Equity & Global climate change

The Complex Elements of Global Fairness

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Foreword *Eileen Claussen, President, Pew Center on Global Climate Change*

What constitutes a fair response to climate change is the main question underlying many of the unresolved issues in the climate change debate. It is behind the questions of the level of commitment by industrialized countries, the type of participation to be undertaken by developing countries, the structure of the various trading mechanisms, and the nature and magnitude of financial obligations. What has been missing from the debate, however, are consensus principles that define equity in the context of this issue.

This report, which offers insight on global equity, is the second in a series by the Pew Center on Global Climate Change. The Pew Center was established in 1998 by the Pew Charitable Trusts to bring a new cooperative approach and critical scientific, economic and technological expertise to the global climate change debate.

Using the language already in the Framework Convention and the Kyoto Protocol and the way equity has been invoked in other international treaties as a backdrop, the report lays out a new paradigm. We suggest that three criteria—responsibility for the emissions that can cause climate change, standard of living (or the ability to pay for climate change mitigation), and opportunity to reduce emissions—should be considered in differentiating country obligations. Based on these criteria, the report suggests that it is appropriate to divide countries into three groups rather than two: those that must act now; those that should act now, but differently; and those that could act now if feasible. We hope that these ideas will stimulate debate and draw us toward an objective and transparent approach to this critical cause.

The Pew Center and its Business Environmental Leadership Council believe that climate change is serious business. Fairness demands that countries step up to the plate.

Executive Summary

Of the many pending issues within the climate change debate, the question of what constitutes equitable international commitments may be the most difficult to address. Long-unresolved divisions about the distribution of resources and equitable access to them must be considered by climate change negotiators in order to agree on a fair and effective global response. Failing to do so may result in the most inequitable outcome of all, by leaving those who have to face the disproportionate burden of the impacts with few options to address the problem.

There are several philosophical approaches to equity, although the concept remains complex and difficult to define. It can be based on allocation of property rights or on the determination of who is most responsible. Some argue for achievement of the greatest good for the most people, while others are more concerned with minimizing the impact on the least fortunate or with plain common sense.[1] There are also many aspects of equity—from maintaining a fair process to ensuring equity for a range of outcomes (baselines, limitations, compliance, monitoring, reporting, etc.). This paper does not review these philosophies in outlining general principles of equity for the climate change debate. Recognizing that pragmatic issues could dominate international discussions, the paper argues for focusing on these principles as early as possible and for using a transparent process.

We propose a new approach to equity, involving three criteria—responsibility, standard of living, and opportunity. Clearly, determining who is responsible for causing the problem is one factor in a fair response to climate change. In line with the "polluter pays" principle, this would include not only who emitted the most in the past, but also who will emit the most in the future. In addition, both national total and per capita contributions are relevant here. A second factor can be represented by national income per person. Looking at relative standards of living might affect who pays for climate change mitigation, who takes action, and when they are required to take those actions. A third, pragmatic, factor would be opportunity. If one country can more cheaply reduce emissions than another, then it perhaps should be asked to do so.

The paper also outlines a set of principles that could guide negotiations:

- *All nations should be able to maintain or improve standards of living under a global climate change mitigation regime. Consequently, climate change mitigation should focus on alternative low-carbon development paths that don't reduce economic growth.*
- *More broadly, the outcome of FCCC negotiations should not undermine or hinder progress toward the goal of sustainable development.*
- *The countries most responsible for greenhouse gas concentrations in the atmosphere should be leaders in the effort to reduce emissions.*
- *All nations should work to the best of their abilities—or with help from other countries—to reduce emissions either absolutely or relative to business-as-usual trajectories.*
- *The world should take advantage of emission reduction opportunities where they exist.*

These principles and these criteria lead to differential treatment for three—rather than the current two—groupings of countries. They also may lead to different actions being asked of countries within these groups. There is a group of "Must Act Now" countries who score high on both the responsibility and standard of living factors; these should be the leaders. There is a group at the opposite end of the spectrum—"Could Act Now"—who score low on at least two factors who should not be asked to take many actions now. The middle group would consist of those countries who score higher on some factors, but lower on others—"Should Act Now, But Differently." The principles above will drive what is asked of these countries.

We hope that these principles, factors and groupings lead to improved international discussions of equity, at the very least, and, even better, to a solution that all parties believe is fair.

Discussing equity in the context of climate change could require taking on a broad range of topics. By and large, this paper will only address consequential equity (outcome), on the assumption that procedural equity (process) will be addressed in other forums, and will largely confine the discussion to the outcomes of who takes on obligations and at what degree of stringency. Negotiations on other outcomes—compliance mechanisms, monitoring and verification systems, etc.—could easily be driven by the same conclusions presented here. For simplicity of presentation, the paper only refers to emission reductions, but efforts related to sinks of greenhouse gases are assumed to be covered by the same points. One other large aspect of equity—related to the distribution of costs and benefits of climate change mitigation within countries, especially the impact on labor and competitiveness—is important enough to warrant a separate analysis.

The complex elements of global fairness

I. Background

A. The Science

Greenhouse gas emissions have dramatically increased in the last one hundred years, mainly as a result of industrialization in western countries. These countries are currently responsible for most of the world's annual emissions, but developing countries—through rapid economic and population growth—are expected to surpass developed countries' emissions levels by 2015.[2] The world's emissions are projected to increase by 69 percent between 1995 and 2020, driven in large part by energy demand growth of 66 percent in the same time period.[3] But the atmosphere reacts the same way to emissions from a developed country as it does to those from a developing country: it traps more heat at the earth's surface.

The Intergovernmental Panel on Climate Change (IPCC), comprised of 2,000 of the world's leading climate scientists, established in their 1995 assessment that the surface temperature of the Earth has increased by roughly 1 degree F over the past century. Much of this warming has occurred over the last twenty years. It appears that 1998 will be the hottest year on record, surpassing 1995. Indeed, the next 10 hottest years on record have all occurred since 1980.[4]

In its second assessment report, the IPCC also states that "the balance of evidence suggests that there is a discernible human influence on global climate."[5] It offers a "best guess" estimate of future temperature increases: 3.5 degrees by 2100. This rate of warming, if it were to occur, would be the fastest seen in the last 10,000 years, leading many scientists to doubt that other natural systems will be able to adapt to the increased warmth.[6] Projected impacts of this warming on the global environment include damage to coastal areas, accelerated rates of species loss, altered agricultural patterns, changes in precipitation, intensified air pollution, and increased incidences of infectious disease.[7] These impacts could also have substantial economic ramifications as they affect health care costs, property insurance, and worker productivity. These impacts will not affect all areas of the globe equally as the weather patterns change.

B. Relationship to the Economy

One of the main difficulties in addressing the problem of climate change is the consistency of the relationship between emissions and daily economic life. Burning fossil fuels to provide energy is the leading source of greenhouse gas emissions in the atmosphere (85 percent in the U.S.).[8] Further, energy use has always been closely tied to the growth of the economy. As income increases, more energy is used to produce goods and services, and personal energy use increases. Consequently, as economies grow, emissions of greenhouse gases increase. The key to cost-effective climate change mitigation is to weaken this relationship.

