view that any such arrangement would first require “an international agreement on what constitutes international distributive justice.” Rather than waiting for that to happen, Traxler proposes that we act on GCC using an approach which is entirely forward-looking.

Peter Singer (2002) advocates an approach that would distribute the global carbon carrying capacity of the atmosphere on an **equal per capita** basis. This approach, like Traxler’s (2002), is entirely forward-looking, taking no consideration of a nation’s historical responsibility for GCC. The reasoning for Singer’s proposal is quite simple, positing that unless there is a good reason for moving from it, the equal distribution of this resource is the most appropriate. One possible concern with such an arrangement is that it would provide an incentive for population growth. Singer counters this by proposing that a particular year be chosen for all countries rather than scaling emission allotments up with population. This approach, when applied most simply, would punish

nations with a particularly young population at present. Thus, Singer proposes that an estimate of future population be used.

It is important to remark on the difference between Singer's (2002) and Traxler's (2002) approach. Whereas Traxler (2002) is looking at the burden of responding to GCC, Singer is looking at the remaining ability to emit carbon. These two approaches can be seen as two sides of the same coin. In any proposal to mitigate GCC, there is the question of how much carbon (and other GHGs) can be emitted before something undesirable happens. This defines how much carbon can be emitted, which is what Singer is concerned with. Taking it a step further as Traxler does, we can consider the burdens which such a limitation will entail. If a reduction in emissions were equally burdensome for each person, there would be no distinction between the two. Since there is a difference in the burdensomeness of reductions, the difference between the two becomes relevant.

Continuing to look forward in questioning which nations are best able to bear the burdens of GCC mitigation, a measure of **capabilities**, as put forth by Amartya Sen and Martha Nussbaum, can be particularly enlightening in making that determination. Sen and Nussbaum advocate a capabilities-based approach to the common question of human rights. Rather than asking "Does Person X in Country Y have the right to activity Z?", Sen and Nussbaum would ask about that person's capability to do that activity. While it may be the case that children have the right to go to school in a particular country, they may not have the capability to. For example, their families may be too impoverished to afford to send the children to school. Even if the education itself is free, there is an opportunity cost to educating children, as it removes them from the pool of available

labor which may be needed for the survival of the family. The discussion of capabilities is connected to the issue of GCC insofar as GCC stands to threaten capabilities and/or capabilities are used as a measure of a nation's obligation to address GCC.

Sen and Nussbaum advocate the understanding of capabilities to take a broader perspective about what development means than a simple economic analysis would allow. The traditional method for determining the state of development in a nation, GDP per capita, does not take into account the full set of capabilities which are required to lead a full, human life. Furthermore, it is ignorant of the disparity of capabilities that may be present in a particular nation. In practice, Amarty Sen has been instrumental in the creation of the Human Development Index (HDI). This index, created by the United Nations Development Program, judges the level of development based not only on per capita GDP (though that is a factor), but education and life expectancy as well. A more full discussion of the HDI occurs below.

Any discussion of justice, particularly where the focus is on the disparity of justice, cannot avoid **John Rawls' *Theory of Justice***. Rawls' theory is premised on two principles of justice and a hypothetical state in which individuals use the two principles to determine the structure of their society.¹⁵ The two principles are:

Equality in the assignment of basic rights and duties, while the second holds, that social and economic inequalities, for example inequalities of wealth and authority, are just only if they result in compensating benefits

¹⁵ Of course, the contribution to philosophical discourse contained in *Theory of Justice* is not limited to these two aspects. For example, the discussion of reflective equilibrium contained therein has contributed significantly to debates of meta-ethics. This paper, being concerned with applied ethics, does not discuss these other contributions.

for everyone, and in particular for the least advantaged members of society. (1971, p. 13)

In plainer language, the above principles guarantee equality of opportunity to political and professional positions and the equal ability to influence political processes. Secondly, Rawls holds that inequalities are only acceptable insofar as they improve the lot of the least-well off. Thus, Rawls disagrees with purely egalitarian distributions as well as utilitarian distributions which could seek to improve the lot of the better off at the expense of the less advantaged.

Rawls proposes a situation, “the original position,” under which just decisions about the structure of society would be made. In this position no person would know his/her place in society so as to ensure that, “no one is advantaged or disadvantaged...by the outcome of natural chance or the contingency of social situation” (1971, p. 11).

Rawls’ theory applies to GCC in two important ways. First is the treatment of the least well off. If GCC itself threatens to increase the disparity in well-being between the most and the least well-off, then it is a matter of particular concern. The second is a procedural consideration. In determining the most just way to deal with GCC, Rawls would claim that exploring the issue from the original position will lead to a just solution. It is important to recognize, however, the considerable limitation which Rawls puts on his theory. Rawls holds that his theory can only apply at the domestic level, for people in one nation who have agreed to be subject to their own authority. This limitation is motivated by considerations of state sovereignty and legitimacy, and skepticism about the possibility of internationally legitimate authority. Rawls discusses this aspect of his theory more completely in his *Law of Peoples*.

Not all authors take Rawls' (1971) theory to completely preclude aspects of international justice as Rawls himself does.¹⁶ In particular **Thomas Pogge** (1994) argues for an international, egalitarian distributive mechanism derived from Rawls' own arguments. Pogge proposes that a global resource tax (GRT) be paid by all national governments for the natural resources which they choose to extract. The obvious candidate for this tax is non-renewable resources such as fossil fuels and minerals, but Pogge holds that it can be extended to reusable resources and, "especially, to air and water used for the discharge of pollutants." The nation extracting the resource or emitting the pollutants would be responsible for paying the tax regardless if the resource were being used domestically or if it were being shipped abroad. Nations would raise the funds for the tax however they so chose and would then pay them to a facilitating organization (e.g. the World Bank or United Nations) who would then distribute the revenues so as to "emancipat[e] the present and future world poor." Ultimately, "the GRT payments would enable the governments of the poorer peoples to maintain lower tax rates, higher exemptions and/or higher domestic spending for education, health care, microloans, infrastructure, etc. than would otherwise be possible."

Though Pogge's proposition is significant for its interpretation of Rawls' theory, it is also interesting simply for its understanding of international resource distribution. Naturally, his concepts are relevant to GCC in terms of distributing the burdens of mitigation and the remaining resources of the atmosphere. For example, under a global cap-and-trade system of the remaining carbon-carrying capacity of the atmosphere there is the significant question of how to initially distribute that resource. Doing so would

¹⁶ While Rawls' *Theory of Justice* (1971) is specifically limited to issues of domestic justice, his later work, *Law of Peoples* (2001) does address issues of international justice. This later work is discussed more fully below.

impose a limit on the ability of certain nations to emit greenhouse gases and would thus entail tangible burdens for those nations. This would act, in a sense, like a tax on consumption, though it is important to note that a cap-and-trade system imposes hard limits on consumption whereas Pogge's GRT does not. On a final note, some of the mechanisms which Pogge proposes for the collection of his GRT could work to process the instruments required by a GCC solution.

3.3 Evaluation of existent approaches

Having considered that limited selection of previously proposed approaches, it is now possible for me to evaluate their merits and demerits and to come to a conclusion on what are the appropriate considerations for addressing GCC.

Before beginning the full evaluation of the approaches, it is important to be reminded of what it is we are attempting to accomplish. In summarizing the approaches above, I have focused on how they distribute the burdens of addressing GCC. In the interest of brevity, I am using the term "obligation" to refer to the obligation to address GCC and, therein, to bear a share of the burdens thus required. In that sense, to say that Nation A has a greater obligation than Nation B is to say that Nation A ought to bear a larger share of the burdens than Nation B. Thus, I am looking for a measure of obligation to address GCC and asking what are the relevant factors which would contribute to such a measure. Secondly, I am looking for a way to translate that measure of obligation into something practical which can be applied to the situation.

3.3.1 Process

As the summaries have shown, there is no consensus on the process by which a measure of obligation should be determined. Some take a very practical approach, limiting the options to what is perceived as possible given the current political climate, whereas others seek to derive the notions of distributive justice through first principles of morality. Unsurprisingly, I am taking the second approach. By taking this approach, I simply rule out some of the approaches. I rule out the Bottom-Up approach and the ad hoc distribution of commitments used in the Kyoto process and remove them from the possible choices. It is necessary, however, to first remark on why these approaches are unethical.

The basic notion of justice holds that decisions should not be made arbitrarily; that there will be some reason for having made that decision. In the words of Rawls, “institutions are just when no arbitrary distinctions are made between persons in the assigning of basic rights and duties and when the rules determine a proper balance between competing claims to the advantages of social life” (1971). As Rawls remarks, such a definition can be agreed upon by individuals with competing claims of justice as the definition of “arbitrary distinction” remains open.

One such example of arbitrariness which Pogge (1994), among others, advances is the historical arbitrariness of national borders and “the enormous distributional significance national borders now have.” There are two main points which Pogge (1994) makes in this claim, that national borders are historically arbitrary and that they carry distributional significance. Both of these points are supported by empirical fact.

Considering the historical arbitrariness of national borders we must only recall the history of most any nation. Its borders have been shaped by centuries, in some cases millennia, of conflict and coercion whereby the powerful have out-battled, out-negotiated, or simply stolen from their weaker neighbors. Looking specifically at the example of the United States, the entirety of its land was occupied at the time when it was “settled” by the immigrant Europeans. Through a series of trades and battles with the indigenous people of the land, the United States has come to be the most powerful and one of the most resource-rich nations in the world. Its claim to the resources which it possesses is based on the means with which it acquired them. In many situations the course of history could have taken a vastly different turn, defining large swaths of land and resources to its neighbors. This, of course, is not meant to be an individual attack on the United States, for the same could be said of any other nation in the world.

The fact that being member of one nation rather than another implies significantly different life prospects for an individual is so near a platitude that it barely warrants discussion, but examples of the sheer scope of the disparity are helpful to put the situation into perspective. Consider life expectancy, perhaps the most basic component to living a good life (as simply *living* is required for such). A person born in Swaziland, a landlocked African nation bordered on three sides by South Africa and on the fourth by Mozambique, is expected to live, on average to be 32.5 years old (UNDP 2005). Compare that to Switzerland, a landlocked European nation, where the average person can expect to live to be 80.5 years old, a difference of 48 years (UNDP 2005). In other words, a person from Switzerland can expect to live *2.5 times longer* than a person from Swaziland. That is, while the average Swiss person is progressing from life to death, one

person from Swaziland, born at the same time as the Swiss, can grow and die, followed by another person who can grow and die and followed by another person who can grow and reach middle-age (at age 15 no less!) all before the Swiss person passes away. How can such a distinction, being Swazi or being Swiss, which leads to such an utterly dramatic difference in capabilities, possibly be justified? Other measures of capability show an even sharper distinction. Sierra Leone has a per capita GDP of \$548 whereas Luxembourg enjoys a rate of \$62,298 113 times as much (UNDP 2005). Whereas 99 out of 100 adults in most any European or North American country can read, only 1 in 7, or 14%, of adult Nigerians can claim the same basic capability (UNDP 2005).¹⁷ I could continue to belabor this point with numerous statistics; but it should be abundantly clear that the reality of the world in which we currently reside shows Pogge's (1994) assertion to be valid.¹⁸

Bringing the discussion back to GCC, it is important to consider how the arbitrary facts of human and natural history contribute to the determination of the obligation to address GCC. In this case we don't need to hypothesize, as the process of determining the commitments in the Kyoto Protocol provides just such an example.

Due to a variety of occurrences which involved both chance and less noble conditions, the United States has come to be the sole superpower of the world.¹⁹ Having achieved that position, the United States is in a position to influence any international

¹⁷ All data for this section are taken from the United Nations Development Program's Human Development Index, 2005.

¹⁸ There are some, notably Nietzsche, who would claim that assertion of power is the purest expression of humanness. Most discussion of justice, both ancient and modern, strives for something more. Such nihilistic arguments do not warrant a great deal of commentary in the contemporary literature and, thus, do not get any significant attention here.

¹⁹ Of course, the rise of the US to this position was not only the result of iniquities. Many instances of valor and courage dot the history of this nation. This paper's focus on the US is motivated by its dominant position in the political landscape and the author's familiarity with its history.

decision, including those regarding the global climate. Describing the negotiations which led to the Kyoto Protocol, Gardiner (2004) recounts the United States' actions as such:

From the early stages, and on the most important issues, the United States effectively molded the agreement to its will, persistently objecting when other nations tried to make it stronger. But then it abandoned the treaty, seemingly repudiating even those parts on which it had previously agreed (p. 594).

At the time when Gardiner wrote his essay, it was still uncertain if it would even be possible for the Protocol to come into support without ratification by the United States. Since then, the ratification by Russia has brought the Protocol into effect, but without world's largest emitter of carbon.²⁰ Very clearly, nations which have the power to bend international agreements to their liking will take the opportunity to do so.²¹ This fact alone, without even blaming the powerful nations for their actions,²² is enough to call for systems that prevent such an abuse of power.

In thinking how to design such systems we need not go further than Rawls and his original position. As originally constructed in *A Theory of Justice*, Rawls only intends for the thought experiment to be used at the domestic level. In *Law of Peoples*, however, he

²⁰ In 2002, the United States emitted 5,773 Mt of CO₂, 23.32% of the world total. In comparison, the next largest single nation was China, which emitted 3,783 MtCO₂, or 15.28% of the world total. The comparison is even starker viewed against population. In that year the United States emitted 20 tons of CO₂ per person, while China emitted only 3 tons of CO₂. Taking measure of cumulative emissions only makes the matter worse for the US. Looking from 1850 to 2000, the United States has emitted 301,365 Mt of CO₂, 29.64% of the historical total, while the next closest single nation, Russia, has emitted 83,643 Mt CO₂, or 8.23% of the world total. (WRI 2003)

²¹ "We will not do anything that harms our economy, because first things first are the people who live in America."—US President George W. Bush, 2001 "The American lifestyle is not up for negotiation."—US President George H. W. Bush, 1992. See footnote 4 above for another relevant quote (all as quoted in Singer 2002).

²² One can imagine a powerful nation's defense of "you would do it if you could too," which is difficult to prove either way but certainly is rather likely to be true.

imagines a second original position consisting of delegates from each nation.²³ The main point, however, of the original position is to get away from the self-serving nature of most political discussions and to focus more on what is truly just and fair. Any arrangement which allows individual nations to exploit the power asymmetries to the benefit of their own, vested interests is almost inevitably going to lead to some form of institutionalized injustice. It is what happened in the Kyoto proceedings and it is what will happen in future situations which follow the same procedural model.

