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CLIMATE CHANGE: SELECTED ECONOMIC DIMENSIONS

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Executive Summary

The paper highlights several key economic issues of the climate change debate. Section I states the need to adopt a precautionary approach to the climate change challenge in the face of uncertainty; while Section II illustrates the key economic drivers of climate change. Section III provides an analysis of the economic gains and losses posed by climate change and the inequalities implied by the regional and sectoral distribution of these gains and losses; and Section IV explores potential economic tools for addressing climate change, namely emissions taxes, cap and trade regimes, command and control measures, research and scientific and technological development and land use policies. Section V looks briefly at options for the Caribbean to address climate change. Major recommendations for the Caribbean center on the conduct of further research on the economic impacts of climate change, the accelerated implementation of national adaptation and mitigation plans that need to be accompanied by national capacity assessments and resource mobilization strategies for funding the plans, increased energy efficiency, incentives for technology transfers and innovation, and greater efforts at implementing existing regional policy frameworks such as the Caribbean Disaster Management Framework. Section VI analyzes the key areas where the United Nations can play a critical role in addressing the economic impacts of climate change. The five areas identified center on: (a) Promotion of sustainable development and implementation of United Nations conventions and treaties; (b) Support to the development and transfer of energy-efficient and renewable energy technologies from developed to developing countries; (c) Facilitating international coordination and actions for the continued reduction and removal of greenhouse gas emissions from the atmosphere; (d) Mobilizing public opinion on the impacts of climate change and needed policy responses; and (e) Mobilizing finance for climate change adaptation and mitigation. Section VII concludes by highlighting the need to depart from "business as usual" approaches in order to address climate change.

…..“ Only When The Last Tree Has Died And The Last River Has Been Poisoned And The Last Fish Has Been Caught, Will We Realize That We Can Not Eat Money”…….

…..… “Ce N’est Que Lorsque L’Homme Aurait Coupé Le Dernier Arbre, Contaminé Le Dernier Ruisseau et Pêché Le Dernier Poisson Qu’il Réalisera Que L’Argent N’est Pas Comestible”….

…..“ Solamente Cuando El Último Árbol Esté Muerto, El Último Rio Esté Envenenado Y El Último Pez Esté Atrapado, Entenderemos Que No Se Puede Comer Dinero”……..

(Native American Indian Proverb, Source: Unknown)

Sustainable development is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
(*Our Common Future, World Commission on Environment and Development, 1987)*.

CLIMATE CHANGE:
THE NEED FOR ACTION IN THE FACE OF UNCERTAINTY

[We are much better off to act to reduce CO^2 emissions substantially than to suffer and risk the consequences of failing to meet this challenge…]

Kenneth Arrow, 1972. Nobel Prize Winner in Economics.

Climate change, global warming and greenhouse gases are not new phenomena. On the contrary, they are naturally occurring phenomena that are essential for the right regulations of activities on earth and for life on earth to prevail. However what is new is man's contribution to the "greenhouse effect" and "global warming" phenomena through the pursuit of industrial activities since the advent of the Industrial Revolution more than 200 years ago. It is argued that man-made activities are causing atmospheric greenhouse gas concentrations to increase thereby intensifying the "greenhouse effect", magnifying "global warming" and causing temperatures on earth to be higher than normal. It is also being argued that these higher temperatures will disrupt, at significant costs, life on earth for plants, animals and humans, and with such devastating consequences that appropriate urgent responses are needed at national, regional and international levels. It is to be noted that the climate system is thought to exhibit threshold or tipping point behavior in which small changes can create large accumulative effects and that past a threshold climate temperature, the planet can shift drastically from one stable climate pattern to a noticeably different one (Alley et al, 2003).

Two main schools of thought can be identified in the climate change debate[1]:

"Wait and see and do nothing for now as there is too much uncertainty": Some argue that climate change, global warming and greenhouse gas effects have both "naturally occurring" and "man-made or induced" components and that it is impossible to ascertain which components are mainly responsible for current observed increases in the earth's temperature (natural climate variability vs. human induced climate change). According to this school, even if it can be ascertained that the earth's temperature increase is due mainly to man-made activity, its impact in the long term is uncertain as the climate system is highly unpredictable and, furthermore, the costs for curbing the Greenhouse Gas Emissions (GHG) responsible for man-made global warming may exceed the benefits. In the face of such uncertainty, the best option is to "do nothing" and for "business to remain as usual".

[1] See http://www.bbc.co.uk/climate/evidence/sceptics.shtml for the arguments put forward by climate change skeptics.

Types of uncertainty

Much uncertainty exists in regard to the issue of climate change:

(a) Scientific uncertainty on the portion of GHG emissions that remain trapped in the atmosphere, the amount needed to create changes in global climate, the speed with which GHG emissions can create changes in climate and the distribution of any global climate change around the world and by regions (Source: US Congressional Budget Office, 2003);

(b) Scientific uncertainty on the quantitative impact of GHG emissions on the carbon cycle and its feedback effects on climate; uncertainty on the interactive effects between increased GHG atmospheric concentrations and the climate and eco systems; and uncertainty as to the magnitude of increases in GHG concentrations that can produce threshold effects on the climate system and cause it to vacillate from one pattern to a drastically different one (Source: US Congressional Budget Office, 2003);

(c) Uncertainty at an economic level in terms of appropriate economic decision-making, choice of economic policies, costs and impact of policies, and size of economic losses and gains, for example, uncertainty about future GHG emissions induced by population and economic growth; uncertainty about future increased demand for energy and fossil fuel use; uncertainty over technological developments in the future and its impact on GHG emissions and energy use; uncertainty over preferences of future generations regarding preserving the environment, to cite a few. (Source: US Congressional Budget Office, 2003).

"The costs of inaction in the face of uncertainty are too high": The other school of thought led by the United Nations and in particular the Inter-Governmental Panel for Climate Change (IPCC), a scientific inter-governmental body set up by the World Meteorological Organization (WMO) and the United Nations Environmental Programme (UNEP), argues that there is enough credible scientific evidence to suggest that man-made activities are hastening the pace of increases in GHG emissions and subsequently the pace of rising temperature; and that the consequences of such increases demand coordinated responses by the international community.

In its latest report (Fourth Assessment Report titled "Climate Change 2007"), the IPCC, made a series of conclusive remarks on the basis of existing scientific evidence and viewpoints of the scientific community that climate change is a reality[2]. Meanwhile, a paper published in 2006 in "Science" by Rignot and Kanagaratnam from National Aeronautics and Space Administration (NASA) Jet Propulsory Laboratory finds evidence that Antarctica, which hitherto was thought to be largely untouched by global warming, has been losing ice for the past 40 years and at an accelerated pace for the past 10 years, mainly on the west coast. It is believed that warming of the seas in the 1980s has led to changes in wind patterns that have in turn brought warmer waters to the shore of Antarctica leading to melting (Source: Martinson, Columbia University). The same authors report evidence that the Greenland glaciers are melting faster than originally estimated. Ice melting from Greenland pouring into the Atlantic has doubled in the last five years.