Historical experience indicates the relationship between economic growth and overall energy use is not fixed but rather tends to decrease over time.[9] One measure of the relationship between growth and energy is energy intensity—the ratio of energy consumption to GDP—a measure of the overall efficiency of the economy's energy use. In the United States and other industrialized countries, income is now growing at twice the rate of energy use, while in developing countries, the rates are roughly equal and are diverging more slowly.[10] A different set of trends is found, however, in the relationship between economic growth and electricity use or transportation fuels. Historically, growth in the latter has more closely followed growth in the overall economy.[11]

Many factors affect the energy intensity of an economy, including the use of energy efficient or inefficient technologies, energy prices, use patterns of electricity and electrical products, and shifts in industrial production between more and less energy-intensive products.[12] In developed countries, energy use per capita is relatively high, but stable. Consequently, total energy use is driven more by population and labor changes.[13] In addition, higher standards of living mean that increases in income tend to result in purchases either of goods and services low in energy intensity or of capital stock to replace existing equipment. In contrast, lower but improving standards of living in developing countries mean that goods and services that use energy are being purchased for the first time, implying that energy use will more closely track changes in income. With increased incomes, many people in developing countries acquire access to electricity (and the goods that use electricity), while many are also increasing their demand for personal automobiles.[14]

Current projections by the U.S. Energy Information Agency (EIA), corroborated by the International Energy Agency (IEA),[15] suggest continued declines in the ratio of energy use to GDP. Taking a macro view, world energy consumption is projected to grow by 2.3 percent annually between 1995 and 2020, while economic growth is expected to average 3.1 percent per year. This represents almost a 25 percent reduction in energy intensity, with some parts of the developing world and regions with economies in transition declining faster.[16]

The correlation between economic growth and carbon emissions (as opposed to energy use) is more complex. At least four major factors are interrelated: (1) the relationship between overall energy use and economic growth, (2) the relative use of different energy sectors (e.g., electricity versus traditional fuels), (3) changes in efficiency and intensity of energy use, and (4) the relative carbon intensity of fuel sources. For example, Organisation for Economic Co-operation and Development (OECD) countries are expected in the next 15 years to see a closer relationship between economic growth and carbon emissions than in the past 20 years. Increases in the use of nuclear power and natural gas have decreased the carbon intensity of energy in the past, but these increases are likely to slow without specific new measures.

Decoupling economic growth and carbon emissions permanently is, of course, the main goal of climate change mitigation activities. For example, the French economy has grown while carbon emissions have lagged due in part to a strong commitment to nuclear power. However, future growth in electricity demand there is unlikely to be met with nuclear generation, causing the relationship to be strengthened again. Brazil is in a similar situation, having relied heavily on hydropower in the past. In many cases, improving the efficiency of energy use and supply, and switching to lower carbon fuel sources (such as renewable energy) can lower emissions while decreasing economic growth. Such strategies can reduce local air pollution and provide additional benefits.

C. Foreign Policy Considerations

Climate change is a global problem that demands a global solution because emissions from one country can impact the climate in all other countries. Because of its global reach, the severity of its potential environmental impacts, the long lifetime of greenhouse gases in the atmosphere, and the fact that the emissions that cause climate

change are related to and embedded in the global economy, climate change is also a major foreign policy challenge. Policy makers involved in international climate change negotiations must cope with the diversity of interests and situations of the approximately 170 countries, each with varying levels of concern, different objectives for the negotiations, and different criteria for evaluating policy choices.

Within the system of the United Nations, countries are typically split along income lines into developed and developing. The climate change negotiations recognize this split, dividing countries into Annex I Parties (developed country parties) and non-Annex I Parties. But there are also splits among those countries. For example, those nations with ample opportunities to reduce emissions cheaply want early actions and deep cuts for everyone, often in opposition to others who fear significant costs from early, substantial reductions. Fossil fuel exporting countries are more likely than others to want to delay action, and/or to seek compensation for losses in revenues. Those most likely to bear the brunt of the damages from climate change also want compensation for future losses, but urge large emission reductions from high emitters.

In addition to disagreeing about the needed quantity and timing of mitigation, governments also differ on the means to achieve it. Some are more concerned with economic efficiency and flexibility, while others value consistency, transparency, or distributional issues, especially within regional economic groups like the European Union. Most governments are also working to ensure that the policies adopted on climate change complement existing policies and goals in areas such as economic or social development and non-climate change related pollution mitigation.

All of these factors contribute to an exceedingly complex set of negotiations, not dissimilar to the trade negotiations that created the World Trade Organization in 1995 after 10 years of Uruguay Round Negotiations.[17] But it can be argued that the stakes are even higher here, and the costs of delay potentially greater. Working out agreements satisfactory to all countries from an environmental, economic, and equity point of view remains a major challenge.

1. The Convention

The Framework Convention on Climate Change was negotiated in 1992 in response to a growing concern about the future of the earth's climate. Under this treaty, countries set a goal of achieving "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous

anthropogenic interference with the climate system."[18] All nations committed to taking policies and measures to mitigate climate change. Annex I (developed) countries also agreed to reduce voluntarily their emissions to 1990 levels by the year 2000.

The Framework Convention directly addresses the issue of equity. Considerations of intergenerational equity—i.e., fairness in the impact of present actions on future generations—is a guiding principle of the treaty, and a primary reason given for countries to take action. The effect of today's emissions on climate will not be seen for many years; but by the time such effects are seen, it may well be too late to reverse the effects for multiple generations.

Considerations of intragenerational equity—or fairness in dividing emission reduction obligations among countries now—also are raised in the text of the Convention, although they are neither clearly defined or described. Article 3.1 of the Treaty states that Parties should act "on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities." On the basis of this, developed countries are asked to "take the lead" (Article 4.2.a). On a more procedural level, Article 11.2 states that "the financial mechanism shall have an equitable and balanced representation of all Parties within a transparent system of governance." In addition, developing countries are recognized as having a right to development, even after considering that development will increase global emissions from those countries. In general, the treaty states that the "specific needs and special circumstances" of developing countries are to be given "full consideration" (Article 3.2)—a far cry from defining what equity should mean in terms of addressing the problem of climate change.

2. The Kyoto Protocol

The Kyoto Protocol was negotiated in December 1997 in recognition of the fact that emission reductions provisions outlined in the Framework Convention were not an effective mechanism to limit atmospheric concentrations and that mere stabilization of emissions in Annex I countries was not sufficient, since few would reach the voluntary target by 2000. In this Protocol, developed countries agreed to binding emission reductions that would take affect in the period between 2008 and 2012 and average 5 percent below 1990 levels.[19] The Kyoto agreement reiterated the Convention's insistence on "common but differentiated responsibilities"[20] and the Berlin Mandate's stipulation that there be no new commitments for developing countries.[21]

In addition, the Kyoto Protocol differentiates within the group of developed countries with respect to how far below 1990 (if at all) their emissions should be by 2008–2012. These targets were arrived at through negotiations, rather than a process of defining and applying specific, transparent, criteria. Reductions targets were set for 39 developed nations, ranging from 8 percent below 1990 levels to 10 percent above 1990 levels. It is unlikely that this approach to differentiation among Annex I countries will set the precedent for an equitable distribution of obligations between developed and developing nations or among developing nations, since it is not based on particular principles, and was not subjected to rigorous analysis or objective criteria. A negotiated emission budget as agreed in Kyoto is a constructive first step, but a framework for future adjustments and amendments that will be equitable and acceptable to all nations remains to be developed.

II. Global Equity: An Historic View

A. Interpretations from Other Contexts

The dictionary defines fair as "impartial; just; in accordance with rules or standards."[22] There are also many different philosophical approaches, although this paper will not attempt to explore all of them fully. Fairness and equity can be premised on "rights, casuality and responsibility, utilitarianism, Kantian ethics, Rawlsian justice, and impartiality,"[23] to name just a few. Since climate change is being addressed in large part through an international treaty, international law and other such treaties can also provide some insight to the concept and use of equity.

The concept of equity, especially as it applies to developing countries, appears both in international treaties and in generally accepted international law principles. The International Court of Justice (ICJ) has defined equity as being a "general principle directly applicable as law," that is, one of many considerations that can be used to reach a solution.[24] However, the ICJ also recognized that there are no precise guidelines for defining equity.[25] Each situation may be different and may need to take into account the varying circumstances of each participating state in regard to the matter at hand.

The Uruguay Round of negotiations of the General Agreement on Tariffs and Trade (GATT) is one major example of an international, though not environmental, treaty that deals with the equity issue. In general, the GATT has taken the most commonly used approach, providing exemptions for developing countries as a group. Developing countries are given more flexibility and longer transition periods to comply with major decisions reached by the ruling body, the World Trade Organization (WTO). In addition, developed countries also are provided with certain exemptions from obligations and with technical assistance.[26] The negotiations also went one step further and created an additional category of least developed countries that require special attention in terms of rights and decreased obligations, "consistent with their individual development, financial and trade needs, or their administrative and institutional capabilities."[27]

In international environmental law, the principle of equity has been invoked in the allocation of natural resources, in the participation of nations in environmental institutions and treaties, in financial

contributions, and in the distribution of benefits.[28] In fact, the concept of "common but differentiated responsibilities" seen in the Framework Convention on Climate Change has itself appeared previously,[29] and is based in part on the obvious differences in abilities to pay and historical emissions among countries.