The Bottom-Up model and an ad hoc method of distributing commitments would not be a fair means to generate an equitable response to GCC, because these methods allow power asymmetries among countries to determine the allocation of burdens of mitigation. What is needed, then, is the rational design of commitments of which Bodansky spoke. All of the other models listed above include a mechanism for designing commitments or burden sharing along lines other than political power and, thus, still stand for consideration. The great loss in excluding political power from the debate is in practicality. Just as the powerful nations have the ability to manipulate the process, they also have the ability to manipulate which process is chosen in the first place. Again, though, practicality is not of present concern. This is a matter taken up by non-ideal or imperfect compliance theories of ethics.

3.3.2 Considerations of Obligation

Having excluded political power from the process of determining obligation, it is now relevant to ask what the relevant considerations for that measure of obligation are. In the approaches summarized above (to say nothing of those not included) there are a great

²³ More accurately, Rawls would have a representative from each group of “peoples,” Rawls’ preferred socio-political grouping. Though distinguishing between states and peoples is, in fact, the main point of *Law of Peoples*, it is a distinction which is not particularly relevant to this discussion.

number of options for making this determination. Naturally, they fall into the two categories for considerations of justice which are typical in the discourse of ethics, those which are forward-looking and those which are backward-looking.²⁴

Responsibility

Backward-looking approaches, or measures of responsibility, combine considerable moral force and marked intuitive simplicity. This makes them hard to ignore in the discussion of obligation. The most common approach to resolve typical environmental problems is the “Polluter-Pays Principle.” In terms of official documentation, the Organization of Economic Cooperation and Development states it quite clearly and very early in the discussion of environmental ethics. In a recommendation on the guiding principles concerning international economic aspects of environmental policies the group states, “the polluter should bear the expense of carrying out the ... measures decided by public authorities to ensure that the environment is in an acceptable state (OECD 1972).” It is almost difficult to discuss the moral force of this principle because it is so obvious. Shue (1999) describes it as a “commonsense principle” of equity: gift shops the world over make claim to it with signs reading, “You break it, you buy it!” It is difficult to find a simpler, more readily understood and agreed-upon measure of obligation to resolve any question of who should bear the burden of correcting a problem. If you are responsible for the problem, then you are obligated to work to resolve it.

²⁴ Singer (2002) uses terminology borrowed from Robert Nozick, calling backward-looking approaches “historical” principles and forward-looking approaches “time-slice” principles. As noted above, Traxler describes the former as issues of “justice” and the latter as issues of “fairness.” In the context of GCC, the South-North Dialogue (2004) uses the terms “responsibility” and “capability,” respectively. As these last two terms capture the issue of GCC most accurately, I will use them in the later portions of this paper.

Since the concept so plainly warrants inclusion in any measure of obligations, it is remarkable that so few proposed approaches include it in their assessments of obligation. The notable exceptions are the Brazilian Proposal and the South-North Dialogue. The differences between the two are what indicator is used as a measure of responsibility and that the South-North Dialogue creates a composite measure of obligation, including other measures as well. I will save the discussion on what the appropriate indicator of responsibility is for a section on technical choices below.

It is not the case that others have simply ignored or somehow forgotten about the claims of responsibility. By and large the exclusion has been conscious and willful. In his comprehensive review of ethics and GCC, Gardiner divides the opposition to including measures of responsibility into two camps, objections on the grounds of mitigating ignorance about the harms of emissions, and objections on the grounds of pragmatic concern. Remarking on the suggestion that ignorance about the harms of emissions mitigates responsibility, Gardiner describes it as “far from convincing.” Referencing United States tort law, Gardiner notes that several environmental cases have allowed for “strict liability—i.e., instances where a party causing harm is liable for damages even when not guilty of negligence.” Thus, if responsibility is to be included in a measure of obligation, it should include historical data reaching as far back as relative scientific certainty will allow.²⁵

²⁵ On a more practical note, using deeply historical data (e.g., dating back to 1850) does not change the ranking or relative positioning of the most responsible nations. In general nations which went through the industrial revolution the earliest, such as the United Kingdom and the United States, fair slightly worse under deeply historic measure. Methodological choices such as what indicator of responsibility used and whether or not to include emissions from land use change play a more significant role in determining the rank ordering and relative positioning of the most responsible nations (Den Elzen 2001, p. 63; Den Elzen 2005, p. 278).

The more common objection to including responsibility in a measure of obligation is that it is impractical (Gardiner 2004, p. 581). Traxler (2002), as stated above, opposes the inclusion of a measure of responsibility on two grounds. First, such an inclusion would require an agreed-upon conception of global justice. Traxler concludes that that waiting for the generation of such an agreement would effectively put off “any implementation concerning climate change indefinitely.” Though certainly I agree that we cannot wait to act in response to climate change, I disagree with the assertion that any action on GCC using responsibility as a consideration would first require an agreed-upon conception of international justice. Gardiner calls to mind the Marshall Plan following the Second World War, which constituted a massive redistribution of wealth without having any background understanding of international justice. Moreover, it is imperative that the “ethical” approach to climate change mitigation not be simply reduced to what is considered practical. The approach should come from the other direction, asking what is ethical and then working to make it practical.

Traxler’s (2002) second objection to including a measure of responsibility in determining obligation is that it will encourage the historical emitters to defect from any such regime. Gardiner (2004, p. 582) objects to this assumption on three main points, with which I largely I agree. The first is that any regime which does not include historical emissions will likely encourage the non-historical emitters to defect. The second is that an enforcement mechanism would not be impossible to implement. We could draw from examples operating today. The final objection is that the inclusion or exclusion of a

measure of responsibility is not the only factor in the regime which would influence defection and, in reality, is unlikely to affect defection one way or the other.²⁶

The main opposition to including a consideration of responsibility in the measure of obligation is derived from either a claim of ignorance or practical difficulty. Those two considerations are not enough to convince me that its inclusion would be inappropriate, especially given the intuitive plausibility of its inclusion. Thus, I conclude that a consideration of responsibility is not only appropriate to include but necessary to include in any meaningful account of ethical obligation to address climate change.

Capability

Having chosen “capability” to be my preferred term to describe forward-looking measures, it should be fairly clear in which direction I am going to turn. I show how capability is the relevant forward-looking consideration for a measure of obligation. This section will also address the moral force behind an equal per capita sharing of burdens and the particular moral force that such a distribution commands.

It is important to first consider what a forward-looking consideration means in the context of GCC. It is a consideration which is blind to the antecedent causes of our present situation and which looks at both the current situation and the expected future situation to determine what would be a fair resolution to the issue. These considerations

²⁶ The developed nations are most likely to defect as a result of including a measure of responsibility in determining obligation as it would, quite clearly, increase their level of obligation. There are two grounds on which to respond to this concern. The first is that any regime which is in the most basic agreement with the UNFCCC would require a higher burden be borne by the developed nations as Article 3, Section 1 clearly states, “. . .the developed country Parties should take the lead in combating climate change and the adverse effects thereof.” The second is based on the admittedly contingent facts of the situation which show that the responsible nations are also the most capable. Thus, including any information needed for a rational decision imposes greater obligation upon the developed countries. Developed nations are motivated to defect from any regime which is rationally-based or in compliance with the UNFCCC, regardless of whether it includes a measure of responsibility or not.

offer the possibility of “decoupling” the discussion from carbon.²⁷ This approach has a particular attraction. By removing carbon from the determination of obligation, it presents the opportunity to treat GCC as any other humanitarian crisis to which the entire world must attend. The response to GCC could serve as a model for other responses by taking a forward-looking measure which is not limited to the situation at hand, but is general enough to capture the obligation to assist which is implicit in a higher level of capability.

Before diving into an analysis of the above-summarized approaches, we should start by detangling that closing sentence of the preceding paragraph. What does it mean to say that there is an “obligation to assist which is implicit in a higher level of capability”? There are two concepts, the first being an obligation based on a particular state of being, the second is a concept of capability. Starting with the second, what is this notion of capability? According to Nussbaum (2002) capabilities are, “an account of the space within which we make comparisons between individuals and across nations as to how well they are doing.” (p. 123) To elucidate her description, Nussbaum draws comparisons against other measures of international development. The most “common” and “crude” method is to take a measure of GNP per capita. The shortcomings of this approach are twofold; first, such a measure does not take into account who has the money and can hide enormous inequalities and, second, it does not “provide any information at all about elements of human life that might be thought very important in defining its quality but that are not always well correlated with GNP per capita: educational

²⁷ Carbon here is serving as a surrogate measure for other greenhouse gases.

opportunities, health care, life expectancy...”²⁸ A “somewhat less crude” approach measures quality of life in terms of utility (subjective welfare) per capita. Nussbaum objects on three fronts; an aggregate measure of utility does no better than GNP per capita at exposing inequality, it treats the “irreducibly plural goods that figure in a human life” as commensurable, and the phenomenon of “adaptive preference”²⁹ shows that reported satisfactions are not a very good measure of quality of life. The final approach which Nussbaum analyzes is the approach of Rawls, which “looks at a group of basic resources, and then asks about their distribution, asking, in particular, how well even the worst-off citizens are doing with respect to the items on the list.” Nussbaum references Sen’s criticism of this approach, that “individuals vary greatly in their need for resources and in their ability to convert resources into valuable functionings.”

On the basis of these criticisms of alternative approaches, Nussbaum and Sen argue for a measure of capabilities. The question for Sen and Nussbaum is not, “How satisfied is person A?” or “How much in the way of resources does person A command?” but “What is A actually able to do and to be?” This approach does not limit the measurement of a society as an aggregate whole, but emphasizes the capabilities of each and every individual. Sen and Nussbaum diverge on what the central capabilities are. Nussbaum develops a list of twelve broad categories encompassing everything from life and bodily health to practical reason, friendship and the opportunity to participate in the political process. Sen’s view on relevant capabilities is evidenced in his work on the

²⁸ For example, China has a GDP per capita of \$5,003 and an average life expectancy of 71.6 years. Gabon, on the other hand, has a GDP per capita of \$6,387 and an average life expectancy of 54.5 years. Compare Burkina Faso with a GDP per capita of \$1,174 and an adult literacy rate of 12.8% and Tajikistan with a GDP per capita of \$1,106 and an adult literacy rate of 99.5%. (UNDP 2005)

²⁹ Nussbaum recounts a case (itself borrowed from Sen) in which a survey of reported well-being was conducted in India after a famine and the responses showed widows as far less likely to report illness or indifferent health than the widowers. In Sen’s words, “Quiet acceptance of deprivation and bad fate affects the scale of dissatisfaction generated, and the utilitarian calculus gives sanctity to that distortion.”

United Nations Human Development Report and its Human Development Index. That gauge of well-being takes into account measures of life expectancy, education and wealth. The differences between the two sets of capabilities can be traced back to the authors' personal predilections. Sen is an economist by training and, hence, has a preference for the quantifiable such as life expectancy, gross enrollment rate and GDP per capita. Nussbaum, on the other hand, is deeply Aristotelian in her philosophical foundations and thus seeks to capture the more abstract notion of a "good life" by including concern for political participation and friendship. What is common to the two, though, are the basic capabilities, those which prevent the enjoyment of other capabilities and therefore take a position of primacy. Basic measures of life, health, and control over one's bodily integrity are central to both. Since GCC presents a threat to those most basic capabilities, there is no need to differentiate between the two proponents of the capabilities approach.

The second potentially controversial aspect of my statement above is that a nation with a higher level of capabilities has an implicit obligation to bear a greater share of the burdens associated with resolving a problem of global concern. The controversy surrounding this obligation is largely the result of a deceptive formulation of the principle. The suggestion is that having an obligation associated with the capabilities of a nation would constitute punishing nations (or individuals, for that matter) for their success. The implication is that we ought to be congratulating our most successful nations and individuals and not forcing them to bear the burdens of the least well off. The moral bearing for such a claim, however, is highly dubious. Given a situation which requires wide action, ought the burden be borne more heavily by those whose energies are largely

constrained to the provision of basic functionings, or by those who have already achieved a level of basic function and now have the ability to enjoy a greater standard of being? Clearly an obligation for the more capable nations to bear a greater share of the burdens entailed in responding to a global problem is more demanding on them. Would it be preferable, however, for the greater burden to be borne by the less capable nations, who are already burdened by their domestic affairs? Certainly, any consideration of a fair distribution of the burdens would have to say no. This question raises the distinction between subsistence and luxury emissions, as discussed above. Any regime which restricts emissions required for subsistence prior to restricting all other luxury emissions defeats the humanitarian approach. The central purpose of that approach is to prevent shortfalls in the basic functioning of humans. If restrictions of emissions contributed to that shortfall, then clearly the approach is contributing to the problem and not to the solution.

Turning now to the specific proposals summarized above, Traxler in particular claims to have a response to the above concern about placing a greater burden upon the more capable or the less capable. Traxler's approach, of course, is to apply the burdens of GCC mitigation equally to all nations. To define an amount which is "equally burdensome," Traxler looks to measures of opportunity cost, that is to say, the cost which will be incurred by bearing the burdens of GCC mitigation rather than doing something else. The central problem which Traxler faces is that traditional methods of determining financial opportunity cost remain ethically vacuous. That is because the opportunity cost, as measured in dollars, to limiting the production of luxury goods in one nation may be greater than limiting the production of certain staple items in other nations. To avoid this,

Traxler states that, “what is needed is a measure of opportunity cost that reflects the costs in terms of human well-being rather than in monetary costs.” Traxler acknowledges that no such measure of well-being opportunity cost currently exists and that creating one presents its own set of procedural challenges.

The primary motivation behind Traxler’s choosing equally burdensome shares is the likelihood that it will garner the widest support in a global regime. This is a pragmatic concern. Gardiner shows that this approach may not be as practically attractive as it may at first seem. Though it divides burdens equally, Traxler makes it clear that developed nations ought to give up all of their luxury emissions before developing countries have to touch their subsistence emissions. Though certainly a morally relevant claim, it does undercut Traxler’s aims of creating an approach which would have significant practical appeal. That said, it is still worthwhile to consider the ethical implications of this approach.