[2] See ECLAC LC/CAR/L.149 and IPCC, 2007 for details of the scientific evidence.

Although the scientific evidence can only be reported within confidence intervals and carries a margin of uncertainty, this school argues that the costs of inaction in the face of uncertainty will be high. As the economist Milton Friedman once said, it is better to be vaguely right than precisely wrong. In a climate change context, the argument goes that the potential costs to society's welfare for not addressing the impacts of climate change because no precise scientific evidence exists will far outweigh the costs of addressing it through specific measures. In other words, the inter-generational cost-benefit analysis on climate change indicates that society stands to gain by addressing climate change. After all, humans live in a world of imperfect knowledge and imperfect information; decisions are made under conditions of uncertainty at all times; uncertainty cannot be an excuse for inaction.

Endorsement of the precautionary approach in the face of uncertainty

As a matter of fact, the international community has adopted what is known as the "precautionary approach" or "precautionary principle", which constitutes Principle 15 of the Rio Declaration on Environment and Development. This latter principle states that "*In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation*". This approach has been applied in several United Nations conventions and treaties (e.g. Article 6 of the 1995 Agreement on Fish stocks and Highly Migratory Fish Stocks, Convention on Biological Diversity and Article 3.3 of the Convention on Climate Change). It has been invoked by the International Court of Justice as well as used in national laws and regulations (e.g. Australia, Israel and Pakistan). The basis of the precautionary principle are that: (a) Precautionary measures must be adopted to curb an activity if that activity raises the risk of harm to human health or the environment even if scientific cause and effect relationships are not yet fully established. This implies taking a pro-active, pre-emptive stance towards curbing threats on human health and the environment and anticipating future developments in scientific evidence; (b) The burden of proof regarding lack of harm should be shifted towards those undertaking the activity; (c) The opinions of those whose lives stand to be affected by the decisions made during the course of the activity need to be taken into account; and (d) it is important to set goals, monitor scientific evidence, heed early warnings and adopt corrective measures (Source: Science and Environmental Health Network). The international community has endorsed the use of this approach that amounts to "erring on the side of caution" when dealing with preserving and protecting forms of life and the environment[3].

However, endorsement of this principle not-withstanding, it is widely accepted within international circles, that there is enough credible scientific evidence to warrant action in terms of adaptation to climate change (with short and medium-term impact) and mitigation (for long-term impact). In the words of Yvo DeBoer, Executive Secretary of the United Nations Framework Convention on Climate Change (UNFCCC) at the United Nations Climate Change Conference in Bali in December 2007, *[……Early in the year, scientific evidence of global*

[3]. There are subtle differences between the precautionary principle and the precautionary approach. See http://en.wikipedia.org/wiki/Precautionary_principle for more details. It is to be noted that the application of the precautionary principle remains to be more effectively enforced in many countries and spheres of decision-making.

warming, as set out in the fourth assessment of the Intergovernmental Panel on Climate Change (IPCC), put the reality of human-induced global warming beyond any doubt…].

CLIMATE CHANGE FROM AN ECONOMIC PERSPECTIVE: THE TRAGEDY OF THE GLOBAL COMMONS, MISSING MARKETS AND COORDINATION PROBLEMS

Climate change is undoubtedly a multi-dimensional problem, be it environmental, social, cultural, economic, financial, technological and political. However, it is important to understand the specific economic characteristics of the natural resources being impacted by climate change, namely air resources and the associated climate change system in order to understand the causes of climate change as a phenomenon and appreciate the challenges in responding to it. In a nutshell, the basis of the climate change problem comes down to the fact that air is a common global natural resource on which all countries depend, which is, however, not owned by any specific country and for which no country is willing to pay to maintain quality because it is a global resource that transcends artificial political boundaries and territories. The absence of a clearly defined property rights system over the global resource leads to a situation of over-exploitation and degradation. This is a situation that economists refer to as "the tragedy of the global commons". While *collectively* it is in the common interest of each user party to protect the resource to ensure *long-term benefits through continued use*, *individually* each user party does not find it in its interest to spend money to protect the resource in the *short term* for various reasons:

(a) In case others "free-ride" (that is, use the resource without investing in its maintenance while reaping the benefits of protection provided by others). Alternatively, "free-riding" may the best course of action for all (every user finds it beneficial to wait for someone else to pay to protect the resource with the outcome that in the end no one protects the resource);

(b) Because at the margin the benefit from using the resource is less than the cost incurred for protecting it.

To understand the causes of climate change, there is a need to understand the fundamental economic drivers of the climate change problem. A few of these drivers are listed below.

Driver 1: A market for pricing the resource, earth's clean atmosphere, is missing. Whenever an economic resource is not transacted through a market and its use is not "priced", it is likely to be subject to "over-utilization". The Earth's clean atmosphere is subject to "free", unrestricted use as a "dumping place" for pollutants. As a result of the lack of pricing, an excessive amount of pollutants finds its way into the clean atmosphere.

Driver 2: The non-existence of markets for transacting atmospheric pollutants and for utilizing the clean atmosphere can in turn be ascribed to the absence of certain economic conditions that are necessary for markets to arise.

One such condition is "excludability" in consumption. Markets for the consumption of private economic goods arise because it is possible to exclude consumers who do not pay to consume the good from consuming the good, while those consumers who do pay to have access to the good are the only selective end–users of the good in question. For instance, one cannot drive a car and enjoy the benefits of owning a car unless one buys a car; one cannot enter a cinema to watch a movie and enjoy the benefits of movie-watching unless one buys an entrance ticket at the cinema. In these cases consumption is "excludable" meaning it is possible to exclude those who do not pay to get access to a good from enjoying the benefits of consuming the good. In the case of the earth's clean atmosphere, it is clear that consumption is "non-excludable". It is not possible to bar countries or manufacturers from access to the clean atmosphere or its benefits.

The second condition needed for a market to arise is for consumption to be "rival". For private economic goods transacted in a market, their consumption is "rivalrous", that is, one unit of the good consumed by one economic agent reduces the amount of the particular good available for other agents to consume. When a car gets sold, there are fewer cars available to be sold on the market; rivalry in consumption creates scarcity to the consumer and such scarcity in supply of the good creates a market value for the good. In the case of the atmosphere, it is clear that the amount of air (polluted or clean) breathed by one person does not diminish the amount of air available to others. Consumption of clean air is "non-rivalrous", thereby making it difficult to generate a value for clean air.

Goods and resources that are both "non-excludable" and "non-rival" in consumption, such as a clean atmosphere, actually belong to a category of goods that economists label as "public goods", as distinct from private goods. Private goods are transacted in markets, exchanged between buyers and sellers at a price; they are subject to clear ownership rights by the buyers giving them a vested interest to protect the value of the good; they are readily supplied by private sellers as the latter stand to profit from the sale of the good. Public goods, on the other hand, display opposite features. No private seller is willing to supply a public good as he will not be able to exclude those who do not pay from consuming the good and in the end no buyer will be willing to pay to consume it. There is a free-riding problem that ultimately leads to under-provision of the good. There are no ownership rights over the good or resource and consequently there is no market for that good or resource. When public goods are such that benefits from their consumption transcend borders, generations and population groups, they are referred to as "global public goods". Clean air is one such global public good in the same line as global peace and security or unpolluted oceans. Clean air as a global public good tends to be under-supplied in the absence of a market for it. In these cases a collective action mechanism at the international level is needed to undertake supply. Conversely there are also "global public bads" and polluted air is an example. These are bads that are not "owned" or generated by any single entity and consequently no one entity can be made to account for it. It is the outcome of collective irresponsible behavior across borders, generations and population groups and resolving the "over-supply" of these bads again necessitates collective action at an international level.