One way to analyze the treatment of equity in various global instruments is to return to the concepts of intergenerational and intragenerational equity. The former, intergenerational equity, has been invoked frequently in international law. It is the basis for action for a large number of treaties, particularly environmental ones, where current actions may cause damages over the long term (e.g. the International Whaling Convention, the World Heritage Convention, and the Montreal Protocol).

If intergenerational equity is the basis for decisions to act on an issue, it is intragenerational equity that could help guide the decision-making on the levels of action that may be required. But while it is possible to find treaties where the concept was invoked, few precise formulae exist. One example is the United Nations Convention on the Law of the Sea[30] (1982) that obligates Parties to act "in accordance with their capabilities" in the event of pollution of the marine environment.

One major reason behind the lack of precise equity criteria is that symmetric commitments—where each party to the agreement does basically the same thing—are easier to negotiate.[31] In a paper on equity and negotiations, Parson and Zeckhauser provide a detailed discussion of the benefits of symmetric commitments, but also point out the shortcomings. In the presence of asymmetric interests of the involved parties, symmetric obligations can be both inefficient and inequitable.[32] On the other hand, symmetric obligations are easier to negotiate because the universe of potential solutions is reduced. In order to achieve different solutions for different parties on the basis of equity, the authors recommend grouping nations into a few, similar classes to increase the likelihood of a consensus.[33]

There are many examples of symmetric obligations. The Basel Convention on Transboundary Movement of Hazardous Waste compels each party to use the same standards and procedures. The Antarctic Treaty (1959) completely bans military operations by all nations. Other treaties ban activities including whale hunting and trade in ivory. More recently, treaties have begun to set symmetric obligations as national limits—uniform percentage reductions—on emissions or other activities. Asymmetric obligations are harder to find in international law. Several treaties, including the Montreal Protocol on Substances that Deplete the Ozone Layer, delay compliance for developing countries.[34]

B. Interpretations in the Context of Climate Change

The debate around an equitable solution to climate change has tended to converge on two different definitions of equality. One is an equality of result, with each country reaching the same level of per capita emissions at some point in time. The second is an equality of effort, where each country adopts the same policies and measures and essentially expends equal effort. There are also variations of both definitions, sometimes involving a delay in implementation for developing countries.

But are they fair? One very equitable solution is to equalize per capita emissions—to assign everyone the same property rights to the atmosphere—thereby giving each party the same per capita right to emit. Equal rights for everyone is a common basis of fair actions. But in the context of climate change, there are additional factors to consider. First, it is important to take into account historical emissions, and who was responsible for them. Another is the possibility of creating perverse incentives for population growth. In fact, there is a risk that a country that slows population growth could actually be penalized for having "shrunk" out of compliance. A similar situation—where a country's compliance is influenced by factors not directly related to intended or permanent emissions reductions—is complicating the debate on emissions trading. Some hold that reductions achieved through slowed economic growth rather than climate change implementation are not valid.

Further, several proposals for convergence around a uniform per capita emissions level have set the bar at around one ton of carbon dioxide—a level significantly lower than most Annex I countries and even lower than some developing countries.[35] Is this possible? If enough people think it is impractical—regardless of whether they think it is fair—the chances of implementing any international mitigation standards are reduced. While equal property rights can be one important underlying goal of negotiations, other factors must also be considered.

A recent paper from the World Resources Institute offers an interesting twist to the proposal of equal per capita emissions.[36] The authors calculate cumulative emissions from both fossil fuel burning and land use changes, discounting older emissions by a factor related to average sink uptake by oceans and vegetation. The cumulative number is then divided by annual population to approximate the "legacy" for each citizen from past and current emissions. This measure of each country's contribution

to the problem of climate change could be an attractive starting point for discussions of what constitutes an equitable emissions reduction path and addresses some of the concerns about per capita goals, as it combines measures of both past and current responsibility.

The second option often considered—having everyone do the same thing—apparently seeks to equalize effort. However, given that everyone does not start from the same place, the additional effort required on the part of some countries and the lack of effort required by others clearly would not indicate a fair strategy. This strategy also is completely unrelated to either past or future emissions.

Other policies exist that do not achieve underlying performance and equity goals. Countries could all spend the same percentage of national budgets or of Gross Domestic Product on climate change mitigation, for example, or achieve uniform annual reductions in energy intensity.[37] Given the disparity in Gross Domestic Product (GDP) or in national budgets and priorities, however, these choices are also unlikely to be judged as fair, since it is not clear that the item being equalized addresses the fundamental inequality of emissions.

III. A Fundamental Rethinking

A. How to Think About Fairness

Since climate change is a global phenomenon, a global benchmark for fairness is a valid starting point. If we lay out an objective to achieve particular emissions reductions of greenhouse gases (preventing "dangerous interference with the climate system"), we establish a base from which to examine the fairness issue. This base rests on three factors: responsibility, standard of living and opportunity.

First, to achieve a concentration limit for climate change mitigation, we will have to look at which nations shoulder the greatest responsibility for concentrations in the atmosphere—historically (because of the long lifetimes of greenhouse gases), currently, and in the future (because emissions are not static). We will also need to look at both total national emissions and per capita emissions, since we need to be able to look at responsibility absent population trends as well.

In cases of environmental harm, it is assumed that the funds and effort to remedy a problem should come from those who contributed to or created the problem—the "polluter pays" principle. This is easiest to implement with discrete environmental problems, such as an oil spill or a toxic release, where it is relatively easy to identify a small number of polluters. When the environmental problem is more continuous (e.g. the polluters will continue to pollute in the future but perhaps at a lower level) or where everyone is a polluter and has been for an extended period of time, this principle can still be applied; but other factors, such as ability to pay, may become more relevant, and implementation becomes more difficult.

For example, when more than one person is contributing to the problem, it may be fair to consider who has the resources to address the problem, or who could do so at lower cost. Alternatively, one may want to ensure that all parties are made better off, or, failing that, at least assure that no one is made worse off. The IPCC clearly states this latter point as a goal, insisting that the Framework Convention not "aggravate existing disparities."[38] The Framework Convention also reiterates this point, arguing that the climate system should be protected by the Parties in accordance with their "respective capabilities."[39]

This leads us to the second factor: standard of living. In the language describing its overall objective, the Framework Convention also states that the stabilization of concentrations should be done in such a way as to enable "economic development to proceed in a sustainable manner."[40] The preamble to the Convention further amplifies this where the "achievement of sustained economic growth and the eradication of poverty" are listed as essential elements of strategies to deal with climate change. These points, and their reiteration in the Kyoto Protocol, strongly suggest that a climate change policy that does not work toward continued economic growth and improved standards of living could not be judged ultimately as either sound or equitable.

Third, a further differentiation between countries could be made in those cases where responsibility and standard of living are similar, but opportunity to make real, cost-effective reductions varies. Some countries use energy very inefficiently as they produce national income and could improve their efficiency cost-effectively. Others with high potential are installing energy-using equipment for the first time and could install highly-efficient equipment. In contrast, there are countries already using energy very efficiently that have fewer low-cost options available to reduce emissions. Because of the global nature of climate change, the location of emissions reductions is not as important as the amount, although there are indirect health benefits that depend on the geographic location of the reduction. Simply shifting emissions to other countries by substituting away from the production of energy-intensive products and instead purchasing these products should not be counted. (In fact, some propose going further to hold countries responsible for emissions based on net consumption of goods rather than production.)

B. Analysis

Analyzing the three factors described above—responsibility, standard of living and opportunity—presents an interesting array of results.

Data gathered on the three factors are presented in Appendix I and summarized below.

Using information gathered by the Carbon Dioxide Information Analysis Center (CDIAC) of the Oak Ridge National Laboratory, four "responsibility" variables can be calculated for a subset of countries (see Table 1). The first is a variable that is most invoked in the name of equity: past responsibility. Available data from 1950 to 1995 were added together to give an estimate of past emissions of carbon dioxide from the burning of fossil fuels. The numbers range from over 180 billion metric tons for the United States, down to less than one hundred thousand tons for several small island nations. While the

Table 1

Responsibility Carbon Dioxide Emissions

	Cumulative CO_2 Emissions *1950–1995*	CO_2 per capita *1995*	Total CO_2 *1995*	Estimated Growth in CO_2 Emissions[1]
Average	3,850,234,000	4.6	132,063,000	1.1%
Median	272,594,000	2.2	10,475,000	1.7%
Maximum	180,235,575,000	53.1	5,156,190,000	9.1%
Minimum	92,000	0	4,000	–11.9%

Source: See Appendix 1.