By and large I am in agreement with Traxler’s approach, though I believe that it can be reduced to the capabilities approach described above. In order to determine what the opportunity cost in terms of human well-being is for a nation to assume some burden, it will have to include myriad factors which could include both subjective and objective measures. Traxler observes a concern with the opportunity cost approach, that “the estimations that particular nations make of the benefits or losses associated with a particular project or cost may seem utterly exotic or unreasonable to other nations.” (p. 132) That is to say, what is valuable in one nation may not be equally or at all valuable in another nation. At this point Traxler proposes that a measure of human well-being be used to avoid the particularities of a certain culture’s tastes. However, the conceptions of

what constitute well-being are at least as diverse as what constitutes good taste. In order to put into practice some international measure of well-being opportunity cost, there would have to be some approximation of consensus on what constitutes human well-being. This, however, is exactly what Sen and Nussbaum are attempting to accomplish. Of particular note is Nussbaum's (1990) "thick, vague conception of the good." Nussbaum describes this conception of the good as, "an ethical-political account given at a very basic and general level, and one that can be expected to be broadly shared across cultures, providing focus for an intercultural ethical-political inquiry." The measure which Traxler is seeking is the account of capabilities on which Nussbaum and Sen have been working for decades.

Understanding how the idea of capabilities, as advanced by Sen and Nussbaum, is connected with an obligation to address problems of global concern, it is now clear how the alternative proposals fall short of the ideal arrangement. The Ability to Pay model, with its focus on GDP per capita, is far too narrow in its scope of concern. Traxler's model of equally burdensome shares reduces to a measure of capabilities. As stated above, however, this evaluation of proposals must still address a particularly weighty suggestion, the idea of equal per capita distribution of burdens. Naturally, the next section discusses this approach.

Equal per capita emissions rights

Notions of equality have been invoked in this paper multiple times, primarily in regard to an equal per capita distribution of emissions permits, as advocated by Singer (2002) and the equally burdensome shares of GCC mitigation as proposed by Traxler (2002). This distinction recalls the two sides of the same coin discussion in Section 3.2 as

the equal per capita distribution of emission permits has to do with distributing a resource whereas the equally burdensome shares of GCC mitigation has to do with distributing burdens. Distributing one does not equate to distributing the other as the current levels of emissions varies from nation to nation. For example, for the United States to have 1 ton of carbon to emit per person per year would require significant emissions reductions and, thereby, significant burdens. That same amount, 1 ton per person per year, is far more than Chad is presently emitting and would thus require no burdens to achieve. The equal per capita distribution of emission rights shares support both from the scientific and philosophical community with similar regimes proposed by both Anil Agarwal (Bodansky 2004) and Singer (2002). The primary appeal for the per capita distribution of burdens is its intuitive simplicity. At face value, a simple, equal distribution is the most straightforward form of impartial decision making. It reflects each person's moral standing to make an equal claim on the world's biggest public resource—its atmosphere. An equal per capita distribution of emissions rights captures the particular value of equality which theories of justice hold in such high regard.

An approach based on a conception of equality is, however, deceptive in its simplicity, so much so that Sen has devoted an entire book to the subject (*Inequality Reexamined*, 1992). The basic thrust of that work is to call attention to the large number of ways in which equality can be defined and the fact that, given the unavoidable diversity among humans' situations,³⁰ that achievement of equality in one dimension will result in inequality in other dimensions. There is always some way in which the arrangement is unequal, favoring some over another. Thus, the challenge is defining what

³⁰ The simple diversity of physical shapes and sizes precludes the possibility of absolute equality.

ought to be the relevant considerations in defining equality, that is, asking, “Equality in terms of what?”

In the case of distributing the burdens of GCC mitigation, it makes sense to design the distribution from the most basic principles. Given the history of negotiations and the ability of powerful nations to bend the arrangement to their will, it is important to not deviate too far from the most fundamental and clear principles of justice, lest the deviations be distorted by the interests of the powerful. At the base of nearly all theories of justice³¹ lies a claim to equality in one form or another. Thus, in distributing the burdens of GCC mitigation, it is appropriate to initially assume an equal distribution of emissions rights based on nothing more than a person’s status as a person. It is not equality in terms of purchasing power, not equality in terms of the burden caused, but simple, per capita equality. Using this measure as the base, however does not and should not preclude its modification if warranted by other relevant measures. In order to approach the problem of distribution, however, from a truly impartial position, it is not immediately obvious how that would be done if we do not begin by assuming an equal distribution at the outset.

The question left lingering, then, is what would constitute a relevant measure for departing from the equal per capita distribution of burdens? The answer, quite clearly, is a measure of responsibility and a measure of capability. Imagine a house with seven undergraduates living together. Early one morning, they wake to find the sink has backed up and overflowed. Given no other information on the situation, the only fair distribution

³¹ Sen recounts a variety of theories and their invocation of equality: Rawls (equal liberty and equality in the distribution of ‘primary goods’), Dworkin (‘treatment of equals’ and ‘equality of resources’), Nagel (‘economic equality’), Scanlon (‘equality’), Nozick (equality of libertarian rights) and a “hidden equality” in utilitarian theories.

of the burdens of cleaning the mess is an equal share for each housemate. Perhaps, though, there is more information to be had. One house member has recently broken a leg while another is tending to urgent family concerns. It would be reasonable to say that those less capable housemates would be obligated to share a smaller portion of the burden or, perhaps, none at all. After the remaining five housemates have set to mopping up the mess and inspecting its cause, they notice a bright green sock blocking the drain. Knowing that only housemate wears such garish attire, there is clearly relevant information regarding responsibility for the mess. It would then be appropriate to say that the housemate who is responsible for the mess is obligated to bearing a larger share of its resolution. The intuitive and ethical appeal of such an approach is abundantly clear. It is the approach which I am proposing for GCC.

3.4 Proposal of a new approach

Drawing inspiration from the South-North Dialogue (2004), I propose that the distribution of burdens entailed in a response to GCC be based on a modified per capita approach. The relevant considerations which ought to modify that per capita distribution are a measure of responsibility and a measure of capability. This approach would be both forward-looking and backward-looking and aims at capturing all of the information relevant to determining an equitable distribution in one approach. To review the situation and arguments thus far, GCC stands to threaten the lives and well-being of an immense number of people. There is an uncontroversial humanitarian duty to respond to situations of this kind as well as a negative duty to not harm others. Responding to this situation, as is the case in any other humanitarian response, will be burdensome for those that do

respond. The distribution of burdens ought to be on an equal per capita basis unless there is other relevant information to do otherwise. Measures of responsibility and capability present just such information and show that an equal per capita distribution of burdens is insufficient to capture all of the morally relevant information surrounding GCC.

There are two main arguments doing the work here. The first is the rather uncontroversial argument that we must respond to GCC in one way or another. The second is a more complex, potentially controversial argument for the distribution of the burdens associated with the response required by the first argument. The first argument finds wide support in the literature of ethics. Even authors skeptical about the notion of international justice³² make a claim to the basic humanitarian duty to prevent catastrophe, and, even more urgently, to not *cause* catastrophe. It would be possible to do away with the second argument all together and simply leave the distribution of the burdens to some negotiation process. This approach has been attempted and has been shown to be susceptible to the manipulation of the powerful to the disadvantage of the less-powerful. Thus, there needs to be some rational design of the distribution. Stripping away all of the information which could lead to procedural bias, a simple equal per capita distribution of burdens is the only sensible approach. Upon further review, however, such an approach seems to have gone too far and has removed information relevant to determining the distribution of burdens. The polluter-pays principle, what Shue (1993) calls a “commonsense principle,” holds that those who are responsible for the problem ought to bear a great portion of the burden entailed in resolving it. A forward-looking approach asks whether it is appropriate to distribute the burden equally to all nations, regardless of

³² Nagel (2005) assumes that there is a “minimal concern we owe to fellow human beings” threatened with the consequences of a catastrophe. Rawls makes a similar claim in his *Law of Peoples*.

their ability to handle it without harming their own populations. Advocates of a strong sense of global justice, such as Pogge, see this as necessary and show that Rawls, on his own grounds, would have to concede. Sen and Nussbaum show that the appropriate measure of capability is not a simple measure of GDP per capita, but a more complex calculation of well-being encompassing many attributes of a well-lived life. Combining capability to respond and responsibility for the problem gives a measure of obligation. Calculating obligation per capita will allow for a relative comparison of one nation to another. That value can then be scaled to population to yield an absolute value of obligation which is necessary for calculating the final distribution of burdens.

3.5 Technical Choices

In order to perform the proposed calculations, it is necessary to choose some data for each of the relative measures. The basic equal per capita distribution requires nothing more than world population data, which is readily available from the World Bank. It is not as clear what data should be used for calculating the measures of responsibility and capability. This section will justify the choices that I have made.

3.5.1 A Note on Indexing

Given the variety of data and units involved in these calculations, indexing is frequently used to put the measures on a common scale. The concept of indexing is quite simple. The purpose is to proportionally scale the data, whatever the range, from one to zero. To do that, one employs a simple formula for each data point: $(\text{actual value} - \text{minimum value}) / (\text{maximum value} - \text{minimum value})$. Under such a calculation, the minimum value in the index has a value of zero and the maximum value in the index has

a value of one. The relative distance between all other data points in the set is maintained; the only difference is that it is now scaled down. This would not be particularly informative if only one data set were being considered. With one data set, the only advantage is the intuitive understanding of where 0.12 lies on a scale of 0 to 1 as compared to where 3,266 lies on a scale of 406 to 24,243. The important advantage comes in comparing data sets of different units and, especially, in creating an aggregate index from multiple indices.

3.5.2 Measure of Responsibility

The following debates regarding indicators of responsibility have been played out on the political and academic stages in the context of the Brazilian Proposal to the Kyoto Protocol. As originally proposed in 1997 during the third Conference of Parties which established the Kyoto Protocol, the Brazilian Proposal sought to apportion the burden of mitigating emissions based on the integrated past concentrations of CO₂³³, serving as a rather simple proxy for temperature increase (UNFCCC 2002, Rosa et al. 2003). The Proposal was not accepted in its initial form at COP-3, but garnered significant attention and was referred to the Subsidiary Body for Scientific and Technological Advice (SBSTA) of the UNFCCC. Since 1997 the Brazilian Proposal has been reviewed many times under the supervision of the SBSTA, This process has yielded some revisions which have been in keeping with the spirit of the original proposal. Rather than using integrated past concentrations as the indicator, the revised Brazilian Proposal uses more accurate, non-linear models to calculate temperature increases. In essence, the question

³³ Integrated past concentrations of CO₂ is an aggregate measure of historical emissions using basic calculus to find the total emissions over time.

which the Brazilian Proposal seeks to answer is what percentage of temperature increase, both historic and future, can be attributed to each country.

To understand the variety of possible indicators or responsibility for GCC it is important to recall the physical process itself. The causal chain of GCC begins at the “greenhouse-effect,” the process by which atmospheric gases allow ultraviolet energy from the sun to pass unhindered, thereby warming the earth and being radiated back as infrared energy which is trapped inside the atmosphere, a process known as radiative forcing. Certain quantities of the greenhouse gases are taken up by sinks on the earth eventually striking a balance between emissions and absorption. It is the overloading of this process which leads to the “greenhouse-effect,” the continual warming of the atmosphere, land, and oceans which causes the most concern. There are a number of links on this causal chain which can be targeted as the appropriate indicator of responsibility for GCC. These indicators, listed in order of increasing causal complexity, include cumulative emissions, current concentrations of greenhouse gases, past concentrations integrated with climate response, radiative forcing, integrated past radiative forcing, integrated future radiative forcing, temperature increase, rate of temperature increase, and sea-level rise (Rosa et al. 2004). All of these indicators take the data for historical emissions for each nation and then do increasingly complex calculations to derive their final values. There is an implicit trade-off between certainty and the closeness of the indicator to the actual impacts of GCC (UNFCCC 2002, Rosa et al. 2004, Den Elzen 2002, Den Elzen 2005). According to the experts set to study these indicators, the ideal indicator should be close to the impacts of climate change, understandable to scientists and the public, and certain. An area of contention in the expert discussions is the notion

of “backward discounting,” whereby gases emitted long ago are counted for less than gases emitted more recently, due to their re-absorption and atmospheric decay. It was not decided whether the concept is appropriate to include and, if so, at what rate (ibid.).

Pausing briefly from the technical discussion and taking the question from a purely moral perspective, the climate experts got it largely right. In an ideal world there would be a clear and completely certain measure for harm created by each country and how it affected each other country. Unfortunately, the world in which we are operating has no such measure and we must use proxies for that measure instead. The indicators listed above are just such proxies and each has its own set of advantages and disadvantages, as well as questions regarding the appropriate method for its creation.

There has been considerable effort in determining historical cumulative emissions, most notably by the United States Department of Energy's Oak Ridge National Laboratory's Carbon Dioxide Information Analysis Center (CDIAC), the International Energy Agency (IEA) and the Netherlands Environmental Assessment Agency's Emission Database for Global Atmospheric Research (EDGAR). Given the amount of effort which has been focused on determining historical emissions, this indicator is considered the most certain (Den Elzen 2002, UNFCCC 2002, Rosa et al 2004, Den Elzen 2005). Unfortunately, as the foundation for GCC impacts, it is the furthest away from the actual impacts. The global carbon cycle is an extremely complex system as it includes both anthropogenic and natural emissions as well as re-absorption (Den Elzen 2002). Determining who emitted what volume of carbon when is one challenge, but determining what has happened to that carbon since then is an entirely different challenge. Many models have been constructed to estimate what has happened to the

carbon and, over time, there have been considerable advances in making ever more accurate models (Den Elzen 2002). Using these models, namely MAGICC (Wigley 1993) and meta-IMAGE (Den Elzen 1998), it is possible to get a fairly accurate estimation of what has happened to the historical emissions, resulting in present-day concentrations of carbon attributable to each nation (Den Elzen 2002, Den Elzen 2005).

Ultimately though, it is not the excess carbon in the atmosphere which is and will continue to be causing harm to people, but the effects of that carbon on the climate system. The next link in the causal chain from emissions to impacts is radiative forcing. Naturally, accompanying this progression down the causal chain is increased complexity. One important feature of radiative forcing is that each “additional unit increase of concentration will gradually have a relatively smaller impact on radiative forcing” (Den Elzen 2002), known as the saturation effect. In order to accurately determine national contributions to radiative forcing, it is necessary to understand that the impact of early emitters is greater than those who emitted later as the saturation was less pronounced in the past (Den Elzen 2002)³⁴. This fact requires a non-linear approach to properly attribute radiative forcing of each nation (Enting 1998). Again, though, it is not the process of radiative forcing which is of concern to human processes: it is the consequences of radiative forcing.