Driver 3**:** A fundamental characteristic of a "global public good", such as a clean atmosphere, is the absence of property rights over its ownership and use that leads to a problem of "under-provision". And in the case of "global public bads" such as polluted air, the absence of a property rights leads to a problem of "over-provision". Clearly the absence of property rights over the earth's atmosphere is a key driver of global climate change. The earth's atmosphere is a global commons free to be used by all and yet owned and protected by no country in particular. Consequently no country wants to bear the costs associated with cleaning up the atmosphere. There may be a need to create at an international level an institutional body for managing and regulating access of polluted air to the Earth's atmosphere.

Driver 4: Associated with "global public goods" subject to "missing markets" and undefined property rights, there is also the issue of "externalities". In the case of the earth's atmosphere, as in all other global public goods or public bads, there is a strong inter-dependency among economic agents in the outcomes of their actions and decisions. Such inter-dependency is reflected in what economists term "externalities". Externalities are spillover effects imposed on third parties arising from the production or consumption of a good and for which no compensation is made to these third parties. In the case of the Earth's atmosphere, any activity undertaken by a consumer or producer that releases pollutants to the atmosphere or impacts on the climate change system imposes an effect on others who may be dependent on the Earth's climate system, but at no additional costs to those undertaking the activity. The existence of these externalities drive a wedge between the social costs and private costs of consuming or producing any good that, in the course of its production or consumption, impact on the earth's atmosphere, and this wedge leads to an "over-provision" of that good in relation to what is socially optimal.

Figure 1: Positive Externality
Divergence between Marginal Social Benefit and Marginal Private Benefit

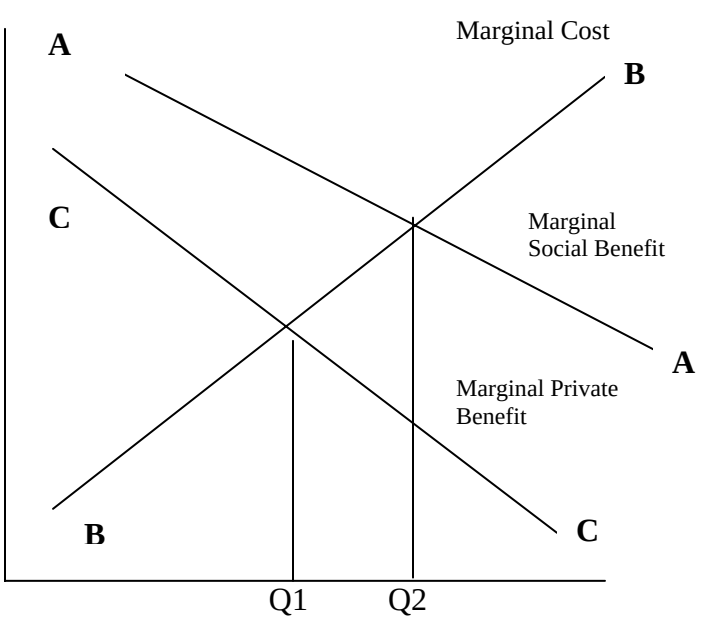
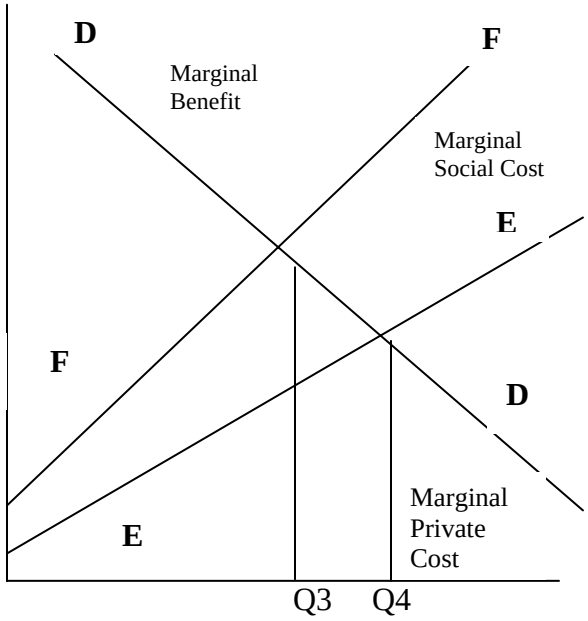


Figure 2: Negative Externality
Divergence between Marginal Social Cost and Marginal Private Cost



As a further example, the market for the production of chemicals can be considered. It is assumed that the manufacture of chemicals generates polluted air where the amount of polluted air emissions increases proportionately to the amount of chemicals produced. Each manufacturer of chemicals derives a profit or private benefit from production and it is plausible to assume that the marginal private benefit from an additional unit of production falls as production increases[4] (Line DD in Figure 2).

The production of chemicals necessitates two types of costs: a private cost of production incurred by the individual manufacturer and a cost imposed on society due to the by-product released during the production of chemicals, that is, polluted air which causes harm to the environment and humans. Both the marginal social cost and marginal private cost of production are likely to increase as production increases. The optimal level of production for the manufacturer (the "individual optimum") is Q4 (see figure 2), where his profits are maximized (where marginal private cost equals marginal benefit from an additional unit of production). However, the optimal level of production from society's point of view (the "social optimum") is Q3 where the marginal social cost equals marginal benefit from an additional unit of production. Social welfare is higher with a lesser amount of production of chemicals (Q3 instead of Q4) due to the costs imposed by polluted air emissions. However since the private producer fails to internalize the costs of his actions on others in his decision-making, he often produces an excessive amount of chemicals that generate an excessive amount of pollution (a negative externality).

Conversely investing in clean technologies that filter polluted air into clean air can be considered. Any manufacturer that invests in such technology incurs a marginal private cost (line BB in figure1). It may also incur a marginal private benefit (line CC), for instance, if the technology allows it to increase its marginal revenues and profits by building an image as a "clean manufacturer" engaging in corporate social responsibility. However society as well incurs a marginal benefit (line AA) owing to reductions in polluted air emissions. The manufacturer finds it profitable to invest in the clean technology and produce clean air emissions up to the point where marginal private cost equals its marginal private benefit to maximize its own profits (Q1 in figure 1). Society, on the other hand, will like to see a bigger investment resulting in larger clean air emissions at Q2 where social welfare is maximized (this is where marginal social cost equals marginal social benefit). However the "individual" optimum fails to match the "social" optimum as the manufacturer does not internalize the benefit derived from society in his profit maximization calculus. These examples illustrate how a divergence between private costs or benefits and social costs or benefits leads to too much of the wrong good being produced (polluted air) and not enough of the right good being produced (clean technology resulting in clean air). The key to any sustainable solution therefore lies in bridging the divide between marginal private costs (or benefits) and marginal social costs (benefits) so that markets can function more effectively by accurately pricing the good or resource being transacted.