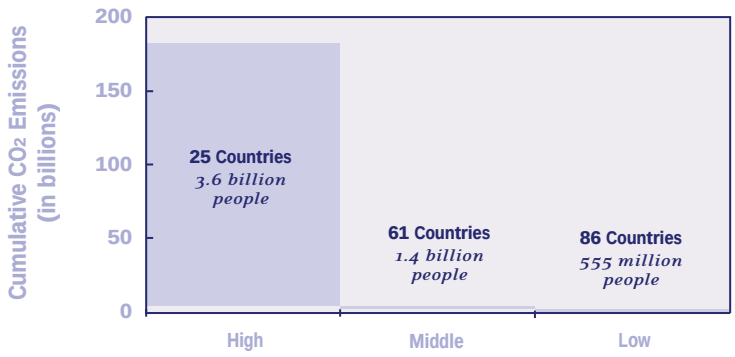
[1] Some outliers were removed from the calculation on the assumption that the estimated growth was not sufficiently representative of future growth.

average is almost 4 billion metric tons, the median is only 272 million tons—meaning that half the nations listed have cumulative emissions less than that. Surprisingly, the middle of the list is 660 times less than the top of the list, while the carbon emitted in a single year (1991) by the Kuwait oil fires is close to 500 million tons, or almost twice the median.

Twenty-six countries fall above the average cumulative emissions figure, including all developed, or Annex I, countries except Denmark, Switzerland, or Sweden. Several of the larger developing countries also fall into this category, including China, India, and Brazil. On the other hand, the 88 countries that fall above the median include all developed countries except Portugal, the larger developing countries, and also Colombia, the Philippines and Bangladesh. Graph 1 presents the number of countries (and people living in those countries) who fall into three categories—"high" (above average), "middle" (between the average and the median) and "low" (below the median).

Graph 1

Responsibility Cumulative CO2 Emissions in Metric Tons, (1950-1995), Grouped



Source: See Table 1

It is also useful to look at current emissions (1995) for each country, both in absolute and per capita numbers. For carbon dioxide emissions per capita, the average is 4.6 metric tons and the median is 2.2 metric tons. All Annex I countries are above the median per capita emissions figure, but a number of developing countries also are above the average, including Malaysia, Venezuela, and Lebanon. Falling above the median figure are all the developed countries, plus such developing countries as China, Thailand, and Suriname. For total emissions in 1995, the range varies from over 5 billion metric tons down to virtually no emissions for several small nations. A handful of large emitters brings the average up to over 132 million metric tons, but the median is only 10 million metric tons.

Trying to estimate future responsibility is more difficult, but also important. Most data sources only have estimates of projected emissions growth through 2020 for a small subset of countries or for aggregated regions (see Table 2). These estimates predict that total developing country emissions will exceed those of the developed world starting around 2015, as a result of average growth rates that are roughly three times higher. In this paper, average annual growth from 1992 to 1995 is calculated to provide an imperfect glimpse of what the recent past can predict for the near-term future (see Table 1).[41] These numbers range from plus 9 percent to almost negative 12 percent. In spite of this variation, the average and the median are quite close and are both over 1 percent annual growth. Most of the countries above the median are developing countries, although Israel, the United States, and Australia are notable Annex I members in this category. Most of

Table 2

Growth in Total Carbon Emissions by Region, Reference Case

(million metric tons)

Region/Country	Average Annual Percent *1995*	*2020*	Change, *1995–2020*
North America	1,629	2,313	1.4
Western Europe	925	1,239	1.2
Industrialized Asia	379	514	1.2
EE/FSU	866	1,223	1.4
Developing Asia	1,427	3,835	4.0
Middle East	229	409	2.3
Africa	192	341	2.3
Central and South America	194	574	4.4
TOTAL WORLD	5,841	10,447	2.4
United States	1,411	1,956	1.3
Canada	135	198	1.5
Mexico	82	159	2.7
Japan	281	385	1.3
China	792	2,340	4.4
India	222	523	3.5
Brazil	64	208	4.9

Source: Table taken from the Energy Information Administration, *International Energy Outlook 1998*.

the Annex I countries are clustered around the mean, while some have actually posted negative growth rates. Many of the countries with lower rates of growth are Eastern European countries and countries from the former Soviet Union.

The second major source of inequality described above is standard of living. This can be measured by a variety of social and development measures, but also can be broadly captured by income levels per capita. The UNFCCC and the Kyoto Protocol already differentiate on the basis of income, basically dividing countries between developed and developing. Again, the summary numbers in Table 3 (and country numbers in Appendix 1) show how far apart countries actually are. GDP per capita calculated using purchasing power parity (see note to Table 3) varies from $460 to $26,000, the latter being more than $460 per week. The mean is just under $6,700, which is below the poverty level in the U.S., and also much higher than the median, implying that half of the world's countries—but 65 percent of the people—survive on less than $4,000 per year. Using groupings as defined above, Graph 2 illustrates income disparities, and the concentrations of wealth at both the high and low ends.

Table 3

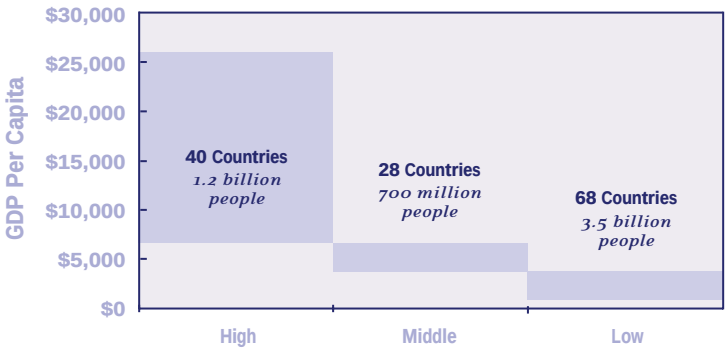
Standard of Living
National Income

1995 US$	GDP per person Purchasing Power Parity
Average	6,663
Median	3,973
Maximum	26,026
Minimum	460

NB: GDP can be calculated two ways, depending on the way local currencies are converted into dollars. The traditional way is to use market exchange rates. An alternative is gaining in popularity that corrects for the under- or over-valuation of some currencies (relative to the dollar) to better reflect actual purchasing power parity (PPP). In general, this latter results in higher GDP estimates for developing countries and lower ones for developed countries. For most purposes, GDP calculated using PPP is used to make international comparisons.

Graph 2

Standard of Living GDP (Calculated Using PPP) Per Capita (1995), Grouped



Source: See Table 3

Interestingly, there are 39 countries above the average GDP per capita, but not all of these countries are Annex I countries who have taken on binding commitments. Coming in below the average (and in some cases the median) are almost all of the countries with economies in transition. A fair number of developing countries, including Mexico, Argentina, and South Korea, are earning above average GDP per capita. Brazil, Russia, South Africa, and other developing countries, while still having incomes substantially below many OECD countries, also all have incomes above the median.