The step from radiative forcing to temperature increase is a rather substantial one on two counts; first, it gets into some of the most complex estimates of the impact of

³⁴ The consequences of one emission event at a particular point in time are unlikely to be intuitive. There are multiple forces working in sometimes opposite directions to which ultimately determine the consequences of that one event. For example, though the emission event from long ago will have a greater affect on today’s climate as a result of the above-mentioned saturation effect, the absorption of that emission over time may have counteracted that effect. Ultimately, the question of how to accurately balance these forces is one for the climatologists designing and building the models used to perform the estimations. For this paper I have used data derived from CAIT which uses an admittedly simple linear model.

climate change and, second, it is the most palpable impact for most nations. One fact which complicates the calculations of temperature increase is the large heat capacity of the oceans. By absorbing a lot of the energy that is being trapped in the atmosphere, the world's oceans work as a buffer, catching and storing the energy without having noticeable impacts above the surface of the water. This imparts a significant time lag into the calculations, so significant that roughly 50% of the final global warming and sea-level rise will manifest itself decades or centuries after emissions have stabilized (Den Elzen 2002). Further complicating things is the open, though rapidly closing, question of climate sensitivity. Most basically, the question asks how many degrees increase can be expected for a given quantity of carbon in the atmosphere. For example, should the concentration of CO₂ be stabilized at 550 ppmv, the potential temperature increase could vary from 1.9°C to 6.5°C with a best guess of 3°C (Figure 2). Given the wide range of uncertainty which is present in the models, it is difficult to predict exactly what increase in temperature will result from a given concentration of CO₂ in the atmosphere.

Ultimately, though, in order to determine responsibility for GCC, it is not entirely necessary to know the absolute amounts by which each nation has increased the mean surface-air temperature of the world. What are most valuable are the relative contributions of each nation, information which can be determined from radiative forcing data and a reasonable estimation of how the climate systems will respond to that process.

Still, though, it is not an increase in mean surface-air temperature which will be the most disruptive for human beings, but the effects which that increase will have on the natural systems of the earth. Examples include the collapse of the thermohaline currents, massive crop failures and, the most frequently discussed, sea-level rise (Pew 2001,

UNFCCC 2002). On the causal chain from emissions to impacts, these are the final link on the impact side. These are the changes which will most severely affect human beings and which would lead to the substantial reduction in human capabilities discussed above. However, these are the indicators of responsibility which are most susceptible to variation and uncertainty. Take, for example, sea-level rise. There are three primary factors which contribute to sea-level rise; the expansion of ocean water as it is heated, the melting of ice and its flow into the oceans, and finally, the displacement of water and the resulting rise in sea-level should ice shelves or sheets become destabilized by warming and previous sea-level rise (IPCC 2001 technical). The complexity of the calculations and the degree to which they rely on assumptions makes them less favorable indicators (UNFCCC 2002).

Two final choices in determining the appropriate measure of responsibility is in regard to the time frame chosen and the source of emissions. Singer (2002) and Ott et al. (2004) propose that emissions only from 1990 to present be considered. As stated above, I disagree with this approach and consider emissions from 1850 until 2000, the fullest range of data available to me. Choosing what the appropriate sources of emissions to consider are is more complicated. The main distinction is between emissions from the combustion of fuels and emissions as a result of land-use change. Land-use change covers a broad range of activities from deforestation and reforestation to filling in wetlands and burning rangeland. The largest potential source of a net contribution to greenhouse gases in the atmosphere comes from deforestation. This process contributes to global warming in two ways; the first being the direct addition of gases to the atmosphere as the natural material rots and the second being the destruction of what was

once a sink for CO₂. This sink-to-source shift is a large potential source of greenhouse gases in the atmosphere and should be considered in any evaluation of responsibility. Unfortunately, the data available on land-use change is nowhere near as certain as the data on fuel use emissions (Den Elzen 2004). Including that data would introduce an unacceptable level of uncertainty in my evaluation and, thus, I regrettably exclude it from my evaluation. There is a need for this data to be collected more completely and more accurately in the future.

Taking, then, national contribution to increase in surface temperature as the appropriate measure of responsibility, how do the nations compare to one another? The table (Table 7) of the full data for a 173 nations can be seen at the end of this paper. Table 1 summarizes the five nations highest on the responsibility index and the five nations

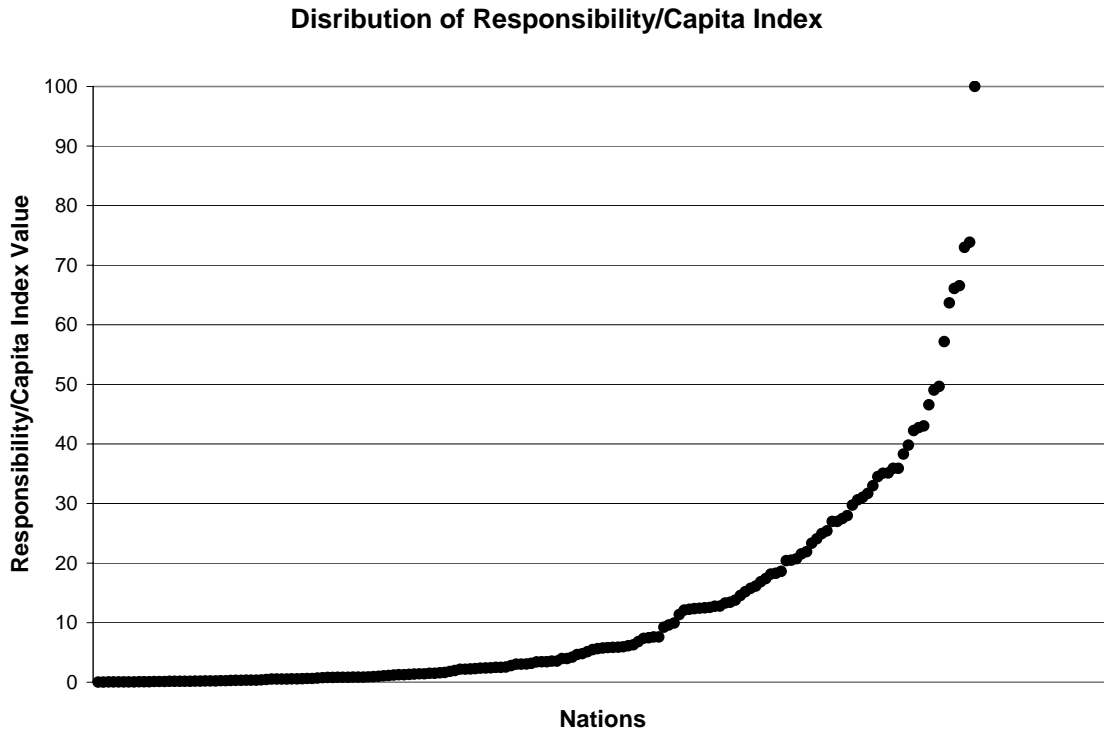
Table 1: Ten nations with the highest and lowest five values of the responsibility/capita index

Highest Nations	Responsibility/Capita Index	Lowest Nations	Responsibility/Capita Index
<i>Luxembourg</i>	100.000	<i>Nepal</i>	0.035
<i>United States</i>	78.823	<i>Ethiopia</i>	0.024
<i>United Kingdom</i>	72.986	<i>Eritrea</i>	0.023
<i>Belgium</i>	66.540	<i>Chad</i>	0.003
<i>Czech Republic</i>	66.084	<i>Burundi</i>	0.000

Source: WRI 2003

lowest on the index. The above list is created using available data reaching back to 1850 when possible and scaled to a nation's population in 2000. Figure 3 illustrates the distribution of the index, showing that there a very few nations with very high values and a great many nations with relatively low values. As shown, the majority of nations, in fact, have a responsibility per capita index value that is less than 10.

Figure 3



This distribution does not come as too great of a surprise, as it simply illustrates that a few nations are predominantly responsible for the temperature increase that the world has already witnessed. It is important to remember, as well, that it is not simply a few extremely populous nations who are skewing the distribution such. The index is responsibility *per capita*, meaning that a few nations have had a disproportionately large impact over time, given their population. In aggregate, the disparity is even more extreme with only 6 of 174 nations having an index value greater than 10.³⁵

3.5.3 Measure of Capability

Deciding on the appropriate measure of capability to use is made much easier by the predominance of one such measure. That measure is the Human Development Index

³⁵ Those nations are the United States (100), Russia (29.44), Germany (24.97), China (24.37), the United Kingdom (20.77), and Japan (14.13). (WRI 2003)

(HDI) as created annually by the United Nations Development Program. The HDI is a composite measure of three dimensions which are deemed “essential” for enhancing human capability (Noorbakhsh 1998). Sen was instrumental in the creation of the HDI and, thus, it reflects his views on what human capability means. The three dimensions included in the HDI are life expectancy, as a measure of a long and happy life, knowledge, as measured by adult literacy (with two-thirds weight) and gross enrollment ratio (one-third weight), and a decent standard of living as measured by GDP per capita in purchasing-power parity (PPP) in USD.³⁶ In general the HDI is very simple in its calculations, creating an index for each of the three dimensions and then performing a simple average to come to the composite index. One aspect of complexity in the HDI is its use of goalposts. Rather than using the given maximum and minimum values for a particular data set, as is case in a standard index, the HDI uses values that its creators believe more accurately capture the demands of a well-lived life. The goalposts for the 2005 HDI are listed in Table 2. A final point of note on the HDI is that it uses a

Table 2: UNDP goalposts for HDI dimensions

Indicator	Maximum Value	Minimum Value
Life expectancy at birth (years)	85	25
Adult Literacy Rate (%)	100	0
Gross Enrollment Ratio (%)	100	0
GDP per capita (PPP US\$)	40,000	100

Source: UNDP 2005

logarithmic transformation on the GDP per capita measurement. The result of these adjustments is to reduce some of the extreme unevenness in the data and to provide a measure which is more smoothly distributed across the set of nations. The motivation to calculate the income measure as such is because that measure is functioning not only as a

³⁶ PPP takes into account not only the exchange rate, but the cost of goods and services in each nation. For example, PPP equalizes the cost between the falafel sandwich that costs \$4.79 in Ann Arbor, Michigan and the similar falafel sandwich that costs 1 Egyptian Pound (\$0.18) in Alexandria, Egypt.

measure of income, but as a surrogate for all of the other dimensions of human development not captured by the measures of knowledge and of a long and happy life. In short, it is a proxy for a decent standard of living. Since a decent standard of living does not require unlimited income, higher values are discounted (UNDP 1999).

As with any prominent feature in the academic and professional landscape, the HDI does not escape without a certain amount of criticism. One central point of criticism is the simple averaging that the index uses to combine the three dimensions. The interpretation of addition is that it implies perfect substitution between the dimensions. Since the goal is to measure progress in all three categories, then allowing for such a substitution permits one parameter to increase while another measure decreases, leaving the final average the same. It is proposed that the three parameters be multiplied rather than averaged, as this would require good performance in all three categories to have a high final mark (Sagar and Najam 1998). Another observed advantage of this approach is that it is more sensitive to improvements in low-performance dimensions than high-performing ones. That is to say, an increase from 0.1 to 0.2 results in a greater change in the index than does an increase from 0.8 to 0.9. It is not entirely clear, though, the advantage that such a method would impart upon the system. It would lead to a drastically more asymptotic distribution of final values than would the approach used by the UNDP. This would not necessarily reflect the situation in the world more accurately, and would likely lead to a conclusion of greater inequality than actually exists.

Another criticism of the HDI is that its results don't always match "what we see around us" (Sagar and Najam 1998). Here, a comparison is made between Switzerland and Mexico who, in 1997, had values of 0.99 and 0.96, respectively. The "absurdity" of

this is founded on the difference in per capita GNP values, \$37,390 and \$4,180, respectively. There are three points which are relevant in response to this criticism. The first is that the UNDP changed its method of calculating the index of standard of living in 1999, showing that the HDI is an ever changing measure, responding to criticism and, hopefully, ever improving. The second is that using GDP per capita is not intended to be a measure of income, but a catch-all for capabilities which are related to a person's income. The resources which a person commands are not to be intrinsically valued, but are used instead as a proxy measure of other capabilities which are not as easily quantified. Sen himself admits to the conceptual difficulty of including an income index in the HDI which had been designed from the beginning to get away from just such a measure (Qizilbash 2002). The third and final response to such a criticism is that it is based on preconceptions of what the state of development is in a particular country, in this case Switzerland and Mexico. Regionalism, nationalism, and racism can cloud our perceptions without our knowledge and it is important to evaluate our expectations against the results. If the results were derived in an appropriate and well reasoned manner, then it stands to say that it is our expectations which ought to be adjusted, not the measure itself. Creating a measure that matches "what we see around us" is, more accurately, creating a measure which matches what we *expect* to see and that expectation may not be founded on defensible grounds.

Though there is some concern about the strength of the HDI, it stands as certainly the best *available* measure and as a very good measure regardless. It captures the multi-dimensionality of human development and gives a clear indication of a nation's capability. As with the index of responsibility, the values for 173 nations can be found in

Table 7 at the end of the document, Table 3 is a summary containing the top and bottom five.