As exemplified in Figure 2, the production of chemicals releases an excessive amount of pollutants in the atmosphere. There is a divide between the social cost and the private cost of producing chemicals which reflects the externality created during the course of chemicals

[4] The marginal benefit curve corresponds to the demand curve for chemicals.

production (social cost = private cost + externality) and this externality leads to an excessive amount of polluted air. The presence of such externalities is another key driver of climate change. There is a need to introduce economic instruments (such as carbon taxes) that will allow agents to internalize "externalities" created in the course of the activity they are undertaking in their decision-making calculus.

Driver 5: Another economic driver of climate change consists of coordination challenges arising from collective action problems. Even if "utilization" of the earth's atmosphere cannot be regulated through a market-price mechanism, the climate change problem can still be mitigated if all countries were to agree on exercising deliberate restraint in their production of atmospheric pollutants and any other economic activity that may harm the climate system. This will require countries to place the "collective interest" above their own "individual national interests", or to value the "social optimum" above their own "individual optimum". However it is usually rational for any individual entity to pursue its own interests (where its individual pay-off is higher) rather than to pursue the collective interests (where its individual pay-off may be lower). If each and every individual entity pursues its individually rational course of action (the individual optimum where its individual return is maximized), in the end the course of action leading to the "social" optimum or "collective good" may not be implemented and as a result collectively everybody is worse off (which is referred to as the collective action problem). This situation where the sum of individually rational actions across all individuals does not add up to the "collective best situation" can best be illustrated by what economists refer to as the Prisoner's Dilemma.

Prisoner's Dilemma in a climate change context

The Prisoner's dilemma game[5] when applied to the climate change context can be relevant in highlighting the coordination challenges that bedevil the mitigation of the global climate change problem. The collective action problem is another key economic driver of climate change as the following hypothetical example will demonstrate.

Suppose there are two neighboring countries A and B that currently have a well-developed but declining industrial sector that generates atmospheric pollutants. Suppose both countries currently have a severe pollution problem that represents a burden on their medical systems and is hindering the development of their eco-tourism sector that has the potential to supersede industry as a key engine of development. Both countries can opt to cooperate by each reducing their polluted air emissions continuously and simultaneously every year for the next five years (by allowing their industrial sector to contract every year) in return for reaping an expansion of their Gross Domestic Product in five years (say equivalent to 10% of their current GDP as a result of a booming eco-tourist sector). On the other hand, if one country defects in the fourth year, then the other country reaps a loss of 8% of current GDP in the fifth year due to losses in both its contracting industrial sector and the non-materialization of the expected gains from tourism. Suppose the country that defects on the other hand gains by reneging on the agreement. It gains 12% of its current GDP by gaining market share in industrial activity and reaping the benefits of partial reduced air emissions from the other country. If both countries defect on the agreement in the fourth year, the net gains to each country, however, are zero. The

[5] For further details about the Prisoner's Dilemma, see http://en.wikipedia.org/wiki/Prisoner's_dilemma.

matrix below summarizes the strategies and associated payoffs in five years for each country in terms of gains or losses as a percentage of current GDP.

Country B

Country A		Cooperates	Defects
	Cooperates	(+10, +10)	(-8, +12)
	Defects	(+12, -8)	(0,0)

In this game-theoretic set up, the dominant strategy for each player, if each is to pursue its individual interest and maximize its own pay-off, is to defect, irrespective of what the other does. Each country by pursuing its own individual interests ends up defecting at some point within the five-year interval. Both countries end up in a sub-optimal outcome, which amounts to zero net gains in GDP rather than in the first-best outcome, which is for both to cooperate and switch from a declining industrial sector to a booming eco-tourism sector that will have allowed them to increase their current GDP by 10%. This hypothetical example illustrates how countries can end up in the worst case situation by allowing their individual national interests to take precedence over the collective interests, leading them to fail to cooperate and fail to commit to an agreement. The global climate change problem is driven by a collective action problem, arising from countries failing to subordinate their national interests to collective world interest and failing to enter in sustainable agreements. There is a need for a third-party mechanism to enforce international cooperation and lead countries to enter into binding commitments that are self-enforcing over time. This is in essence what the Kyoto Protocol and its successor aim to achieve.

Driver 6: Another economic driver of climate change that relates directly to the sustainability (or inter-generational) dimension of the climate change problematic is myopic behavior and the associated high social rate of time-preference of current generations. In this context, it is important to understand the concept of discounting and the discount rate. Usually people value present consumption (or income) more than future consumption (or income), that is a dollar today is worth more than a dollar tomorrow. By how much more is quantified by the discount rate[6]. The more impatient people are with respect to the present as opposed to the future (the higher their time preference), the more they value a dollar today relative to a dollar tomorrow and the higher is the discount rate, all else equal. The discount rate allows the calculation of the net present value of a dollar, that is how much a dollar tomorrow is worth today. The higher the discount rate, the lower is this net present value.

In the inter-temporal welfare maximization problem of society, it may be assumed that society as whole wants to choose welfare for each generation in order to maximize the net present value of welfare across generations i.e.

[6] The (social) discount rate or social rate of time preference is the pure rate of time preference (PRTP) plus the product of the income elasticity of the marginal utility of consumption and the growth rate of per capita real consumption. See Guo et al in Environmental Science and Policy Vol 9, 2006 for further details.

$$\text{Max } V = \text{Max } [W_0 + W_1/(1+r) + W_2/(1+r)^2 + W_3/(1+r)^3 + W_i/(1+r)^i \ldots\ldots\ldots] \quad \text{Eq (1)}$$

Where W_i = welfare of generation i; r = constant discount rate; V = net present value of the stream of welfare across all generations. A society that has a higher discount rate (higher value of r) will value the welfare of current generations more than that of future generations because it has a stronger preference for the present over the future. Such a society will be less inclined to engage in the sustainable management of natural resources compared to societies that have a lower discount rate. This society will be less willing to postpone today's industrial production for future times in order to curb air emissions in the present. It will also be less willing to invest in clean technologies today to reap higher consumption tomorrow. When societies have a high discount rate, the net present value of future streams of welfare are low and more emphasis is laid on maximizing current welfare (W_0) as opposed to future welfare (W_1, W_2 and so on) in order to maximize V. The higher the discount rate, the more myopic people are, meaning they place greater weight on maximizing current welfare as opposed to future welfare.