The UN Human Development Report 1998 examines the inequalities in incomes across countries in more depth,[42] highlighting that the problem is only worsening. Among the findings are that:

- *private consumption has increased in industrial countries by 2.3 percent per year in the last 25 years, while consumption in Africa has decreased by 20 percent;*
- *the richest 20 percent of the population represent 86 percent of private consumption expenditures, while the poorest 20 percent represent only 1.3 percent;[43] and,*
- *the three richest individuals hold assets that are greater than the combined wealth of the 48 poorest countries.[44]*

The third difference between countries is the number and cost of opportunities to reduce greenhouse gas emissions. This is more difficult to change by policy intervention. However, a fair policy might take into consideration the variations in opportunity across countries. While more difficult to quantify than income or carbon emissions, the energy intensity of an economy—the energy required to produce a dollar of national income—can be considered as a proxy (see Table 4). Energy intensity varies over time and by stage of development: industrialized countries average around 10, developing countries average over 20, and the Eastern Europe/Former Soviet Union countries are closer to 40 when measured in units of thousand Btu per dollar.[45]

Table 4

Opportunity

Energy Intensity

1995 US$	Energy consumption/ GDP (PPP)
Average	9.5
Median	6.0
Maximum	72.1
Minimum	0.2

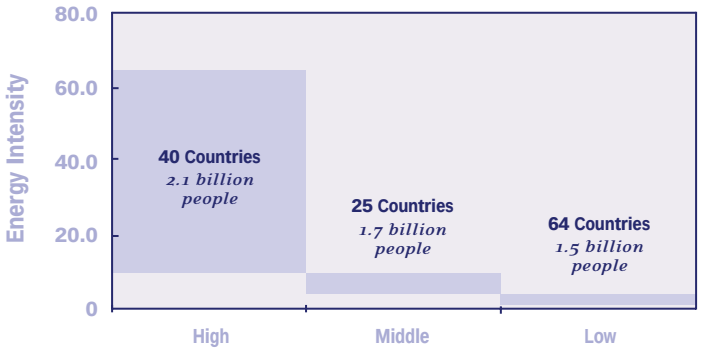
Source: See Appendix 1

The list of countries with above-average opportunity to reduce emissions is an interesting mix. Many of the countries with economies in transition are included, but so are other OECD countries such as Canada, the United States, and The Netherlands. Relatively industrialized developing countries such

as China, India, Mexico, and South Korea are all above the median energy intensity, while those below that mark are the vast majority of middle- to low-income developing countries. Graph 3 highlights the fact that the world's population is more evenly divided across "high," "middle," and "low" countries, making this factor perhaps the least important of the three discussed for ranking countries, although it will still impact decisions on the level of action.

Graph 3

Opportunity Energy Intensity (Energy Use Per $ of GDP, 1995), Grouped



Source: See Table 2

Several general points can be gleaned from the data presented above. First, these are three out of many areas of vast inequality among countries. The regional differences in vulnerability to the damages caused by climate change are likely to be extensive. The infrastructure already in place—defined broadly to include both human and physical capital—also varies and can be difficult to describe by a single measure that captures both quantity and quality.

Second, these areas are not always correlated or interchangeable, so that some countries rank high on one variable and lower on another. In other words, fixing one doesn't automatically fix the others.[46] Third, it may not be possible or desirable, solely in the context of climate change and proposed implementation policies, to correct all of the inequities. But a goal should be to try to avoid making any of these inequities any worse. Fourth, the data series presented should be viewed as imperfect indicators of relationships. For example, a whole set of indicators (literacy, maternal and child health, formal social safety nets, etc.) all are part of what is broadly referred to as standard of living. Other indicators are incomplete; the data on emissions does not include the contributions of sinks. In addition, data in some countries are more accurate than in others. Finally, the data predates the current economic downswings; consequently, the relative positions of some countries may have changed. What can be taken from the data is an indication of the relative positions of countries, an initial assessment of who should take action in a fair system, and some rationale for a sliding scale of action.

IV. Conclusion: A Fresh Approach

What are the criteria that climate change negotiators need to employ when considering equity? If the end result of negotiations is not fair—by most governments' definitions—then it will not be fully implemented. Little to no mitigation of climate change is then the unfair outcome to those who will have to bear the brunt of the impacts. Even the perception of unfairness could hinder negotiations or impact compliance and enforcement. We would like to posit the following new paradigm as a guide, starting with three criteria just discussed.

Standard of living. Citizens of industrialized countries enjoy a significantly higher standard of living than people in developing countries. Many people in the latter live their lives without having basic needs met—clean water, adequate food and shelter, and access to health care and education. It is critical that climate change policies seek either to maintain or to improve the standard of living in developing countries. This is not an issue of mitigation costs (since marginal costs can be equalized through trading) but rather of broader economic and technological development based on the assumption that absolute caps on emissions for developing countries may hinder growth at their current state of development. At the same time, citizens of industrialized countries would naturally not wish to see a lessened standard of living. This, too, must be taken into account in the development of a fair framework for climate change mitigation.

Responsibility. Industrialized countries have been historically responsible since they as a group have some of the highest per capita energy use and also have benefitted from emitting vast quantities of greenhouse gases over the last century. However, the emissions in developing countries, led by a few large emitters, will increase in the future as they grow and develop and thus these countries can be viewed as having increased future responsibility.

Opportunity. Countries differ in the options available to them to directly reduce their emissions. Some countries already use resources very efficiently and have fewer cost-effective alternatives available to them. Others are less efficient. Many developed and developing countries have cost-effective

options to reduce their future emissions below a business-as-usual baseline. These opportunities should be capitalized on to achieve the environmental and economic benefits that can accompany the carbon reducing activities (*e.g.,* energy efficiency upgrades, use of less carbon-intensive fuel sources, etc.).

Combined, the three factors—standard of living, responsibility, and opportunity—point to principles of equity that could guide negotiations:

- *All nations should be able to maintain or improve standards of living under a global climate change mitigation regime. Consequently, climate change mitigation should focus on alternative low-carbon development paths that don't reduce economic growth.*
- *More broadly, the outcome of FCCC negotiations should not undermine or hinder progress toward the goal of sustainable development.*
- *The countries most responsible for greenhouse gas concentrations in the atmosphere should be leaders in the effort to reduce emissions.*
- *All nations should work to the best of their abilities—or with help from other countries—to reduce emissions either absolutely or relative to business-as-usual trajectories.*
- *The world should take advantage of emission reduction opportunities where they exist.*

Obviously, given these factors and principles, the current assumption of uniform per country reductions, taken as a percentage from the total, is inequitable. What should replace this? What are the implications of using these three criteria on the choice of equitable emission reduction targets?

First, there is an obvious set of countries who have high responsibility, standards of living, and opportunities and room for improvement—"Must Act Now." Clearly they should provide the leadership on climate change mitigation activities. This set of countries may not include all current Annex I countries, but might contain others currently without binding commitments. Obviously, the specific actions required of any one country would be in line with its relative national circumstances.

A second group falls at the opposite end of the spectrum. These developing countries have extremely low national incomes, low emissions both historically and for the predictable future, and, consequently, relatively few opportunities to reduce emissions—"Could Act Now." These countries would

not be required to take action until their situations changed. However, where feasible, they should be encouraged to decrease the carbon intensity of their energy sources and increase the energy efficiency of end use. This would entail investment decisions more than additional expenditures, on the assumption that existing and future funding mechanisms (including investments by other countries through the Clean Development Mechanism) will fill the void. Having different implementation strategies or regulations for a subset of the developing countries—the least developed—mimics the treatment used by the World Trade Organization for trade purposes and by the World Bank for concessional funding.

The remaining (almost exclusively) developing countries would see their status and commitments negotiated in international sessions where equity might be balanced by other national and international interests—"Should Act Now, But Differently." The countries in this group might be above, or even well above, average for one or two of the variables described above, but not for all. The actions requested of them by negotiators might vary depending on whether they have higher income, higher responsibility, or more opportunity. Consequently, a country with higher than average income yet less responsibility might still be asked to incur some mitigation costs. On the other hand, a country with high responsibility (either for emissions in the past or the future) might be requested to make more near-term reductions relative to their projected emissions trajectory than another country with lower responsibility, even given similar standards of living or opportunity.

One example of a set of quantitative rules and the corresponding tiers of countries is contained in Appendix 2. These clearly illustrate how the process could work of applying the principles and criteria to the development of country groupings, in conjunction with transparent rules. Which tier countries fall into depends not only on the relative weight given to each of the three factors, but also on how countries are ranked—"high," "middle," or "low"—within each factor. The tiers also depend on the data used; including sinks or using more recent economic data could change the rankings for some countries. Precise obligations within the tiers would be subject to debate and negotiation and is beyond the scope of this paper.