Table 3: Ten nations with the highest and lowest values of the human development index

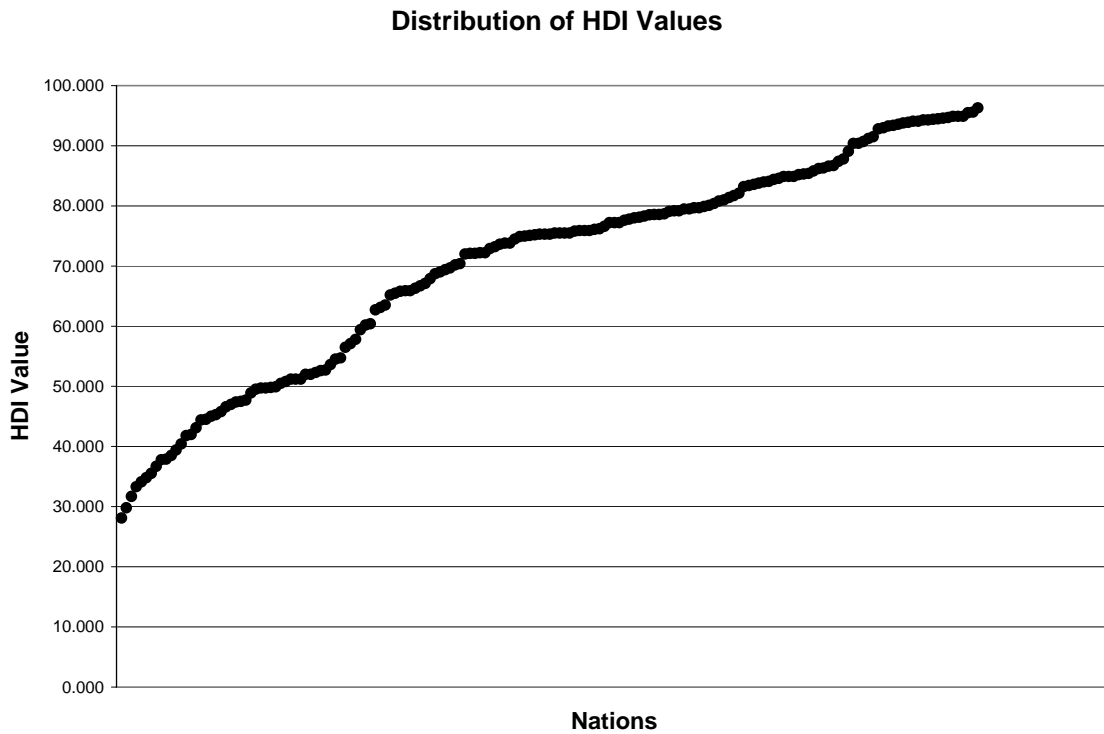
Highest Nations	HDI	Lowest Nations	HDI
<i>Norway</i>	0.963	<i>Chad</i>	0.341
<i>Iceland</i>	0.956	<i>Mali</i>	0.333
<i>Australia</i>	0.955	<i>Burkina Faso</i>	0.317
<i>Luxembourg</i>	0.949	<i>Sierra Leone</i>	0.298
<i>Canada</i>	0.949	<i>Niger</i>	0.281

Source: UNDP 2005

The HDI does not scale from 0 to 1 for two reasons. The first reason is the use of goalposts discussed above. The second is true for all composite indices; unless there is a nation with 0 (or 1) in all of its dimensions then no nation will have 0 (or 1) in the final index as a simple result of averaging.

Just as the distribution was shown for the index of responsibility per capita, Figure 4 shows the distribution of HDI values. This figure makes clear how the use of

Figure 4



goalposts and a logarithmic transformation of the GDP per capita measure make for a generally more linear distribution of values.

3.6 Creation of the Obligation Index

With indices of responsibility and capability defined and selected, it is now possible to combine them into an aggregate index of obligation. The first question in this process is how to combine the two indices into one. There are several increasingly complex mathematical methods that could be used for this step, but the simplest approach produces the best results. Employing a simple average of the two is intuitively simple and avoids the effects of multiplication. If the two sub-indices were multiplied by another it would doubly obligate those nations who are both highly capable and highly responsible. Furthermore, a low value in one of the two indices would significantly reduce the overall

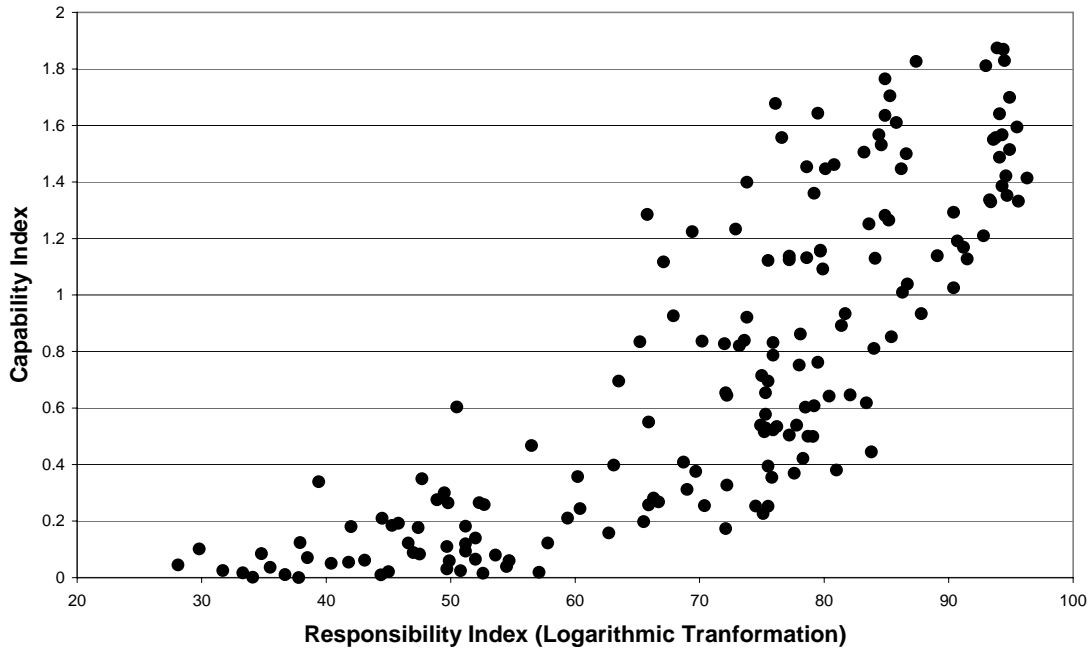
index of obligation. This would not be appropriate as the measure of obligation is intended to represent the data as accurately as possible. Without further justification, nothing other than a simple average is warranted.

A second consideration is whether to weight the sub-indices. First, as stated above, without reason to do otherwise, a simple average should be employed. Second, as might be intuitively apparent, there is a high correlation between the two measures. Traxler (2002) hints at this connection when he includes, somewhat confusingly, the ability to pay approach in his account of backward-looking approaches. Traxler observes that a nation's ability to pay is largely the result of its past emissions. Stated more clearly, a nation's current state of capability is frequently the result of its previous industrialization which, in turn, entails emission of greenhouse gases. This intuition is verified simply by plotting the indices of capability and responsibility on the same graph, as is done in Figure 5. It is necessary to perform a logarithmic conversion on the measure of responsibility because, as shown in Figure 3, the distribution of values is decidedly non-linear and showing multiplicative effects.³⁷ In order to perform a meaningful linear analysis this transformation is necessary and justified given the steps that have been taken to make the distribution of values in the capability index (the HDI) more linear. The correlation coefficient derived from the

³⁷ It is wholly conceivable that beginning on a path of emissions enables further emissions, leading to an upward cascade of emissions and, thus, responsibility.

Figure 5

Scatterplot of Capability vs. Responsibility



linear analysis of the two data sets is a rather high 0.82. Thus, weighting one index more heavily than the other would have little practical effect on the outcome.

Creating the index produces the results evident in Table 7 at the end of this paper and the summary of the five highest and lowest nations in Table 4 below.

Table 4: Ten nations with highest and lowest values of the obligation index

Highest Nations	Obligation Index	Lowest Nations	Obligation Index
<i>Luxembourg</i>	97.450	<i>Chad</i>	17.052
<i>United Kingdom</i>	83.861	<i>Mali</i>	16.669
<i>United States</i>	83.693	<i>Burkina Faso</i>	15.880
<i>Belgium</i>	80.520	<i>Sierra Leone</i>	15.031
<i>Germany</i>	78.345	<i>Niger</i>	14.104

Source: WRI 2003, UNDP 2005

Recall that the above values are the per capita values and must be multiplied by population to get a measure of absolute obligation.

4. Into Practice

Having an index of obligation, in itself, does little to actually address GCC; it must be applied, in some way, to the problem itself. In order to determine how to do that, it is helpful to review what the obligation index is and is not. It is a relative scaling of obligation to bear the burdens of climate change. The nations with higher values of obligation ought to bear a proportionally larger share of the burdens than those nations with a smaller value. It is a scale from 1 to 0, its values could be manipulated in any number of ways to yield different results.³⁸ There is no intrinsic limitation as to how it should or should not be applied. How it is used is a separate matter from its method of and reason for creation.

Given the goal of GCC mitigation with the distribution of burdens based, in some way, on the obligation index, to what should the index be applied? A more fundamental question is what is the most promising approach to resolving climate change? Given that any approach will entail global burdens, it is both ethically and economically advisable³⁹ to pursue the lowest cost option. In the case of GCC mitigation, that option has been shown to be a global cap-and-trade system.

4.1 Cap-and-Trade Systems

The concept of a cap-and-trade system is quite simple. Given a certain quantity of gases which can be emitted while avoiding some consequence (the capping), that available quantity is divided and distributed as emissions permits among the parties

³⁸ Naturally, such manipulation would require justification to be warranted.

³⁹ As well as called for in UNFCCC Article 3.3, “policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost.”

involved in the system. Certain parties will receive more than they need and other parties will receive less. The parties can then trade their allotments amongst themselves (the trading). The advantage of such a system is quite clear as well. The key observation is that the marginal mitigation costs are not equal the world over. In one study, the costs of making the commitments demanded by the Kyoto would be \$311.80 per ton of CO₂ for Japan and \$0 for the former Soviet Union (Zhang 2004).⁴⁰ Trading allows for “where flexibility,” the flexibility to make the lowest cost reductions first, regardless of where they are located (Edmonds et al. 1997). Given that there is no difference to the atmosphere where an emission occurs, it makes sense to make the reductions wherever it is possible to do so at the least cost. Various studies have attempted to calculate exactly how much cheaper it is to mitigate using a cap-and-trade system. Edmonds et al. (1997) calculated that for the United States to mitigate so as to reach 10% less than its 1990 emissions would cost \$173 per ton of carbon without trading and \$38 per ton with trading. Zhang (2001) calculates similar costs for the United States to be \$160 per ton of CO₂ and \$9.60 per ton of CO₂. Clearly, there is an advantage for using this scheme.

The main determinant in the actual price of mitigation under a trading scheme is how broad it is, especially if it includes developing countries (Edmonds 1997, Zhang 2000, Zhang 2001). By broadening the scope of the trading scheme, more low cost reduction opportunities are introduced and the same goal of reducing emissions to a specific level is achieved for far less cost. In nations with particularly high marginal abatement costs, the bulk of the permits used may come from trades with countries with

⁴⁰ The possibility for \$0 mitigation costs is created by the existence of what is called “hot air,” emissions allotments which exceed what the party is predicted to emit. Thus, the nation with the hot air could simply trade it away and still making its commitment and remaining on a “business as usual” path. It is possible that this form of “mitigation” could be profitable for certain parties.

lower costs. In his study, Zhang (2004) calculated that Japan would import fully 81.2% of its emissions permits from other countries while the United States would import 53.6%.

The advantages of using a trading system are clear. There are a number of practical concerns surrounding the implementation of such a plan, particularly surrounding enforcement and how to gradually include more parties. But that is not my primary concern. A cap-and-trade system provides, on paper at least, the lowest cost option for climate mitigation. Thus, it is the mechanism to which I choose to apply the obligation index.

4.1.1 Initial Allocation of Permits

An open question among the proposed cap-and-trade systems is how to distribute the initial allocation of permits. In many cases the Kyoto commitments are used, or, some grandfathered figure, for example, 1990 emissions (Edmonds et al. 1997, Zhang 2000, Zhang 2004). The initial allocation of permits, however, is central to how the burdens are shared amongst the parties. It is important to remark here on the possibility for some confusion between resources and burdens. In a sense, the remaining carbon-carrying capacity of the atmosphere is a resource which can be divided and distributed. As many of the authors have noted, this has the potential for significant wealth transfers dependent upon how the permits are initially distributed (Edmonds et al. 1997, Stavins forthcoming). The inverse of this, however, is the burden which is entailed in having to reduce emissions to meet those commitments. Whereas a nation would have previously been free to emit as it so pleased, it must now reduce its emissions to comply with the new demands. In the case of a cap-and-trade system, how much the nation would be able to emit would simply be a function of how many permits it could acquire given its

demand, the supply of the market, and the price at which those two factors meet. The burden which a nation bears under a cap-and-trade system is the number of permits which it does not receive and must acquire elsewhere. Thus, a nation with an obligation to bear a larger share of the global burdens than another nation will be granted fewer permits than it needs during the initial allocation phase. The opportunity to use the obligation index from above is clear.

Recalling back to the discussion of how to determine obligation, it was decided that an equal per capita distribution of burdens is appropriate unless there are other relevant considerations that require the equal per capita distribution be modified. The measures of responsibility and capability, as combined into the obligation provide just such a reason to depart from the basic per capita distribution. Applying this reasoning to the initial allocation of emissions permits is quite simple and requires only a few steps of arithmetic.

The first step is to invert the obligation index so that the large values become small and the small values become large. Given that it is scaled from 0 to 1, it is simply a matter of subtracting each value from 1. This first step is necessary because we want the nations with what began as the large values to receive fewer permits than they would have under a simple per capita permit distribution. The results of this step are in the column titled “Ob Coeff” (an abbreviation of “Obligation Coefficient”) in Table 7 at the end of this paper. This inverted measure of obligation is still a measure per capita and must now be translated to an aggregate measure. This second step is a matter of multiplying the obligation coefficient by the nation’s population. This yields the “carbon

coefficient” (abbreviated “C Coeff” in the table).⁴¹ The ratio of each nation’s carbon coefficient to the sum of all nations’ carbon coefficients is equal to the each nation’s ratio of emissions permits to the total number of permits available. Thus, each nation’s allocation of emissions permits is determined by taking its ratio of its carbon coefficient to the sum of all carbon coefficients and multiplying it by the total number of permits to be allocated. In the case of the table at the end of this paper, a total of 40 billion carbon permits have been allocated.⁴² Each nation’s allocation is in the column titled “C Permits” (“Carbon Permits”). The column “% C Perm” is each nation’s percentage of the world total, the column “% Pop” is each nation’s percentage of the world population and the column “Ratio” is the ratio of each nation’s percent of the total carbon permits to its percentage of the world population. This ratio is mathematically equivalent to the number of permits allocated per capita in a scheme where the total number of permits allocated is equal to the total world population. Thus, nations with a higher ratio are receiving that many more credits per capita than a nation with a lower ratio.

Table 5 and Table 6 summarize the nations with the five highest and five lowest

Table 5: Nations with the five highest allocations of carbon permits of 40 billion total

Nation	Carbon Permits	% of World Permits	% of World Population	Ratio
<i>China</i>	8,702,115,963	21.755	21.755	1.022
<i>India</i>	8,190,110,962	20.475	17.426	1.175
<i>Indonesia</i>	1,539,676,378	3.849	3.520	1.094
<i>Pakistan</i>	1,196,778,647	2.992	2.408	1.243
<i>Brazil</i>	1,158,340,645	2.896	2.900	0.999

Source: WRI 2003, UNDP 2005

⁴¹ The terms which I have coined for these columns are of no consequence as their values are simply steps on the way to the final distribution of burdens.