However, the climate change problematic requires current generations to value the welfare of future generations and be willing to restrain current economic activity (and incur the losses of lower income and lower consumption today), in order to safeguard the climate change system for future generations and maintain welfare at high levels in the future. Clearly any climate change policy will be successful only if it is accompanied by a lowering of the discount rate of societies and takes into account variations in the discount rate across societies. It is important therefore to understand the determinants of the discount rate. The discount rate reflects a society's inter-temporal and distributional choices. Discount rates are likely to vary according to a number of factors including the level of wealth and development of societies (richer and highly educated ones may be less impatient about the future and more willing to sacrifice already high current levels of consumption for future generations). Discount rates can also vary in accordance with investment opportunities (societies with a greater investment potential may be more willing to postpone current consumption for future ones); inflation rates and market interest rates; cultural norms and social capital; preferences towards inequality, life expectancy, uncertainty and state of technology, among others. Societies that face technological growth, for instance, may be less willing to sacrifice production today, curb air emissions today to safeguard higher consumption for future generations if it is believed that the costs of reducing air emissions are likely to go down in the future with better technology. In general the higher the time preference of societies and the higher its discount rate, the likelier it is for that society to engage in myopic behavior, to value short-term welfare more than long-term welfare. The more challenging it will be to get agents in that society to curb air emissions and postpone today's production and consumption for the future.

Driver 7: In the inter-temporal welfare maximization problem faced by society as described by equation (1), the generation at the start of the time horizon (say time T_0) needs to set the level of welfare Wi for each future generation i in order to maximize V, the net present value of the stream of welfare across all generations. This requires generation T_0 to determine the optimal time path of production, consumption and welfare for the remaining time periods or generations, an optimal path that is denoted as X*. However such an inter-temporal maximization problem can be subject to what economists call the "time inconsistency" problem, that is, over time

preferences change and future generations may choose at subsequent time periods not to commit to X*, as determined at T_0 by the previous generation. Future generations may alter that optimal path and choose to put more weight on its own welfare than on the welfare of the generations to come. Or each generation may find it optimal to pass the burden of air emission reductions onto the next generation. If each generation chooses to maximize its own welfare while ignoring the welfare of future generations, sustainability in consumption and production cannot be achieved. In a climate change context, the time inconsistency problem explains why an agreement negotiated at time T_0 to reduce air emissions by a certain percentage over a future time horizon can be reneged over time. Commitments become non-binding. It is not possible for the current generation to restrain the behavior of future generations. Even if at present all countries could agree over a time schedule for curbing air emissions, there is no guarantee that subsequent decision makers will commit to that schedule.

To recap, the climate change problematic is an exemplification of the "tragedy of the global commons" where there is a finite resource (planet earth's atmosphere including the ozone layer) that is subject to free, unregulated common access by all. The lack of a market for the utilization and sustainable management of the resource (missing market), the absence of an institution and/or rule-based property-rights regime for regulating access to the resource (institutional failure) as well as the presence of externalities (market failure) create problems of over-use and lack of sustainability in use of the atmosphere. In addition coordination problems, high discount rates, myopic behavior and time inconsistency compound the challenges of finding long-term sustainable solutions to curbing air emissions in order to maximize global long-term welfare.

ECONOMIC GAINS AND LOSSES AND DISTRIBUTIONAL IMPLICATIONS OF CLIMATE CHANGE: THE NEED FOR A BALANCING ACT

At the heart of the climate change problem lies profound welfare distributional issues that can be characterized at three levels:

(a) An inter-generational distributional issue relating to how climate change will alter the distribution of welfare between the current generation and future generations. In this context, technological development will play a large role in determining gains and losses across generations.

(b) Regional distributional issues relating to how climate change may deepen or narrow the divide between developed and developing countries and exacerbate existing regional tensions. The climate sensitivity of countries to climate change will vary, creating a coalition of "winners" and "losers" depending on the countries' endowments, geographical locations, political clout, stage of technological development and resources, to name a few.

(c) National distributional issues relating to how climate change can exacerbate or narrow down inequalities and tensions within society. Some groups will be more vulnerable to the impact of climate change than others and their participation in the decision-making process will be critical in ensuring that due attention is given to their needs.

An analysis of the distributional impact of climate change at all three levels necessitates an assessment firstly of the physical impact of climate change. This, in turn, requires both an understanding of the natural drivers of climate change and the use of scientific climate models in order to simulate the physical impact of climate change under a set of different scenarios and for a varied set of assumptions[7]. The distributional impact of climate change on countries and social groups within these countries will depend secondly on the regional and sectoral distribution of the physical impact of climate change along with, thirdly, the economic valuation of that regional and sectoral impact. The latter may involve the use of integrated assessment models.

The actual physical impact of climate change over the next decades is likely to depend on a number of factors[8] which include:

(a) Actual climate-carbon cycle feedbacks.

(b) Actual rate of ice loss from Greenland and Antarctica.

(c) Capacity of countries to respond and adapt to climate change and timeliness of response.

(d) The follow up to the Kyoto Protocol and success at curbing air emissions by countries worldwide.

(e) Actual population growth and patterns in world population levels (including timing of a world demographic transition) and changing age–patterns.

(f) Actual rates of economic growth and poverty reduction rates.

(g) Introduction and diffusion of clean technologies and energy efficient technologies.

(h) Actual shifts towards the utilization of renewable energy sources, including bio-fuels.

(i) Utilization rates of fossil fuels and evolution of fossil fuel prices.

(j) Actual shifts towards service-based and information-based economies.

(k) Rates of urban migration.

(l) Acceleration of research and development in the area of climate change including diffusion of climate change modeling at a regional and national level and integration of such research into policy-making.

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[7] Examples of such assumptions relate to future greenhouse gas emissions and aerosol concentrations, physical processes built in the climate change models used and the range of uncertainties assumed in the models.

[8] A few of these factors are reflected in the assumptions made by the IPCC in the construction of its four basic storyline scenarios for calculating emissions (scenarios A1, A2, B1,B2).

(m) Progress in achieving the Millennium Development Goals particularly education and poverty goals and the implementation by countries of United Nations environmental conventions and treaties including the UNFCCC and the Montreal Protocol[9].

(n) Increased globalization and regional integration including migratory patterns of human populations.

(o) Spread of local governance and involvement of local populations and communities in decision-making in areas such as environmental protection.

The IPCC report illustrates some of the sectoral impact of climate change in the areas of freshwater resources; ecosystems; food, fibre and forest products; coastal systems; health and industry and settlements[10] as well as regional impacts.

Our key interest in this section is to present a few examples of the potential economic losses and economic gains that may arise as a result of the sectoral and regional impact of climate change and the concurrent distributional implications of these gains and losses across generations, countries and social groups within countries. Climate change will produce a coalition of winners and losers. In the face of uncertainty, identification of these winners and losers should become more precise as time unfolds and greater information is generated. However current research does allow us to make some preliminary inferences about the gains and losses.