Appendices

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APPENDIX I—Data for Three Criteria

Standard of Living

Country	Gross Domestic Product per Capita calculated using Purchasing Power Parity (1995 Int$)
United States	26,026
Switzerland	24,900
Singapore	22,610
Norway	22,450
Kuwait	22,060
Denmark	21,990
Japan	21,930
Canada	21,900
Belgium	21,560
Austria	21,320
France	21,180
Iceland	21,080
Italy	20,180
Germany	20,120
Netherlands	19,880
Australia	19,630
Sweden	19,310
United Kingdom	19,300
Finland	18,540
Ireland	17,800
New Zealand	17,190
Israel	16,700
Spain	14,780
United Arab Emirates	14,440
Mauritius	13,270
Portugal	12,690
Greece	11,640
Korea, South	11,550
Czech Republic	9,770
Chile	9,730
Trinidad & Tobago	9,610
Malaysia	9,520
Oman	9,350
Saudi Arabia	8,690
Argentina	8,450
Venezuela	8,100
Thailand	7,710
Mexico	6,750
Uruguay	6,700
Hungary	6,680
Colombia	6,330
Panama	6,260
Fiji	6,200
Costa Rica	5,920
Syria	5,650
Botswana	5,630
Belize	5,620
Algeria	5,600
Iran	5,550
Turkey	5,510
Brazil	5,500
Yugoslavia	5,467
Poland	5,430
Tunisia	5,260
South Africa	5,240
Jamaica	4,930

Country	Gross Domestic Product per Capita calculated using Purchasing Power Parity (1995 Int$)
Russia	4,820
Bulgaria	4,700
Ecuador	4,560
Romania	4,390
Belarus	4,250
Estonia	4,220
Turkmenistan	4,217
Jordan	4,140
Lithuania	4,120
Namibia	4,100
Gabon	3,983
Moldova	3,976
Indonesia	3,970
Egypt	3,890
Peru	3,800
Dominican Republic	3,740
Paraguay	3,630
Slovak Republic	3,600
Morocco	3,470
Latvia	3,360
Guatemala	3,290
Sri Lanka	3,290
Kazakhstan	3,040
China	2,970
Swaziland	2,950
Philippines	2,760
Bolivia	2,680
El Salvador	2,600
Papua New Guinea	2,600
Guyana	2,580
Congo, Republic of	2,480
Ukraine	2,440
Nicaragua	2,430
Uzbekistan	2,370
Cameroon	2,300
Armenia	2,280
Solomon Islands	2,230
Pakistan	2,210
Zimbabwe	2,140
Suriname	2,120
Honduras	2,040
Ghana	2,030
Mongolia	2,010
Senegal	1,830
Kyrgyz Republic	1,800
Cote D'Ivoire	1,770
Laos	1,709
Benin	1,660
Mauritania	1,620
Uganda	1,490
Georgia	1,480
Azerbaijan	1,460
Kenya	1,430
India	1,420
Bangledesh	1,380
Nigeria	1,310

Country	Gross Domestic Product per Capita calculated using Purchasing Power Parity (1995 Int$)
Bhutan	1,290
Angola	1,170
Togo	1,160
Nepal	1,140
Central African Republic	1,080
Zambia	990
Tajikistan	970
Gambia	950
Haiti	920
Mozambique	910
Guinea-Bissau	800
Burkina Faso	790
Malawi	770
Niger	750
Sudan	726
Chad	710
Myanmar	696
Madagascar	680
Tanzania	670
Sierra Leone	620
Guinea	577
Mali	560
Congo, Democratic Republic of	473
Ethopia	460
Albania	–
Antigua & Barbuda	–
Bahamas	–
Bahrain	–
Barbados	–
Cambodia	–
Cape Verde Islands	–

Country	Gross Domestic Product per Capita calculated using Purchasing Power Parity (1995 Int$)
Comoros	–
Cook Islands	–
Croatia	–
Cuba	–
Cyprus	–
Djibouti	–
Dominica	–
Eritrea	–
Grenada	–
Iraq	–
Kiribati	–
Korea, North	–
Lebanon	–
Libya	–
Lichtenstein	–
Luxembourg	–
Macedonia,FYR	–
Maldives	–
Malta	–
Monaco	–
Nauru	–
Niue	–
Qatar	–
Samoa	–
Seychelles	–
Slovenia	–
St. Kitts and Nevis	–
St. Lucia	–
Vanuatu	–
Vietnam	–
Yemen	–

Source: World Resources Institute, 1998. *1998–99 World Resources: A Guide to the Global Environment.* Oxford University Press.

Country	Energy Intensity Energy consumption divided by GDP (1995)
Ukraine	72.12
Kazakhstan	54.83
Azerbaijan	46.58
Russia	41.22
United Arab Emirates	33.57
Uzbekistan	32.72
Estonia	32.39
Suriname	29.48
Lithuania	23.48
Bulgaria	23.02
Trinidad & Tobago	22.65
Turkmenistan	21.92
Belarus	21.61
Tajikistan	20.26
Saudi Arabia	20.17
Mongolia	19.50
Poland	19.11
Latvia	18.57
Georgia	18.27
Romania	17.82
Kuwait	17.04
South Africa	16.83
Venezuela	16.28
Canada	14.51
Hungary	14.50
Gabon	13.92
Kyrgyz Republic	13.58
United States	12.77
Singapore	12.38
Australia	11.61
Finland	11.40
Netherlands	10.93
Mauritania	10.74
Iran	10.71
Korea, South	10.51
Moldova	10.29
Sweden	10.10
Jamaica	10.06
New Zealand	9.86
China	9.63
Belgium	9.35
Norway	9.16
Jordan	9.09
Mexico	8.83
Algeria	8.62
Greece	8.25
Germany	8.20
Oman	8.17
Iceland	8.06
India	7.97
Armenia	7.85
Argentina	7.69
Malaysia	7.57
France	7.35
Ireland	6.90
Japan	6.81

Country	Energy Intensity Energy consumption divided by GDP (1995)
Syria	6.68
Denmark	6.45
El Salvador	6.39
Bolivia	6.35
Turkey	6.33
Spain	6.33
Guyana	6.30
United Kingdom	6.16
Egypt	6.00
Italy	5.98
Israel	5.86
Austria	5.85
Portugal	5.70
Zambia	5.61
Dominican Republic	5.55
Zimbabwe	5.44
Belize	5.34
Switzerland	5.32
Nicaragua	5.05
Ecuador	5.00
Panama	4.92
Brazil	4.85
Honduras	4.82
Thailand	4.78
Pakistan	4.73
Chile	4.66
Philippines	4.54
Tunisia	4.33
Uruguay	4.29
Guinea	4.20
Peru	4.19
Indonesia	4.19
Colombia	4.04
Cote D'Ivoire	3.95
Morocco	3.67
Myanmar	3.66
Paraguay	3.62
Congo, Republic of	3.57
Costa Rica	3.43
Guinea-Bissau	3.41
Bhutan	3.32
Papua New Guinea	3.22
Nigeria	3.19
Kenya	2.91
Gambia	2.87
Sudan	2.53
Guatemala	2.47
Senegal	2.44
Solomon Islands	2.24
Niger	2.22
Fiji	2.22
Bangledesh	2.11
Angola	2.06
Ghana	1.93
Sierra Leone	1.92
Togo	1.89

Country	Energy Intensity Energy consumption divided by GDP (1995)
Cameroon	1.83
Madagascar	1.82
Tanzania	1.71
Burkina Faso	1.70
Ethopia	1.66
Malawi	1.59
Sri Lanka	1.56
Mauritius	1.44
Haiti	1.36
Mali	1.28
Central African Republic	1.12
Mozambique	1.09
Nepal	0.94
Benin	0.77
Laos	0.60
Uganda	0.56
Chad	0.22
Albania	–
Antigua & Barbuda	–
Bahamas	–
Bahrain	–
Barbados	–
Botswana	–
Cambodia	–
Cape Verde Islands	–
Comoros	–
Congo, Democratic Republic of	–
Cook Islands	–
Croatia	–
Cuba	–
Cyprus	–

Country	Energy Intensity Energy consumption divided by GDP (1995)
Czech Republic	–
Djibouti	–
Dominica	–
Eritrea	–
Grenada	–
Iraq	–
Kiribati	–
Korea, North	–
Lebanon	–
Libya	–
Lichtenstein	–
Luxembourg	–
Macedonia, FYR	–
Maldives	–
Malta	–
Monaco	–
Namibia	–
Nauru	–
Niue	–
Qatar	–
Samoa	–
Seychelles	–
Slovak Republic	–
Slovenia	–
St. Kitts and Nevis	–
St. Lucia	–
Swaziland	–
Vanuatu	–
Vietnam	–
Yemen	–
Yugoslavia	–

Source: World Resources Institute, 1998. *1998–99 World Resources: A Guide to the Global Environment.* Oxford University Press.