⁴² The choice of 40 billion permits is motivated by the Eickhout et al. study (2003, p. 30) analysis of different scenarios required to achieve a 2°C increase in temperature. The scenario which allowed for the highest annual emissions (650-WIRE scenario) allowed for 9.3 billion tons of CO₂ to be emitted in 2050. I rounded this value up to 10 billion per year and multiplied by 4 to simulate a 4-year commitment period, in the mold of the Kyoto process.

Table 6: Nations with the five lowest allocations of carbon permits of 40 billion total

Nation	Carbon Permits	% of World Permits	% of World Population	Ratio
<i>Seychelles</i>	532,043.745	0.001%	0.001%	0.971
<i>Dominica</i>	481,138.548	0.001%	0.001%	1.018
<i>Antigua and Barbuda</i>	460,971.682	0.001%	0.001%	0.907
<i>Saint Kitts and Nevis</i>	298,770.650	0.001%	0.001%	0.962
<i>Luxembourg</i>	127,526.715	0.000%	0.007%	0.043

Source: WRI 2003, UNDP 2005

allocations of carbon permits in absolute terms, of a total 40 billion distributed.

As can be expected, the nations with the highest obligation indices have the lowest ratios and vice versa. Thus, to see the nations with the highest and lowest ratios, simply reference Table 4.

5. Discussion

This proposal is very broad and takes a very wide perspective on what is relevant information in considering the distribution of burdens entailed in GCC mitigation. It involves arguments from many arenas and data from many sources. By taking so many routes to reach its conclusion, it exposes itself to many avenues of criticism. Every choice; what argument to favor, which data to use, which calculation to perform, opens the entire proposal to review and debate. There are a few central themes on which most of the discussion is focused. The most obvious is the perceived impracticality of such an arrangement. The ethical justification for the approach as well as the process of putting those principles into practice is also an aspect open to discussion. Finally, the data on which the calculations are based is seemingly always open to debate. I will attempt to address some of the concerns in this section, starting in reverse order from what is listed above.

5.1 Data

The data on which the scientific claims for GCC are based receives more abuse and criticism than most any other set of data. The political motivation to not act on GCC is huge and, rather than arguing with the morality of the situation, politicians prefer to go after the data itself. Though the majority of the criticism is unfounded and is generated merely out of political expedience, there is some legitimate concern about the level of certainty present in the data. Typically, though, it is not the type of uncertainty that the politician would prefer not to use. As more and more data is collected and the models are refined, the general trend is that the consequences of continued emissions are going to be worse than originally predicted. Furthermore, there is a special concern regarding threshold events and the difficulty in predicting nonlinearities in the systems (Schneider and Azar 2001). While these arguments may make the case for mitigation even stronger, it might show that distributing burdens, or other activities which involve significant economic costs for nations, based on such information is inappropriate. There is a difference between acting out of precaution given a level of uncertainty and making dramatic policy choices with a similar level of uncertainty. The data which I have used, however, is data which has been discussed and evaluated for a considerable amount of time. At this point, even the data for implementing the Brazilian Proposal has been thoroughly vetted and deemed to have a level of uncertainty low enough to justify implementation (Den Elzen 2002, 2005).

Regarding the data used specifically in this report, most emissions and population data came from the Climate Analysis Indicators Tool (CAIT), created and made freely available by the World Resources Institute (WRI). CAIT combines data from a number of

sources in order to present the analyst the fullest picture possible of GCC. The primary databases on which CAIT draws for the bulk of its emissions data are Carbon Dioxide Information Analysis Center (CDIAC), the International Energy Agency (IEA), and the Energy Information Administration (EIA). Each of these databases has its advantages and disadvantages; some score high in terms of geographic coverage while others score well in terms of geographic coverage. No one database has complete coverage on all fronts. By combining these databases into one easily navigated tool, CAIT aims to have good coverage along all parameters, using the best data available for the question at hand. Thus, one set of data taken from CAIT may have data points from a number of different sources.

CAIT is not only a store of data, but, as its name indicates, capable of its own data analysis. For example, the data on contributions to temperature increase used in this proposal were derived in CAIT, using its own model. The model that CAIT uses is self-described as having “a simple relationship between radiative forcing and temperature increase” and is calculated, “in the simplest linear form” (WRI 2005). Clearly more sophisticated models would be more accurate in translating historical emissions into temperature increase though I am not expert enough to weigh the severity of the deficiencies inherent in CAIT’s model.

A more general criticism of CAIT is that it presents the data with an “aura of precision” which may mask “considerable uncertainty in the data below” (Baumert et al. 2004). Thus, the ease with which the data used in this proposal were generated may be at the cost of certainty in the data itself. This is a tradeoff which I have accepted given the resources at my disposal, though clearly with more time and energy available, more

certainty could be gained in the data, strengthening the argument for its use in the manner which I have proposed herein.

5.2 Method

A theme throughout this proposal has been preference for the most simple, intuitive approach unless there is sufficient justification to depart from that approach. This leads to the possibility that I have erred on the side of simplicity to the detriment of my primary purpose. The most likely place where I see this as having happened is in the application of the obligation index to the distribution of carbon permits. There are a number of alternative methods which I can imagine that may prove to be more appropriate than my simple arithmetical distribution. For example, the obligation index could be scaled up or down to increase the total spread between the most and least obligated. Using the ratio of a nation's percentage of world population and percentage of carbon permits as an example, at present the total range is from 0.043 (Luxembourg) to 1.457 (Niger), a 33-fold difference. Removing the value of Luxembourg, as it is a considerable outlier, the total range is from 1.457 (Niger) to 0.274 (United Kingdom), a 5-fold difference. There could be arguments for either more or less extreme distribution. Not having any good indication of relevant factors, I present the data as unadulterated as possible.

Another relevant question regarding the method used to generate the data in the final proposal regards the correlation between the measures of responsibility and obligation. If those two measures are so tightly correlated, it is useful to wonder if there is any need to have both measures. The answer to this question depends on how the

measure of obligation is intended to be used. If it is supposed to be a static measure, created with the present-day data and set for eternity, then the answer is no, there is no practical need to include both. If, however, the index of obligation is intended to be reassessed over time, then it is important to have both measures included. As time progresses and different measures are taken to address climate change, it is not certain that responsibility and capability will forever be so tightly correlated. Indeed, there is a sincere hope that they divorce from one another as nations gradually become more and more developed without emitting so many greenhouse gases. Decoupling development from emissions is a key challenge for the present and future.

Another question regarding the correlation between the two measures is what would the response be to a situation in which they were not tightly correlated, would there be justification for weighting one measure more heavily than the other? The challenge in responding to this question is balancing the needs of impartiality with the subjective nature of weighted averages. There is no clear indicator of whether responsibility or capability ought to be preferred, other than to consider the consequences of various approaches. Through a review of independent parties, it would be possible to assess different outcomes and to determine, according to some notion of justice, which approach is most suitable.

5.3 Practicality

Throughout the development of this proposal I have made it clear that my approach will come purely from the side of reason and data and that the results which follow will be just, despite how unpleasant or impractical they seem. I feel that I have

successfully followed that mission and that the results do have moral force, given my methods. At some point though I have to step down from the clouds and look at just what exactly I have created. The distribution which I have proposed concentrates a full 42% of the initial allocation of carbon permits in the hands of two nations, China and India. Nearly 75% of the permits are possessed by 20 nations, not one of which is a member state of the European Union. The United States, the sole super-power who can make or break international agreements, who in 2002 emitted 23.32% of the world's carbon (WRI 2003), will receive only 1.33% of the initially allocated permits. I might be so humble as to suggest that my approach may be politically impractical at present.

One way to mitigate the political impracticality of this approach is to not propose it as a method which ought to be adopted immediately, but as a final goal toward which we ought to strive. Imagine a cap-and-trade system started today. It would be possible to structure it around four-year commitment periods during which a certain number of permits are allocated.⁴³ The number of permits allocated would correspond with the temporal position on a stabilization pathway. Given the calculations done, they could increase to a period around 2030 after which they would have to decrease and stabilize. The initial allocation period could start with a simple grandfathered allocation where each nation is allocated the scalar equivalent number of permits to what it would have emitted under a business as usual approach. At each allocation period there could be a gradual step toward my proposal and away from the grandfathered approach. At some point, say after 40 years or 10 commitment periods, my proposal would be fully implemented. The

⁴³ Rather than allocating permits to all nations once every 4 years, it could be beneficial to employ a staggered allocation scheme whereby $\frac{1}{4}$ of the permits would be allocated every year so as to reduce the overall shock to the market when a vast quantity of permits are released.

nations feeling the strongest shock from my proposal would have had nearly two generations to adapt to the changes and challenges which it would entail.

The above suggestion should not be taken to mean that I am advocating for it on any ethical grounds, only in observation of the practical reality in which my proposal would have to work. I stand by its ethical force; it has been derived from reasoned principles of justice and the empirical data of the situation. The result is clearly shocking, but that is not to say that it is invalid. What is ethical and what is politically feasible are often not aligned. Continually conceding and allowing what is ethical to be reduced to what is deemed practical will only serve to further entrench the powers who presently determine what is practical. I am sympathetic to the desire to get something rather than nothing done, but catering to the least common denominator will continually reduce the bargaining position of those who attempt to make appeals founded in ethics. If it should become the norm that the person professing a solution to a political problem based on ethical standards is viewed as the radical, then I must admit that I hold little hope for our future. At some point ethics has to shout as loud as those who cry for pragmatism. Being polite to unethical approaches need not be a value which an ethical approach necessarily possesses.

6. Conclusion

I have presented an approach to climate change mitigation which has approached the subject from a purely ethical foundation. The duty to respond to GCC, in one way or another, is uncontroversial. The choice of how to respond and share the burdens or responding is the main ethical choice in the discussion. My proposal uses measures of

responsibility, defined as each nation's proportional contribution to surface temperature increase, and capability, as defined by the Human Development Index, to determine a measure of obligation, which is then used to modify an equal per capita distribution of the burdens entailed therein. The proposal is brought into practice by distributing the initial allocation of carbon permits in a global cap-and-trade system using the modified equal per capita approach. This proposal is intended to avoid the manipulation that powerful nations can wield over the less-powerful in negotiations and to not concede forceful ethical claims on the grounds of practicality.

The duty of responding to climate change, like most other ethical duties, is neither easy nor clear cut. With this understanding of an ethical response to climate change mitigation, hopefully some greater clarity can be achieved in other proposed responses that make greater or total concessions to pragmatic concerns.

We must not forget that the world's social, economic, and political institutions are our creations and that we bear ultimate control over them. We must not resolve ourselves to what simply is, we must ask what ought to be. This is the basic demand of ethics, present in nearly every human choice, including the response to global climate change.

References

- Azar, C. and Henning Rohde. 1997. Targets for Stabilization of Atmospheric CO₂. *Science*. Vol. 276, No. 5320, pp. 1818-1819.
- Baumert, Kevin and J. Pershing. 2004. Climate data: Insights and observations. Prepared for the Pew Center on Global Climate Change. Available at <http://www.pewclimate.org/orderreport.cfm>.
- Bodansky, Daniel. 2004. International climate efforts beyond 2012: A survey of approaches. Prepared for the Pew Center on Global Climate Change. Available at <http://www.pewclimate.org/orderreport.cfm>.
- Den Elzen, Michel and M. Schaeffer. 2002. Responsibility for past and future global warming: Uncertainties in attributing anthropogenic climate change. *Climatic Change*. Vol. 54, pp. 29-73.
- Den Elzen, Michel G.J., M. Schaeffer, and P.L. Lucas. 2005. Differentiating future commitments on the basis of countries relative historical responsibility for climate change: Uncertainties in the 'Brazilian Proposal' in the context of a policy implementation. *Climatic Change*. Vol. 71, pp 277-301.
- Edmonds, J.A. et al. 1997. Return to 1990: The cost of mitigating United States carbon emissions in the post-2000 period. Prepared for the US Department of Energy.
- Eickhout, B., den Elzen, M.G.J., and van Vuuren, D.P. 2003. Multi-gas emission profiles for stabilizing greenhouse gas concentrations: Emissions implications of limiting global temperature increase to 2°C. RIVM report 728001026. National Institute for Public Health and the Environment: Netherlands Environmental Assessment Agency.
- Gardiner, Stephen M. 2004. Ethics of global climate change. *Ethics*. Vol. 114, No. 3.
- Hahn, Robert W. and Robert N. Stavins. 1999. What has Kyoto wrought? The real architecture of international tradable permit markets. Washington, D.C.: The AEI Press.
- Intergovernmental Panel on Climate Change. 2001a. *Climate Change 2001: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK: Cambridge University Press.
- Intergovernmental Panel on Climate Change. 2001b. *Climate Change 2001: Mitigation*. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK: Cambridge University Press.

- Kahn, Matthew E. 2005. The death toll from natural disasters: The role of income, geography, and institutions. *The Review of Economics and Statistics*. Vol. 87, No. 2.
- Kyoto Protocol. 1997. United Nations Framework Convention on Climate Change. New York: United Nations. Available at <http://unfccc.int/resource/docs/convkp/kpeng.html>.
- Nagel, Thomas. 2005. The problem of global justice. *Philosophy and Public Affairs*. Vol. 33, No. 2.
- Najam, Adil and Thomas P. Page. 1998. The climate convention: Deciphering the Kyoto commitments. *Environmental Conservation*. Vol. 25, No. 3, pp. 187-194.
- Najam, Adil. 1998. Avoiding a COP-out: Moving towards systematic decision making under the convention. *Climatic Change*. Vol. 39, pp. iii-ix.
- Noorbakhsh, Farhad. 1998. The Human Development Index: Some technical issues and alternative indices. *Journal of International Development*. Vol. 10, pp. 589-605.
- Nussbaum, Martha C. 1990. Aristotelian social democracy. *Liberalism and the Good*. Ed. Douglass, Bruce R., G.R. Mara, and H.S. Richardson. New York: Routledge.
- Nussbaum, Martha C. 2002. Capabilities and human rights. *Global Justice and Transnational Politics*. Ed. De Greiff, Pablo and Ciaran Cronin. Cambridge, Massachusetts: MIT Press.
- Olmstead, S.M. and Robert Stavins. 2006. An international policy architecture for the post-Kyoto era. *American Economic Review Papers and Proceedings*, forthcoming.
- Ott, Herrmann E. et al. 2004. South-north dialogue on equity in the greenhouse: A proposal for an adequate and equitable global climate change agreement. Published by Deutsche Gesellschaft für Technische Zusammenarbeit, in cooperation with Wuppertal Institute for Climate, Environment and Energy. Available at wupperinst.org/download/1085_proposal.pdf.
- Pogge, Thomas W. 1994. An egalitarian law of peoples. *Philosophy and Public Affairs*. Vol. 23, No. 3, pp. 195-224.
- Qizilbash, Mozaffar. 2002. On the measurement of human development. Lecture prepared for UNDP training course, Oxford, 11 September 2002.
- Rawls, John. 1971. *A Theory of Justice*. Cambridge, Massachusetts: Harvard University Press.
- Rawls, John. 2001. *Law of Peoples*. Cambridge, Massachusetts: Harvard University Press.