Economic Gains and Distributional Impact

A window of opportunity for investment and reform

Climate change is likely to generate incentives for substantial investment in clean technologies, in more resilient infrastructure and in disaster prevention and mitigation facilities as well as incentives for innovation in several sectors ranging from industry to agriculture (e.g. weather-resistant crops). Such investments could generate increased aggregate demand for a new range of goods and services, create new jobs as well as generate increases in productivity. Challenges and economic shocks bring in their wake opportunities to engage in corrective behavior that can shift the world on a higher, sustainable development path. The rise of Japan and Germany after the Second World War has been attributed by some economists to the fact that the war destroyed inefficient institutions in these countries[11] that allowed them later to reform their institutions and invest in higher productive technology that eventually shifted them on a higher long-run growth path (Olson's hypothesis). Climate change can be viewed as offering a "window of opportunity": climate change is an economic and environmental shock that can allow countries to reform their legislation, policies, and institutions in order to veer from

[9] See ECLAC Port of Spain Focus Newsletter (Issue 3 July-September 2008) for a list of the major United Nations conventions, treaties and protocols in the area of sustainable development.
[10] See IPCC Fourth Assessment Report (2007) – Synthesis report for policy makers- Table SPM2 and SPM3.
[11] Arguments of institutional sclerosis.

a path of low sustainable development towards a long-term path of high sustainable development.

The word "can" however is emphasized here, as turning that opportunity into a concrete economic gain will depend crucially on the ability and willingness of the political system of countries to institute and implement reform in a timely fashion and go beyond the mere myopic behavior that electoral cycles and interest group politics may dictate. Reforms will need to be broad-based and will need to include, among others, substitution away from a fossil-based economy towards a renewable-energy based economy, substitution towards cleaner and energy-efficient technologies and infrastructure, coastal planning and management, the integration of disaster risk in urban and rural planning as well as the implementation of zoning plans and the integration of environmental considerations in economic decision-making. The size of the long-term economic gains reaped from climate change will be greater the earlier reforms are implemented and the deeper the reforms. However as populations bear the costs associated with climate change in the years to come, it is to be expected that a constituency for such reforms will in turn arise. Pressure for change and reform could rise from below. Politicians and businesses would increasingly need to heed the discontent of their voters and consumers and engage in sustainable decision-making in order to maximize their own interests.

Winners in agriculture, tourism and shipping

Climate change will alter patterns of comparative advantage in the production of several goods and services due to changes in climatic conditions and due to variations in the magnitude and distribution of global warming across regions. Shifts in comparative advantage across regions are likely in agriculture, tourism, shipping and oil drilling. As temperatures increase, more moisture will evaporate creating higher and longer precipitation in some areas. Some dry regions may experience an increase in rainfall which will benefit their agricultural sector. Other countries will gain as the crops they currently produce experience increases in yields or as crops that hitherto they could not grow are now fit for plantation. According to the IPCC 2007 Report, crop productivity may increase in certain areas (mid to high latitude ranges) and depending on the range of temperature increase (1 to 3 degrees celsius). A big projected winner is the Northern Corn Belt in the United States where corn, wheat and soybeans are expected to grow in yields (Doering, 2002). Other projected winners are Canada, Russia, Mongolia and northern Europe where global warming will liberate frozen zones for agriculture, forest expansion and drilling for minerals, including oil, while increased shipping routes (for example, through the Artic) might reduce shipping costs and lower export prices. Warmer waters in some areas will also bring more fish stocks. Greenland has reported an increased in catches of cods and higher farming yields from warmer temperatures. The migratory patterns of marine animals and birds will change, benefiting some areas. Mendelsson, a leading environmental economist from Yale University, has argued that regions closer to the equator are likely to experience losses in their Gross Domestic Product (GDP) while regions closer to the Poles may gain. As temperatures rise in the regions close to the northern poles, these regions can also benefit from increased tourism. A group of economists from the Economic and Social Research Institute (Tol et al, 2006) predicted that climate change may create shifts in patterns of world tourism by the end of the century with tourism doubling in colder countries and falling by 20% in warmer countries. Currently warm tourism hot spots may become too warm for comfort for the northern tourist as

temperatures rise while currently chillier places may gain. Big projected winners include the United States (+13.7 % in tourism arrivals by 2100), Canada (+220 %), Russia (+174 %) and Mongolia (+122 %) and big losers will include Mauritania (-60 %), Mali (-59 %), Bahrain (-58%), Macau (-48 %), Aruba (-42 %) and Jamaica (-30 %).

Savings/increases in energy consumption

Climate change is likely to be accompanied by changes in the pattern of energy demand worldwide. Northern areas close to the poles are likely to be able to reduce their energy demands in winter as temperatures rise though any gains might be offset by accrued energy needs in summer for air cooling. Caribbean countries, on the other hand, may experience an increase in energy demand due to warmer summers[12].

The emergence of "green" technologies, "green" businesses, "green jobs" and "green" economies

An industry segment likely to prosper as a result of the climate change debate is what can be referred to as "green" industries. These will be industries focusing on seeking alternatives to the use of fossil-fuel such as "green energy" industries (bio-fuel, solar power, wind-power or geo-thermal power companies and their suppliers); industries devoting research and development to develop energy-efficient and clean technologies (such as fuel cell suppliers, hybrid car makers, pollution control companies, bio-technology firms) and industries devoted to creating a new range of environmentally friendly products and services (such as water purification system suppliers, waste recycling companies and organic food companies). These businesses are likely to benefit from increased policy support from governments eager to combat climate change in the form of subsidies, tax concessions, environmental regulations and mandated legislation. They are also likely to benefit from increased consumer awareness about the need to promote sustainable practices. As governments encourage the build-up of "green" economies and creation of "green" jobs, the "green" industry sector stands to gain in the form of profits and enlarged market sizes. However populations also stand to gain in the form of new jobs. An upcoming report[13] on the creation of "green" jobs, commissioned by UNEP, the International Labor Organization (ILO) and the International Trade Union Confederation (ITUC) will be documenting and analyzing the millions of new jobs that have or are about to be created as countries transit towards greener standards. For instance, the report mentions that a 20% increase in energy efficiency will generate about a million new jobs both in Europe and in emerging and developing countries, and that Brazil's ethanol programme has generated about half a million jobs. In the words of Achim Steiner, Executive Director of UNEP, *"millions of new jobs are among the many silver, if not indeed gold-plated, linings on the cloud of climate change…".*

Overall, however, the size of the economic gains is unlikely to exceed the losses (Source: Climate Institute). Moreover these gains will tend to be located in specific regions especially the northern hemisphere. Countries will need to position themselves early to be able to gain

[12] According to results from the PRECIS Caribbean project, the Caribbean will become warmer and dryer by the 2080s in the annual mean.

[13] "Green jobs: Can the Transition to environmental sustainability spur new kinds and higher levels of employment?, UNEP and ILO and ITUC, forthcoming 2009.

economically from climate change, for example, by encouraging the development of "green" industries through the provision of incentives and the forging of strategic alliances among business, labor and governments. It is important, however, to not depict climate change only as a costly catastrophic event. It must also be borne in mind that climate change can be a window of opportunity for economic gains and national and global transformation. However, reaping these opportunities will demand appropriate economic and environmental policies especially fiscal, energy, technology and industrialization policies.