APPENDIX I—Data for Three Criteria **Responsibility**

Country	Cumulative CO_2 emissions (1950–1995) (thousand metric tons)	CO_2 emissions per capita (1995) (tons/person)	Total CO_2 emissions (1995) (thousand metric tons)	Projected growth in CO_2 emissions (averaged from 1992–1995)
United States	180,235,575	19.4	5,156,190	1.9%
Russia	66,694,682	12.1	1,818,011	–1.9%
China	54,030,802	2.6	3,192,484	6.5%
Germany	41,784,828	10.3	835,099	–0.1%
Japan	29,736,951	9.2	1,126,753	1.1%
United Kingdom	26,666,955	9.2	542,140	–0.9%
Ukraine	20,934,158	8.4	438,211	–10.7%
France	16,443,057	5.9	340,085	–0.8%
India	14,507,388	1.1	908,734	6.0%
Canada	14,467,674	14.7	435,749	0.7%
Poland	14,009,231	8.8	338,044	0.2%
Italy	11,924,026	7.3	409,983	0.3%
Kazakhstan	9,977,622	13.2	221,478	–8.6%
South Africa	8,205,447	7.3	305,805	1.5%
Mexico	7,645,988	4.0	357,834	1.0%
Australia	7,325,977	16.1	289,808	3.7%
Czech Republic	6,194,318	11.0	112,049	–5.4%
Spain	5,952,956	5.9	231,605	1.3%
Brazil	5,415,887	1.5	249,196	4.4%
Romania	5,408,588	5.5	121,092	0.7%
Netherlands	5,029,760	8.8	135,909	–0.1%
Belgium	4,814,829	10.3	103,816	1.3%
Iran	4,755,568	4.0	263,760	3.7%
Korea, North	4,699,824	11.7	256,986	0.2%
Korea, South	4,547,456	8.4	373,592	9.1%
Venezuela	3,744,187	8.4	180,243	–
Saudi Arabia	3,731,348	13.9	254,252	5.2%
Argentina	3,720,836	3.7	129,464	3.3%
Indonesia	3,670,910	1.5	296,132	6.6%
Uzbekistan	3,515,861	4.4	98,877	–0.6%
Belarus	3,214,244	5.9	59,302	–
Turkey	3,037,046	2.6	165,917	4.4%
Hungary	2,810,387	5.5	55,876	–2.2%
Sweden	2,749,953	5.1	44,591	–7.3%
Bulgaria	2,471,144	6.6	56,697	2.2%
Denmark	2,192,651	10.6	54,868	1.9%
Austria	2,068,225	7.3	59,280	3.0%
Slovak Republic	2,061,553	7.0	38,036	–4.0%
Nigeria	1,864,089	0.7	90,717	–6.5%
Azerbaijan	1,840,830	5.5	42,576	–7.3%
Yugoslavia	1,773,651	3.3	33,035	–3.2%
Egypt	1,750,645	1.5	91,684	5.1%
Norway	1,713,228	16.9	72,452	7.5%
Thailand	1,686,953	2.9	175,040	–
Algeria	1,632,118	3.3	91,267	3.9%
Greece	1,629,480	7.3	76,284	2.7%
Finland	1,610,039	9.9	51,014	0.4%
Colombia	1,524,220	1.8	67,524	5.9%
Switzerland	1,484,444	5.5	38,853	–4.2%
Turkmenistan	1,402,330	7.0	28,334	–11.6%
Iraq	1,394,354	4.8	99,001	–
Pakistan	1,377,122	0.7	85,357	5.5%
Philippines	1,162,452	0.7	61,159	7.3%
United Arab Emirates	1,110,811	30.8	68,304	4.2%
Malaysia	1,058,028	5.1	106,604	–

Country	Cumulative CO_2 emissions (1950–1995) (thousand metric tons)	CO_2 emissions per capita (1995) (tons/person)	Total CO_2 emissions (1995) (thousand metric tons)	Projected growth in CO_2 emissions (averaged from 1992–1995)
Chile	1,022,758	2.9	44,104	7.2%
Singapore	984,396	19.1	63,669	–
Cuba	984,370	2.6	29,067	1.8%
Portugal	947,477	5.1	51,926	3.6%
Kuwait	941,120	28.9	48,720	–
Ireland	922,496	9.2	32,236	0.9%
Israel	849,905	8.4	46,320	7.3%
Libya	831,746	7.3	39,403	–4.1%
Croatia	768,260	3.7	17,016	3.0%
New Zealand	763,929	7.7	27,440	0.8%
Moldova	744,484	2.6	10,816	–
Peru	743,187	1.5	30,561	–
Lithuania	736,783	4.0	14,814	–11.9%
Vietnam	728,290	0.4	31,708	–
Estonia	727,190	11.0	16,444	–8.1%
Syria	689,286	3.3	46,024	5.3%
Tajikistan	637,946	0.7	3,741	–
Macedonia, FYR	541,070	5.1	10,750	–1.4%
Morocco	531,577	1.1	29,294	5.8%
Georgia	501,308	1.5	7,746	–
Luxembourg	487,671	22.7	9,263	–4.4%
Kuwaiti Oil Fires	477,925	–	–	–
Trinidad & Tobago	465,771	13.2	17,111	–5.6%
Latvia	435,115	3.7	9,318	–9.7%
Qatar	419,788	53.1	–	–
Ecuador	397,881	1.8	22,633	–0.6%
Kyrgyz Republic	374,072	1.1	5,463	–
Slovenia	362,315	6.2	11,714	4.1%
Zimbabwe	338,784	0.7	9,735	–
Bangledesh	296,934	0.0	20,932	8.8%
Tunisia	296,546	1.8	15,308	2.2%
Bahrain	248,643	26.7	14,832	–
Lebanon	248,643	4.4	13,341	5.5%
Yemen	229,150	1.1	14,411	1.7%
Dominican Republic	222,005	1.5	11,769	1.5%
Jamaica	221,928	3.7	9,050	3.9%
Oman	218,700	5.1	11,417	–6.3%
Uruguay	211,281	1.8	5,379	3.3%
Mongolia	210,332	3.3	8,457	–7.1%
Jordan	189,641	2.6	13,308	4.1%
Kenya	173,245	0.4	6,683	7.0%
Myanmar	170,643	0.0	7,031	–
Cote D'Ivoire	169,280	0.7	10,362	0.5%
Albania	162,517	0.4	1,847	–8.5%
Bolivia	150,891	1.5	10,475	–
Sri Lanka	148,165	0.4	5,888	4.3%
Congo, Democratic Republic of	139,914	0.0	2,099	–
Angola	135,026	0.4	4,602	3.3%
Sudan	133,520	0.0	3,499	0.3%
Guatemala	132,637	0.7	7,189	6.3%
Gabon	128,845	3.3	3,543	–
Armenia	127,833	1.1	3,649	–0.4%
Bahamas	114,859	6.2	1,707	–5.7%
Zambia	108,733	0.4	2,404	–0.7%