Rosa, Luiz Pinguelli et al. 2004. Comments on the Brazilian Proposal and contributions to global temperature increase with different climate responses—CO₂ emissions due to fossil fuels, CO₂ emissions due to land use change. *Energy Policy*. Vol. 32, pp. 1499-1510.

Sagar, Ambuj D. and Adil Najam. 1998. The Human Development Index: A critical review. *Ecological Economics*. Vol. 25, pp. 249-264.

Schneider, S. H. and Christian Azar. 2001. Are Uncertainties in Climate and Energy Systems a Justification for Stronger Near-Term Mitigation Policies? Prepared for the Pew Center on Global Climate Change. Available at <http://www.pewclimate.org/orderreport.cfm>.

Schneider, S.H. and Michael D. Mastrandrea. 2005. Probabilistic assessment of “dangerous” climate change and emissions pathways. *Proceedings of the National Academy of Sciences*. Vol. 102, No. 44, pp. 15728-15735.

Sen, Amartya. 1992. *Inequality Reexamined*. Cambridge, Massachusetts: Harvard University Press.

Sen, Amartya. 1999. *Development as Freedom*. New York: Anchor Books.

Sen, Amartya. 2002. Justice across borders. *Global Justice and Transnational Politics*. Ed. De Greiff, Pablo and Ciaran Cronin. Cambridge, Massachusetts: MIT Press.

Shue, Henry. 1993. Subsistence emissions and luxury emissions. *Law and Policy*. Vol. 15, pp. 39-59.

Singer, Peter. 2002. *One World*. New Haven, Connecticut: Yale University Press.

Traxler, Martino. 2002. Fair chore division for climate change. *Social Theory and Practice*. Vol. 28, No. 1.

United Nations Development Programme. 2005. Human Development Index. *Human Development Report 2005*. Available at http://hdr.undp.org/docs/statistics/indices/index_tables.pdf.

United Nations Framework Convention on Climate Change. 1992. New York: United Nations. Available at <http://unfccc.int/resource/docs/convkp/conveng.pdf>.

United Nations Framework Convention on Climate Change. 2002. Methodological issues: Scientific and methodological assessment of contributions to climate change. Report on the expert meeting. FCCC/SBSTA/2002/INF.14.

Wigley, T.M.L; R. Richards, and J.A. Edmonds. 1996. Economic and environmental choices in the stabilization of atmospheric CO₂ concentrations. *Nature*. Vol. 379, pp. 240-243.

World Resources Institute. 2003. Climate Analysis Indicators Tool (CAIT). Available at <http://cait.wri.org>.

World Resources Institute. 2005a. CAIT: Indicator framework paper. Available at cait.wri.org/downloads/framework_paper.pdf.

World Resources Institute. 2005b. CAIT: Greenhouse gas sources and methods. Available at cait.wri.org/downloads/cait_ghgs.pdf.

Zhang, ZhongXiang. 2000. The design and implementation of an international trading scheme for greenhouse gas emissions. *Environment and Planning C: Government and Policy*. Vol. 18, pp. 321-337.

Zhang, ZhongXiang. 2004. Meeting the Kyoto targets: The importance of developing country participation. *Journal of Policy Modeling*. Vol.. 26, pp. 3-19.

Table 7: Full data set used to distribute burdens of climate change mitigation

Country	Obligation	HDI	Temp Index	Ob Coeff	Population	C Coeff	C Permits	% C Perm	% Pop	Ratio
<i>Albania</i>	0.413	0.78	0.047	0.587	3,150,265	1,848,362	20,842,719	0.052%	0.052%	0.995
<i>Algeria</i>	0.378	0.722	0.034	0.622	31,320,430	19,478,597	219,646,883	0.549%	0.520%	1.055
<i>Angola</i>	0.226	0.445	0.006	0.774	13,121,250	10,161,059	114,579,345	0.286%	0.218%	1.314
<i>Antigua and Barbuda</i>	0.466	0.797	0.134	0.534	76,485	40,880	460,972	0.001%	0.001%	0.907
<i>Argentina</i>	0.478	0.863	0.092	0.522	37,515,630	19,598,159	220,995,103	0.552%	0.623%	0.886
<i>Armenia</i>	0.408	0.759	0.058	0.592	3,067,953	1,814,817	20,464,453	0.051%	0.051%	1.004
<i>Australia</i>	0.669	0.955	0.383	0.331	19,662,800	6,508,219	73,388,754	0.183%	0.327%	0.562
<i>Austria</i>	0.641	0.936	0.345	0.359	8,066,000	2,899,422	32,694,805	0.082%	0.134%	0.610
<i>Azerbaijan</i>	0.445	0.729	0.161	0.555	8,172,000	4,534,879	51,136,746	0.128%	0.136%	0.941
<i>Bahamas</i>	0.571	0.832	0.310	0.429	313,989	134,641	1,518,260	0.004%	0.005%	0.727
<i>Bahrain</i>	0.588	0.846	0.330	0.412	697,846	287,600	3,243,067	0.008%	0.012%	0.699
<i>Bangladesh</i>	0.261	0.52	0.002	0.739	135,683,700	100,296,563	1,130,976,078	2.827%	2.255%	1.254
<i>Barbados</i>	0.477	0.878	0.076	0.523	269,384	140,896	1,588,792	0.004%	0.004%	0.887
<i>Belarus</i>	0.530	0.786	0.274	0.470	9,925,000	4,663,020	52,581,702	0.131%	0.165%	0.797
<i>Belgium</i>	0.805	0.945	0.665	0.195	10,333,000	2,012,868	22,697,737	0.057%	0.172%	0.330
<i>Belize</i>	0.388	0.753	0.024	0.612	265,200	162,189	1,828,894	0.005%	0.004%	1.038
<i>Benin</i>	0.216	0.431	0.002	0.784	6,552,181	5,135,209	57,906,258	0.145%	0.109%	1.330
<i>Bhutan</i>	0.269	0.536	0.002	0.731	851,009	622,083	7,014,808	0.018%	0.014%	1.240
<i>Bolivia</i>	0.351	0.687	0.016	0.649	8,645,222	5,608,049	63,238,154	0.158%	0.144%	1.100
<i>Bosnia and Herzegovina</i>	0.456	0.786	0.126	0.544	3,828,000	2,083,309	23,492,058	0.059%	0.064%	0.923
<i>Botswana</i>	0.292	0.565	0.019	0.708	1,711,770	1,211,665	13,663,127	0.034%	0.028%	1.201
<i>Brazil</i>	0.411	0.792	0.031	0.589	174,485,400	102,723,292	1,158,340,646	2.896%	2.900%	0.999
<i>Brunei Darussalam</i>	0.586	0.866	0.306	0.414	350,627	145,146	1,636,711	0.004%	0.006%	0.702
<i>Bulgaria</i>	0.544	0.808	0.279	0.456	7,869,000	3,590,321	40,485,610	0.101%	0.131%	0.774
<i>Burkina Faso</i>	0.159	0.317	0.001	0.841	11,831,090	9,952,363	112,226,023	0.281%	0.197%	1.427

<i>Burundi</i>	0.189	0.378	0.000	0.811	7,070,999	5,734,580	64,664,958	0.162%	0.118%	1.376
<i>Cambodia</i>	0.286	0.571	0.000	0.714	13,172,240	9,408,627	106,094,685	0.265%	0.219%	1.212
<i>Cameroon</i>	0.250	0.497	0.003	0.750	15,769,270	11,827,890	133,375,066	0.333%	0.262%	1.272
<i>Canada</i>	0.720	0.949	0.490	0.280	31,362,000	8,791,310	99,133,623	0.248%	0.521%	0.476
<i>Cape Verde</i>	0.363	0.721	0.005	0.637	458,030	291,784	3,290,248	0.008%	0.008%	1.081
<i>Central African Republic</i>	0.178	0.355	0.001	0.822	3,820,085	3,140,341	35,411,487	0.089%	0.063%	1.395
<i>Chad</i>	0.171	0.341	0.000	0.829	8,340,787	6,918,548	78,015,762	0.195%	0.139%	1.407
<i>Chile</i>	0.458	0.854	0.061	0.542	15,589,000	8,456,184	95,354,627	0.238%	0.259%	0.920
<i>China</i>	0.397	0.755	0.040	0.603	1,280,400,000	771,715,991	8,702,115,964	21.755%	21.277%	1.022
<i>Colombia</i>	0.408	0.785	0.030	0.592	43,834,000	25,969,992	292,845,927	0.732%	0.728%	1.005
<i>Comoros</i>	0.274	0.547	0.001	0.726	585,937	425,249	4,795,248	0.012%	0.010%	1.231
<i>Congo</i>	0.259	0.512	0.005	0.741	3,656,658	2,711,026	30,570,398	0.076%	0.061%	1.258
<i>Congo, Dem. Rep. of the</i>	0.193	0.385	0.002	0.807	51,579,780	41,605,187	469,153,379	1.173%	0.857%	1.368
<i>Costa Rica</i>	0.428	0.838	0.018	0.572	3,941,750	2,254,952	25,427,557	0.064%	0.066%	0.970
<i>Côte d'Ivoire</i>	0.213	0.42	0.005	0.787	16,513,120	13,002,846	146,624,238	0.367%	0.274%	1.336
<i>Croatia</i>	0.483	0.841	0.125	0.517	4,440,000	2,295,787	25,888,023	0.065%	0.074%	0.877
<i>Cuba</i>	0.446	0.817	0.076	0.554	11,251,000	6,228,483	70,234,368	0.176%	0.187%	0.939
<i>Cyprus</i>	0.509	0.891	0.128	0.491	764,967	375,363	4,232,710	0.011%	0.013%	0.832
<i>Czech Republic</i>	0.767	0.874	0.661	0.233	10,201,000	2,372,528	26,753,385	0.067%	0.170%	0.395
<i>Denmark</i>	0.684	0.941	0.427	0.316	5,374,300	1,697,262	19,138,864	0.048%	0.089%	0.536
<i>Djibouti</i>	0.252	0.495	0.010	0.748	693,480	518,389	5,845,525	0.015%	0.012%	1.268
<i>Dominica</i>	0.400	0.783	0.016	0.600	71,079	42,668	481,139	0.001%	0.001%	1.018
<i>Dominican Republic</i>	0.387	0.749	0.025	0.613	8,612,860	5,281,244	59,552,997	0.149%	0.143%	1.040
<i>Ecuador</i>	0.391	0.759	0.023	0.609	12,807,460	7,797,663	87,928,937	0.220%	0.213%	1.033
<i>Egypt</i>	0.342	0.659	0.026	0.658	66,371,670	43,655,589	492,274,359	1.231%	1.103%	1.116
<i>El Salvador</i>	0.367	0.722	0.011	0.633	6,417,185	4,064,531	45,832,955	0.115%	0.107%	1.075
<i>Equatorial Guinea</i>	0.330	0.655	0.006	0.670	481,880	322,673	3,638,564	0.009%	0.008%	1.136
<i>Eritrea</i>	0.222	0.444	0.000	0.778	4,296,700	3,342,335	37,689,235	0.094%	0.071%	1.320
<i>Estonia</i>	0.675	0.853	0.496	0.325	1,358,000	441,775	4,981,601	0.012%	0.023%	0.552
<i>Ethiopia</i>	0.184	0.367	0.000	0.816	67,217,840	54,875,205	618,790,335	1.547%	1.117%	1.385
<i>Fiji</i>	0.387	0.752	0.023	0.613	823,300	504,344	5,687,139	0.014%	0.014%	1.039

<i>Finland</i>	0.619	0.941	0.297	0.381	5,199,000	1,980,670	22,334,664	0.056%	0.086%	0.646
<i>France</i>	0.644	0.938	0.351	0.356	59,485,000	21,150,042	238,494,622	0.596%	0.988%	0.603
<i>Gabon</i>	0.337	0.635	0.040	0.663	1,315,418	871,714	9,829,727	0.025%	0.022%	1.124
<i>Gambia</i>	0.236	0.47	0.002	0.764	1,388,568	1,060,676	11,960,523	0.030%	0.023%	1.296
<i>Georgia</i>	0.394	0.732	0.056	0.606	4,616,000	2,796,902	31,538,757	0.079%	0.077%	1.028
<i>Germany</i>	0.783	0.93	0.637	0.217	82,508,000	17,867,397	201,478,479	0.504%	1.371%	0.367
<i>Ghana</i>	0.262	0.52	0.004	0.738	20,298,490	14,982,286	168,945,042	0.422%	0.337%	1.252
<i>Greece</i>	0.525	0.912	0.138	0.475	11,005,000	5,229,247	58,966,660	0.147%	0.183%	0.806
<i>Grenada</i>	0.404	0.787	0.022	0.596	103,500	61,654	695,230	0.002%	0.002%	1.011
<i>Guatemala</i>	0.336	0.663	0.009	0.664	11,991,950	7,961,986	89,781,901	0.224%	0.199%	1.126
<i>Guinea</i>	0.235	0.466	0.003	0.765	7,744,346	5,927,316	66,838,313	0.167%	0.129%	1.298
<i>Guinea-Bissau</i>	0.175	0.348	0.002	0.825	1,446,881	1,193,567	13,459,044	0.034%	0.024%	1.399
<i>Guyana</i>	0.389	0.72	0.057	0.611	765,592	468,065	5,278,050	0.013%	0.013%	1.037
<i>Haiti</i>	0.239	0.475	0.002	0.761	8,286,491	6,309,681	71,149,983	0.178%	0.138%	1.292
<i>Honduras</i>	0.338	0.667	0.009	0.662	6,796,528	4,500,902	50,753,609	0.127%	0.113%	1.123
<i>Hungary</i>	0.566	0.862	0.270	0.434	10,159,000	4,410,782	49,737,390	0.124%	0.169%	0.737
<i>Iceland</i>	0.580	0.956	0.205	0.420	288,000	120,844	1,362,678	0.003%	0.005%	0.712
<i>India</i>	0.307	0.602	0.013	0.693	1,048,641,000	726,310,661	8,190,110,962	20.475%	17.426%	1.175
<i>Indonesia</i>	0.355	0.697	0.014	0.645	211,816,800	136,540,686	1,539,676,378	3.849%	3.520%	1.094
<i>Iran, Islamic Rep. of</i>	0.398	0.736	0.059	0.602	65,540,000	39,483,123	445,224,303	1.113%	1.089%	1.022
<i>Ireland</i>	0.600	0.946	0.254	0.400	3,930,000	1,572,344	17,730,251	0.044%	0.065%	0.679
<i>Israel</i>	0.520	0.915	0.124	0.480	6,566,000	3,154,548	35,571,695	0.089%	0.109%	0.815
<i>Italy</i>	0.569	0.934	0.204	0.431	57,690,130	24,867,717	280,416,319	0.701%	0.959%	0.731
<i>Jamaica</i>	0.406	0.738	0.073	0.594	2,621,043	1,557,600	17,563,994	0.044%	0.044%	1.008
<i>Japan</i>	0.588	0.943	0.233	0.412	127,399,000	52,482,508	591,809,524	1.480%	2.117%	0.699
<i>Jordan</i>	0.394	0.753	0.035	0.606	5,171,341	3,133,634	35,335,855	0.088%	0.086%	1.028
<i>Kazakhstan</i>	0.613	0.761	0.466	0.387	14,875,000	5,751,087	64,851,089	0.162%	0.247%	0.656
<i>Kenya</i>	0.240	0.474	0.005	0.760	31,344,580	23,837,148	268,795,297	0.672%	0.521%	1.290
<i>Kuwait</i>	0.601	0.844	0.359	0.399	2,334,919	930,608	10,493,832	0.026%	0.039%	0.676
<i>Kyrgyzstan</i>	0.380	0.702	0.059	0.620	5,003,900	3,100,833	34,965,983	0.087%	0.083%	1.051
<i>Lao People's Dem. Rep.</i>	0.273	0.545	0.001	0.727	5,530,092	4,020,537	45,336,855	0.113%	0.092%	1.233