Economic losses and distributional impact

Mountainous regions at risk: Global warming is likely to cause glaciers to melt in some parts of the world, thereby increasing the risk of glacier lakes overflowing as a result of the melting and creating water-related hazards such as floods, landslides and avalanches. Communities living in such mountainous areas will be vulnerable to increased disaster risk while governments will need to respond through increased infrastructural works (building of dams and drainage systems) and through disaster prevention and mitigation expenditures.

Winter tourism and revenues from skiing will be affected: Global warming is likely to impact on the revenues of countries that have a significant winter-tourism based economy in countries in the northern hemisphere such as Austria and Switzerland or even countries in the southern hemisphere such as New Zealand. According to an Organization of Economic Cooperation and Development (OECD) study (2007), the years 1994, 2000, 2002 and 2003 saw the warmest temperatures on record in the European Alps in the past 500 years. The report notes that while currently about 609 out of the 666 Alpine ski areas are naturally snow-reliable, this number will drop to under 500 for a 1ºC; 404 for a 2 ºC; and under 202 for a 4 ºC rise in temperature. There are likely to be "winners" and "losers". Areas in high latitude that are least climate sensitive and have more resources for adaptation may actually gain as more winter tourists come to their resorts while low-lying areas, that are more climate sensitive, will lose as their winter tourists seek alternative resorts. There is likely to be a loss and a redistribution of income and jobs across winter-based economies.

Increased risks of droughts in dry regions and effects on crop production, food prices and poverty: The IPCC report notes that the Sahelian region in Africa is likely to experience warmer and drier conditions that will impact on the length of the growing season for crops and affect crop production. Parts of southern Africa are likely to experience longer dryer seasons with uncertain rainfalls. Australia is another country that is likely to experience a drop in rainfall in certain areas with climate models predicting a rise in temperature of 2º to 8º C there, accompanied by longer droughts. Dryer seasons that impact negatively on crop production will drive up food prices worldwide especially if production is affected in countries that control a large share of the world food production. The hike in wheat prices in 2008 as a result of potentially climate-change related droughts in Australia is a case in point. Rising wheat prices in 2008 even caused riots in some countries and led the Caribbean Community (CARICOM) to revise its import food policy.

Cattle and livestock production will also be affected. A recent World Bank study by Seo and Mendelson (2007), based on 9,000 farmers across 11 countries, shows that animal

husbandry decisions in Africa are climate sensitive and that the net livestock revenues of large farms will fall as temperatures rise. While small farmers are unlikely to suffer due to their better capacity to substitute for heat-tolerant livestock such as sheep and goats, large farms that are especially reliant on beef and cattle will be less able to adapt. The study also finds that increased precipitation will also affect farmers' revenues as grasslands get converted to forests and animal diseases rise. In general, less rainfall, longer droughts, less food production and higher food prices will feed into greater food insecurity for millions of poor around the world. The shift towards bio-fuels as part of an adaptation strategy for climate change will further add mounting pressures on food prices, as farmers convert their crop lands (wheat, maize, corn) to bio-fuel uses especially in places like America and Brazil that are key worldwide suppliers of staple crops. For instance world corn prices increased in 2008 as more corn producers in the United States, which is the world's leading supplier in corn, shifted to corn-based ethanol production. Rising corn prices in turn drove up wheat prices as wheat is a substitute for corn in the production of feed grain. Population growth will also compound the problem of food scarcity and rising food prices. The International Fund for Agricultural Development (IFAD) has predicted that "the number of food-insecure people in the world would rise by more than 16 million for every percentage point increase in the real prices of staple foods, meaning that 1.2 billion people could be chronically hungry by 2025".

Rising sea-levels, rising ocean temperatures and coastal flooding will affect livelihoods of coastal and fishing communities and marine life: The IPCC reports that sea level rises are likely to contribute to flooding and destruction of coastal areas as well as destruction of coastal wetlands and mangroves. The IPCC has estimated a sea level rise between 0.6 and 2 feet in the next century. With rising ocean temperatures, it is conjectured that the intensity of hurricanes may increase while the geographical areas over which cyclones form could extend, thereby putting more coastal areas at risk. Increases in sea surface temperatures by about 1-3º C will increase the incidence of coral bleaching events. A United Nations report released in February 2008 titled "In Dead Water" warns that warmer seas and increased ocean acidification could precipitate a dramatic collapse of fish stocks. It also reported that global warming may be disturbing an ocean circulation system that has hitherto allowed fish stocks to replenish despite intense industrial fishing. Other forms of marine life such as shrimp, corals and plankton are also very sensitive to minor sea temperature rises. Coastal and fishing communities will become very vulnerable to disasters and destruction of their livelihoods, especially in the mega deltas of Asia and Africa and small islands such as the Caribbean.

The special case of small islands: environmental vulnerability and impact on tourism: The 51 Small Island Developing States (SIDS), including 12 Least Developed Countries (LDCs), stand to be among the most affected by the threat of climate change despite the fact that they contribute very little to GHG emissions. A few of these SIDS have been among the first to experience the effects of climate change. Two uninhabited islands of Kiribati have disappeared underwater in 1999. The islands of Tuvalu and Vanuatu are under threat of disappearing due to rising sea levels. Inhabitants of the Carteret Island in Papua New Guinea are about to become the world's first climate change refugees as their island is soon to become uninhabitable. Increases in ocean surface temperatures around SIDS have already been reported and are projected to rise bringing in its wake increased precipitation and heavy rainfall, sea level rise, destruction of mangroves, bleaching of coral reefs, salination that is harmful to agricultural lands and deadlier

cyclones/hurricanes. Economic losses for SIDS are not limited only to losses from tourism and agriculture but encompass as well real and serious threats of extinction for these islands and their way of life. Inhabitants of SIDS could become environmental refugees in need of homes[14].

Inequalities in water supply and water availability may deepen: The IPCC projects that water availability is likely to increase by 10-40% at high altitudes and decrease by 10-30% in some dry regions such as the Middle East, southern Africa and Australia, including areas that are already water-stressed. Glaciers store water in winter and melt at predictable rates in the summer, feeding water systems that allow communities and economies to thrive. Their current melting at alarming rates will jeopardize the availability of water to such communities in the future, affecting around one sixth of the world's population. In dry areas where rainfall will become uncertain and even more scarce, the water crisis will deepen with possibility of increased tensions as countries and communities vie for water. Agriculture will be affected with consequent food shortages and further hikes in food prices. The Cooperative Programme on Water and Climate calls for a need by countries to "climate proof" their water supply, meaning increasing water storage capacity. Water-stressed countries will need to invest in increasing their water harvesting and water management facilities.

Increased incidence of costly disasters and implications for the insurance industry: As noted above, dry regions will face the prospect of more frequent and longer droughts and increased risks of fire as rainfall decreases in these regions; mountainous areas where glaciers will be melting will face the prospect of floods, avalanches and landslides; whilst regions such as the Caribbean will be prone to stronger hurricanes. The increased probability and actual occurrence of such large-scale disasters endanger the viability of insurance companies as they will need to fork out payments on most forms of insurance (property, liability, health and life). Insurance premiums will rise as insurance companies struggle to cover deeper losses, thereby causing some segments of the population to fall out of the insurance safety net. The insurance industry has been sounding alarm bells about the risks posed by climate change to its viability and affordability and has been urging governments and the private sector to consider new forms of risk transfer. The insurance industry is also encouraging stakeholders to invest more in risk reduction and disaster prevention. The Climate Wise Initiative was launched by a group of leading organizations and companies in the insurance industry to stimulate work in the area of climate –change risk analysis and risk reduction.