Country	Cumulative CO_2 emissions (1950–1995) (thousand metric tons)	CO_2 emissions per capita (1995) (tons/person)	Total CO_2 emissions (1995) (thousand metric tons)	Projected growth in CO_2 emissions (averaged from 1992–1995)
Panama	107,938	2.6	6,896	–
Ghana	104,801	0.4	4,045	3.6%
Cyprus	103,699	7.0	5,177	2.2%
Tanzania	98,822	0.0	2,440	2.6%
Mozambique	88,152	0.0	993	–0.1%
Costa Rica	81,608	1.5	5,232	–
Cameroon	80,406	0.4	4,144	6.0%
El Salvador	78,509	1.1	5,188	–
Senegal	72,522	0.4	3,063	0.0%
Iceland	68,337	6.6	1,803	2.8%
Honduras	67,964	0.7	3,855	7.8%
Nicaragua	67,062	0.7	2,700	2.4%
Ethopia	63,490	–	3,525	5.7%
Suriname	61,522	5.1	2,151	0.6%
Papua New Guinea	53,835	0.7	2,481	–0.6%
Guyana	50,974	1.1	934	–3.6%
Paraguay	50,351	0.7	3,796	–
Malta	37,977	4.8	1,726	1.3%
Mauritania	37,790	1.5	3,067	2.1%
Madagascar	36,809	0.0	1,125	3.9%
Congo, Republic of	34,009	0.4	1,268	–
Uganda	31,826	0.0	1,044	3.1%
Guinea	31,280	0.0	1,081	1.8%
Botswana	29,851	1.5	2,242	–2.5%
Mauritius	26,286	1.5	1,491	5.0%
Haiti	24,025	0.0	638	–9.0%
Barbados	23,336	3.3	824	–4.7%
Fiji	22,358	1.1	736	1.4%
Nepal	19,907	0.0	1,532	4.1%
Niger	19,738	0.0	1,118	1.2%
Sierra Leone	19,397	0.0	443	2.9%
Malawi	17,441	0.0	725	4.0%
Togo	16,283	0.0	744	2.2%
Cambodia	14,260	0.0	498	1.5%
Benin	13,769	0.0	634	1.8%
Burkina Faso	13,700	0.0	956	1.6%
Antigua & Barbuda	12,113	4.8	322	3.7%
Mali	11,553	0.0	465	1.6%
Swaziland	11,135	0.4	454	–
Laos	9,054	0.0	308	4.3%
Djibouti	8,163	0.7	370	0.3%
Belize	7,123	1.8	414	3.5%
Central African Republic	5,763	0.0	234	3.9%
Chad	5,056	0.0	95	–
Gambia	4,265	0.4	216	3.0%
Guinea–Bissau	4,210	0.4	231	2.2%
St. Lucia	3,499	1.5	191	4.2%
Solomon Islands	3,327	0.4	161	0.0%
Nauru	3,272	12.5	139	0.9%
Seychelles	3,001	2.2	161	2.4%
Cape Verde Islands	2,810	0.4	114	2.2%
Samoa	2,730	0.7	132	0.9%
Grenada	2,451	1.8	169	–
Vanuatu	2,001	0.4	62	0.0%

Country	Cumulative CO_2 emissions (1950–1995) (thousand metric tons)	CO_2 emissions per capita (1995) (tons/person)	Total CO_2 emissions (1995) (thousand metric tons)	Projected growth in CO_2 emissions (averaged from 1992–1995)
Bhutan	1,755	0.0	238	8.4%
St. Kitts–Nevis	1,623	2.2	95	–
Maldives	1,605	0.7	183	7.7%
Dominica	1,319	1.1	81	–
Comoros	1,290	0.0	66	0.0%
Kiribati	791	0.4	22	0.0%
Cook Island	641	1.1	22	0.0%
Niue	92	1.5	4	0.0%
Eritrea	0	–	–	–
Lichtenstein	–	–	–	–
Monaco	–	–	–	–
Namibia	–	–	–	–

Source: Carbon Dioxide Information Analysis Center. Datset: Global, Regional, and National Annual CO_2–Emissions from Fossil–Fuel Burning, Hydraulic Cement Production, and Gas Flaring: 1751–1995; http://cdiac.esd.ornl.gov/ftp/ndp030/

APPENDIX II—Illustrative Example of Three Tiers

Below are the countries that would fall into the three tiers advocated by this paper—"Must Act Now," "Should Act Now, But Differently," and "Could Act Now"—in an example using the following steps and rules:

Step 1—Group countries into "high," "middle," and "low" for each of the three criteria, using the data in Appendix I. For Standard of Living, "high" countries would be those above whose GDP per capita is above the average; the "middle" countries would be those between the average and the median; the "low" those below the median. Opportunity is divided in the same manner. This division follows the algorithm used in the three graphs in the text.

Responsibility is more complex. First, the Cumulative CO_2 (1950–1995), Total CO_2 (1995), and Per Capita CO_2 (1995) variables are each divided as above. The Growth (average 1992–95) variable is divided by designating "high" countries as those above the median, "middle" as between the median and the average, and "low" as below the average. These four designations are then averaged into an index. A country with an index of 1 or greater but less than 2 is considered "high." Countries with an index of 2 or greater but less than 2.75 are designated "middle;" the rest are "low."

Step 2—Divide countries into the three tiers using the variable rankings from Step 1 and the following rules:

1. *A country is considered to be in the "Must Act Now" tier if it is "high" for both Standard of Living and Responsibility, regardless of the Opportunity ranking.*
2. *A country who is "middle" for any two criteria is in the "Should Act Now, But Differently" tier; same for "low" rankings for any two criteria and the "Could Act Now" tier.*
3. *All other combinations are in the "Should Act Now, But Differently" tier.*

In practice, if a country is an Annex B country (of the Kyoto Protocol), it is considered to be in the "Must Act Now" tier, even if the Opportunity grouping is not "high." Similarly, a country who is a current IDA-eligible borrower (according to the World Bank standards) is a "Could Act Now" country, even if Opportunity or Responsibility is "middle."

In the cases where some data was missing, the country was not ranked unless the Responsibility was "low," in which case the country was added to "Could Act Now."

Using this example procedure, the countries fall into the following tiers:

"Must Act Now"—Tier 1

Argentina
Australia
Austria
Belgium
Canada
Chile
Czech Republic
Denmark
France
Germany
Greece
Israel
Italy
Japan
Korea, South
Kuwait
Malaysia
Mexico
Netherlands
Norway
Portugal
Saudi Arabia
Singapore
Slovenia
Spain
Thailand
United Arab Emirates
United Kingdom
United States
Venezuela

"Should Act Now, But Differently"—Tier 2

Algeria
Azerbaijan
Belarus
Belize
Brazil
Bulgaria
China
Colombia
Ecuador
Egypt
Estonia
Finland
Gabon
Georgia
Hungary
Iceland
India
Iran
Ireland
Jamaica
Jordan
Kazakhstan
Kyrgyz Republic
Latvia
Lithuania
Mauritius
Moldova
New Zealand
Oman
Panama
Papua New Guinea
Paraguay
Peru
Philippines
Poland
Romania
Russia
Slovak Republic
South Africa
Suriname
Sweden
Switzerland
Syria
Tajikistan
Trinidad & Tobago
Tunisia
Turkey
Turkmenistan
Ukraine
Uruguay
Uzbekistan
Yugoslavia

"Could Act Now"—Tier 3

Albania
Angola
Armenia
Bangledesh
Barbados
Benin
Bhutan
Bolivia
Botswana
Burkina Faso
Cambodia
Cameroon
Cape Verde Islands
Central African Republic
Chad
Comoros
Congo, Democratic Republic of
Congo, Republic of
Cook Islands
Costa Rica
Cote D'Ivoire
Djibouti
Dominica
Dominican Republic
El Salvador
Eritrea
Ethiopia
Fiji
Gambia
Ghana
Grenada
Guatemala
Guinea
Guinea-Bissau
Guyana
Haiti
Honduras
Indonesia
Kenya
Kiribati
Korea, North
Laos
Madagascar
Malawi
Maldives
Mali
Mauritania
Mongolia
Morocco
Mozambique
Myanmar
Nepal
Nicaragua
Niger
Nigeria
Niue
Pakistan
Samoa
Senegal
Sierra Leone
Solomon Islands
Sri Lanka
Sudan
Swaziland
Tanzania
Togo
Uganda
Vanuatu
Vietnam
Yemen
Zambia
Zimbabwe

Endnotes

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31. Parson, Edward, and Richard Zeckhauser, "Equal Measures or Fair Burdens: Negotiating Environmental Treaties in an Unequal World," in *Shaping National Responses to Climate Change: A Post-Rio Guide*, Henry Lee, editor, 1995, Island Press. [hereinafter Parson and Zeckhauser].

32. Parson and Zeckhauser.

33. Parson and Zeckhauser.

34. Parson and Zeckhauser discuss these and other examples more fully.

35. see, for example, Kinzig, Ann, and Daniel Kammen, "National Trajectories of Carbon Emissions: Analysis of Proposals to Foster the Transition to Low-Carbon Emissions," *Global Environmental Change,* 1998, Vol. 8, No. 1.

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39. see UNFCCC, Preamble.

40. see UNFCCC, Article 2.

41. The authors acknowledge that such a measure does not yield a rich prediction. Using a longer time frame might have provided better estimates for some countries, but the data set used does not have estimates going back further than that for a sizable number of countries.

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