<i>Latvia</i>	0.502	0.836	0.169	0.498	2,338,000	1,163,712	13,122,390	0.033%	0.039%	0.844
<i>Lebanon</i>	0.405	0.759	0.051	0.595	4,441,245	2,642,105	29,793,221	0.074%	0.074%	1.009
<i>Lesotho</i>	0.249	0.497	0.001	0.751	1,776,616	1,334,480	15,048,022	0.038%	0.030%	1.274
<i>Libyan Arab Jamahiriya</i>	0.456	0.799	0.114	0.544	5,448,226	2,961,984	33,400,281	0.084%	0.091%	0.922
<i>Lithuania</i>	0.513	0.852	0.174	0.487	3,469,000	1,689,663	19,053,178	0.048%	0.058%	0.826
<i>Luxembourg</i>	0.975	0.949	1.000	0.026	443,500	11,309	127,527	0.000%	0.007%	0.043
<i>Macedonia, TFYR</i>	0.465	0.797	0.133	0.535	2,038,000	1,090,556	12,297,456	0.031%	0.034%	0.908
<i>Madagascar</i>	0.250	0.499	0.001	0.750	16,437,220	12,324,113	138,970,635	0.347%	0.273%	1.272
<i>Malawi</i>	0.203	0.404	0.001	0.797	10,743,330	8,566,579	96,599,484	0.241%	0.179%	1.353
<i>Malaysia</i>	0.421	0.795	0.048	0.579	24,304,580	14,062,559	158,573,908	0.396%	0.404%	0.982
<i>Maldives</i>	0.376	0.745	0.008	0.624	286,680	178,759	2,015,739	0.005%	0.005%	1.058
<i>Mali</i>	0.167	0.333	0.000	0.833	11,373,720	9,477,789	106,874,572	0.267%	0.189%	1.414
<i>Malta</i>	0.483	0.867	0.099	0.517	397,000	205,188	2,313,764	0.006%	0.007%	0.877
<i>Mauritania</i>	0.245	0.477	0.012	0.755	2,784,686	2,103,311	23,717,602	0.059%	0.046%	1.281
<i>Mauritius</i>	0.406	0.791	0.022	0.594	1,210,000	718,395	8,100,856	0.020%	0.020%	1.007
<i>Mexico</i>	0.441	0.814	0.068	0.559	100,818,500	56,358,702	635,518,716	1.589%	1.675%	0.948
<i>Moldova, Rep. of</i>	0.396	0.671	0.121	0.604	4,255,000	2,570,140	28,981,718	0.072%	0.071%	1.025
<i>Mongolia</i>	0.377	0.679	0.074	0.623	2,448,509	1,526,135	17,209,181	0.043%	0.041%	1.057
<i>Morocco</i>	0.323	0.631	0.015	0.677	29,640,540	20,066,515	226,276,434	0.566%	0.493%	1.148
<i>Mozambique</i>	0.191	0.379	0.003	0.809	18,438,330	14,913,781	168,172,558	0.420%	0.306%	1.372
<i>Myanmar</i>	0.291	0.578	0.003	0.709	48,786,370	34,607,580	390,246,122	0.976%	0.811%	1.203
<i>Namibia</i>	0.316	0.627	0.004	0.684	1,984,653	1,358,099	15,314,354	0.038%	0.033%	1.161
<i>Nepal</i>	0.263	0.526	0.000	0.737	24,124,750	17,775,643	200,443,829	0.501%	0.401%	1.250
<i>Netherlands</i>	0.651	0.943	0.359	0.349	16,144,000	5,635,997	63,553,298	0.159%	0.268%	0.592
<i>New Zealand</i>	0.570	0.933	0.207	0.430	3,939,100	1,693,776	19,099,562	0.048%	0.065%	0.729
<i>Nicaragua</i>	0.350	0.69	0.011	0.650	5,342,000	3,470,946	39,139,492	0.098%	0.089%	1.102
<i>Niger</i>	0.141	0.281	0.001	0.859	11,425,340	9,813,877	110,664,416	0.277%	0.190%	1.457
<i>Nigeria</i>	0.229	0.453	0.005	0.771	133,189,700	102,669,103	1,157,729,588	2.894%	2.213%	1.308
<i>Norway</i>	0.606	0.963	0.249	0.394	4,538,000	1,786,854	20,149,140	0.050%	0.075%	0.668
<i>Oman</i>	0.422	0.781	0.063	0.578	2,538,000	1,467,301	16,545,757	0.041%	0.042%	0.981
<i>Pakistan</i>	0.268	0.527	0.008	0.732	144,902,400	106,132,029	1,196,778,648	2.992%	2.408%	1.243

<i>Panama</i>	0.419	0.804	0.034	0.581	2,940,414	1,708,598	19,266,699	0.048%	0.049%	0.986
<i>Papua New Guinea</i>	0.266	0.523	0.008	0.734	5,378,120	3,949,126	44,531,607	0.111%	0.089%	1.246
<i>Paraguay</i>	0.381	0.755	0.008	0.619	5,510,000	3,408,260	38,432,630	0.096%	0.092%	1.049
<i>Peru</i>	0.393	0.762	0.024	0.607	26,749,000	16,233,706	183,056,456	0.458%	0.445%	1.030
<i>Philippines</i>	0.385	0.758	0.013	0.615	79,944,220	49,140,573	554,124,792	1.385%	1.328%	1.043
<i>Poland</i>	0.628	0.858	0.398	0.372	38,232,000	14,222,733	160,380,085	0.401%	0.635%	0.631
<i>Portugal</i>	0.500	0.904	0.096	0.500	10,368,000	5,184,064	58,457,158	0.146%	0.172%	0.848
<i>Qatar</i>	0.710	0.849	0.572	0.290	610,487	176,848	1,994,200	0.005%	0.010%	0.491
<i>Romania</i>	0.505	0.792	0.219	0.495	21,803,000	10,782,083	121,582,210	0.304%	0.362%	0.839
<i>Russian Federation</i>	0.612	0.795	0.430	0.388	144,070,800	55,837,369	629,640,007	1.574%	2.394%	0.657
<i>Rwanda</i>	0.225	0.45	0.001	0.775	8,163,000	6,324,284	71,314,641	0.178%	0.136%	1.314
<i>Saint Kitts and Nevis</i>	0.433	0.834	0.032	0.567	46,710	26,495	298,771	0.001%	0.001%	0.962
<i>Saint Lucia</i>	0.397	0.772	0.022	0.603	159,133	95,960	1,082,076	0.003%	0.003%	1.023
<i>Saint Vincent</i>	0.385	0.755	0.015	0.615	109,164	67,147	757,170	0.002%	0.002%	1.043
<i>Samoa (Western)</i>	0.395	0.776	0.013	0.605	176,200	106,653	1,202,650	0.003%	0.003%	1.027
<i>São Tomé and Príncipe</i>	0.306	0.604	0.008	0.694	154,200	107,051	1,207,138	0.003%	0.003%	1.178
<i>Saudi Arabia</i>	0.450	0.772	0.127	0.550	21,885,970	12,045,208	135,825,615	0.340%	0.364%	0.934
<i>Senegal</i>	0.232	0.458	0.006	0.768	10,007,000	7,687,502	86,686,733	0.217%	0.166%	1.303
<i>Seychelles</i>	0.428	0.821	0.034	0.572	82,436	47,182	532,044	0.001%	0.001%	0.971
<i>Sierra Leone</i>	0.150	0.298	0.003	0.850	5,235,472	4,448,511	50,162,827	0.125%	0.087%	1.441
<i>Singapore</i>	0.526	0.907	0.145	0.474	4,164,000	1,972,946	22,247,573	0.056%	0.069%	0.804
<i>Slovakia</i>	0.636	0.849	0.422	0.364	5,379,000	1,960,449	22,106,647	0.055%	0.089%	0.618
<i>Slovenia</i>	0.545	0.904	0.186	0.455	1,994,000	907,141	10,229,209	0.026%	0.033%	0.772
<i>Solomon Islands</i>	0.300	0.594	0.006	0.700	443,296	310,253	3,498,512	0.009%	0.007%	1.187
<i>South Africa</i>	0.420	0.658	0.183	0.580	45,345,290	26,281,783	296,361,783	0.741%	0.754%	0.983
<i>Spain</i>	0.540	0.928	0.152	0.460	40,917,300	18,822,993	212,254,084	0.531%	0.680%	0.780
<i>Sri Lanka</i>	0.379	0.751	0.007	0.621	19,007,000	11,804,648	133,112,981	0.333%	0.316%	1.054
<i>Sudan</i>	0.258	0.512	0.003	0.742	32,790,850	24,344,335	274,514,495	0.686%	0.545%	1.259
<i>Suriname</i>	0.439	0.755	0.122	0.561	433,456	243,303	2,743,561	0.007%	0.007%	0.952
<i>Swaziland</i>	0.253	0.498	0.008	0.747	1,088,176	812,661	9,163,825	0.023%	0.018%	1.267
<i>Sweden</i>	0.633	0.949	0.317	0.367	8,924,000	3,276,016	36,941,407	0.092%	0.148%	0.623

<i>Switzerland</i>	0.581	0.947	0.215	0.419	7,290,000	3,054,289	34,441,135	0.086%	0.121%	0.711
<i>Syrian Arab Republic</i>	0.378	0.721	0.035	0.622	16,985,660	10,564,267	119,126,043	0.298%	0.282%	1.055
<i>Tajikistan</i>	0.355	0.652	0.058	0.645	6,293,000	4,058,106	45,760,497	0.114%	0.105%	1.094
<i>Tanzania, U. Rep. of</i>	0.210	0.418	0.001	0.790	35,181,300	27,804,873	313,536,630	0.784%	0.585%	1.341
<i>Thailand</i>	0.401	0.778	0.025	0.599	61,612,840	36,887,469	415,954,875	1.040%	1.024%	1.016
<i>Togo</i>	0.257	0.512	0.002	0.743	4,759,539	3,535,376	39,866,032	0.100%	0.079%	1.260
<i>Tonga</i>	0.412	0.81	0.014	0.588	101,163	59,484	670,756	0.002%	0.002%	0.998
<i>Trinidad and Tobago</i>	0.535	0.801	0.270	0.465	1,303,976	605,798	6,831,173	0.017%	0.022%	0.788
<i>Tunisia</i>	0.390	0.753	0.028	0.610	9,781,000	5,962,381	67,233,713	0.168%	0.163%	1.034
<i>Turkey</i>	0.396	0.75	0.042	0.604	69,626,000	42,057,738	474,256,483	1.186%	1.157%	1.025
<i>Turkmenistan</i>	0.489	0.738	0.241	0.511	4,792,900	2,447,746	27,601,569	0.069%	0.080%	0.866
<i>Uganda</i>	0.254	0.508	0.001	0.746	24,600,000	18,344,504	206,858,485	0.517%	0.409%	1.265
<i>Ukraine</i>	0.558	0.766	0.351	0.442	48,717,300	21,508,946	242,541,749	0.606%	0.810%	0.749
<i>United Arab Emirates</i>	0.515	0.849	0.181	0.485	3,754,000	1,820,058	20,523,551	0.051%	0.062%	0.822
<i>United Kingdom</i>	0.839	0.939	0.738	0.161	59,229,000	9,558,706	107,787,026	0.269%	0.984%	0.274
<i>United States</i>	0.837	0.944	0.730	0.163	288,369,000	47,024,900	530,267,785	1.326%	4.792%	0.277
<i>Uruguay</i>	0.447	0.84	0.055	0.553	3,361,000	1,857,446	20,945,156	0.052%	0.056%	0.938
<i>Uzbekistan</i>	0.426	0.694	0.157	0.574	25,271,000	14,511,912	163,640,955	0.409%	0.420%	0.974
<i>Vanuatu</i>	0.334	0.659	0.008	0.666	205,573	137,005	1,544,911	0.004%	0.003%	1.131
<i>Venezuela</i>	0.448	0.772	0.123	0.552	25,220,000	13,929,100	157,068,983	0.393%	0.419%	0.937
<i>Viet Nam</i>	0.356	0.704	0.008	0.644	80,423,990	51,794,278	584,048,821	1.460%	1.336%	1.093
<i>Yemen</i>	0.249	0.489	0.009	0.751	18,600,920	13,970,687	157,537,929	0.394%	0.309%	1.274
<i>Zambia</i>	0.203	0.394	0.012	0.797	10,244,420	8,165,701	92,079,050	0.230%	0.170%	1.352
<i>Zimbabwe</i>	0.268	0.505	0.030	0.732	13,000,970	9,522,402	107,377,645	0.268%	0.216%	1.243