Impact on health and spread of diseases: The World Health Organization (WHO), in collaboration with other partners, has carried out numerous studies on the potential impact of climate change on health. It is to be noted that climatic factors impact on various vector-borne diseases, many enteric illnesses and some water-related diseases. There will be positive effects from climate change on health such as a reduction in the seasonal winter-time peak in deaths in temperate countries as a result of milder winters or a reduction in the viability of disease-transmitting mosquito populations as a result of higher temperatures. However scientists project that most of the health impacts from climate change will be adverse. In its 2002 report, the WHO estimated that climate change was responsible in 2000 for 2.4% of diarrhea and 6% of malaria

[14] In 2006 Lohachara became the first inhabited island to disappear from the world map as a result of climate change. The island is a part of the Sundarband islands belonging to India. About a dozen of the islands in the Indian delta, home to 70,000 people, are projected to be submerged by rising seas due to global warming.

worldwide. Examples of adverse health impact will include: (a) increased heat-related mortality and morbidity; (b) greater frequency of infectious epidemics in the wake of climate-related disasters and extreme weather such as floods and storms; (c) increased risks of diseases and illnesses for populations displaced due to rising sea-levels and disasters; (d) increased illnesses stemming from perturbations to the ecological system as a result of climate change; (e) increased risks of illnesses associated with proliferation of insects, bacteria, viruses and pathogens in warmer climate and; (f) nutritional deficiencies from potential disruptions in global and local food production and food prices. States and populations will need increased capacity and resources to be able to cope with increased health costs. There will be negative implications as well on human productivity and household income and savings.

Increased Inequality between developed and developing countries

The stark inequality is as follows: rich industrialized countries, mostly from the north, have been creating wealth for their economies for more than a century through GHG emitting, highly polluting-industrialization processes and through the exploitation of resources from their ex-colonies. Yet today it is the lesser developed and poorer countries that are faced with the prospect of suffering disproportionately from the consequences of the wealth-creating and polluting activities of their past colonial rulers and richer northern neighbors. Currently rich countries account for about 7% of GHG emissions while the LDCs account for less than 1% (UNDP HDR 2007)[15]. Figure 3 shows 2004 data from UNEP on carbon dioxide emissions per capita for the top 40 emitting countries. Figure 4 shows the distribution of total carbon dioxide emissions by region. According to these UNEP figures, 88% of carbon dioxide emissions originate from North America, Europe and Asia and the Pacific while only 4% originate from Africa where more than 50% of LDCs are located.

Greenhouse gases travel fast in space and know no borders. A ton of GHG emissions released from the United States can contribute to the onset of a climate disaster in the Caribbean, Pacific, Africa or South Asia. The distribution of the economic gains and economic losses from climate change is likely to be unequal with most of the small gains skewed towards rich northern countries and most of the losses projected to fall on the less developed countries closer to the equator. There is clearly a need here for accountability as well as moral and ethical responsibilities on the part of developed countries when it comes to addressing climate change. There is a need to redress an inequality between developed and developing nations. When families drive luxury-cars in the rich world, they contribute to global carbon emissions, and this may have an impact on Bangladeshi or Caribbean families living on the coasts when the latter lose their huts or assets as a result of excessive rainfall due to man-made climate change. At another level, richer countries have more resources for climate change adaptation and mitigation than poorer countries. Left to themselves, poorer countries are likely to lack the financial, human and technological resources needed to address the consequences of climate change. In addition,

[15] See Figures 3 and 4. The 10 leading carbon dioxide emitters per capita in 2004 were: Luxembourg, the United States, Australia, Canada, Estonia, Finland, Czech Republic, Belgium, Russian Federation, and Ireland (based on countries for which data were available).

Figure 3 Carbon dioxide emissions (metric tons) per capita by country (2004)

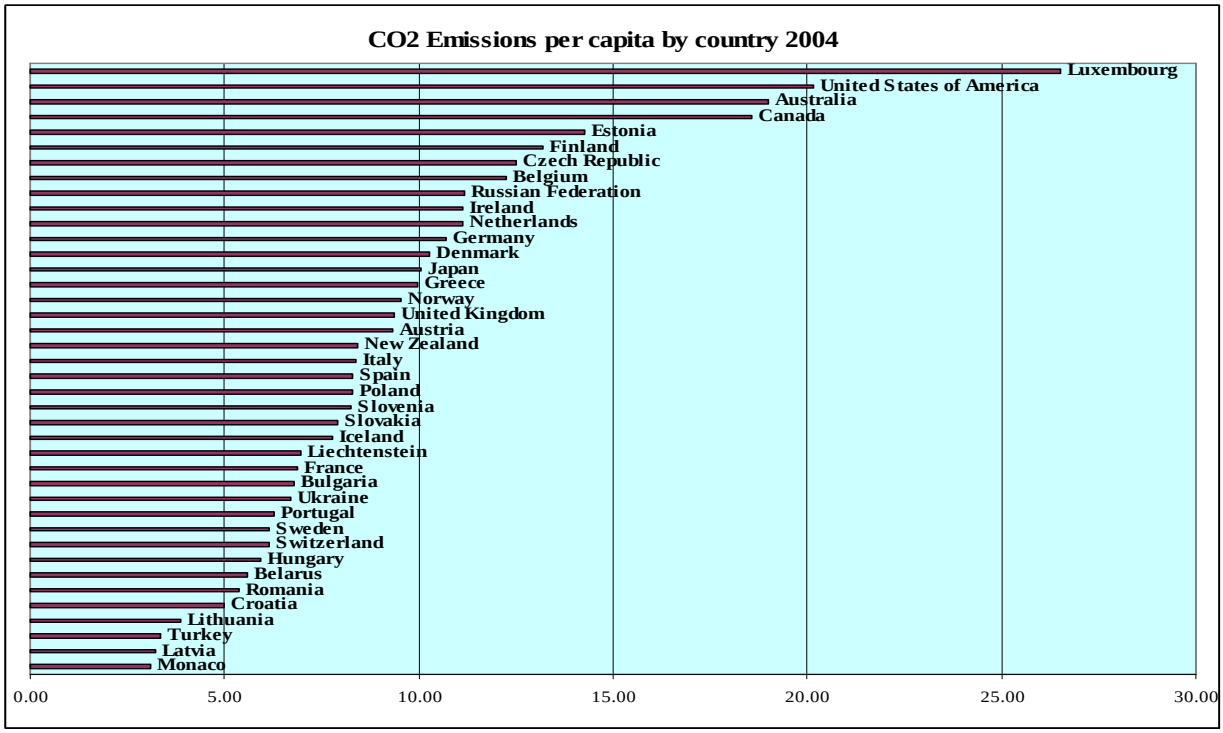
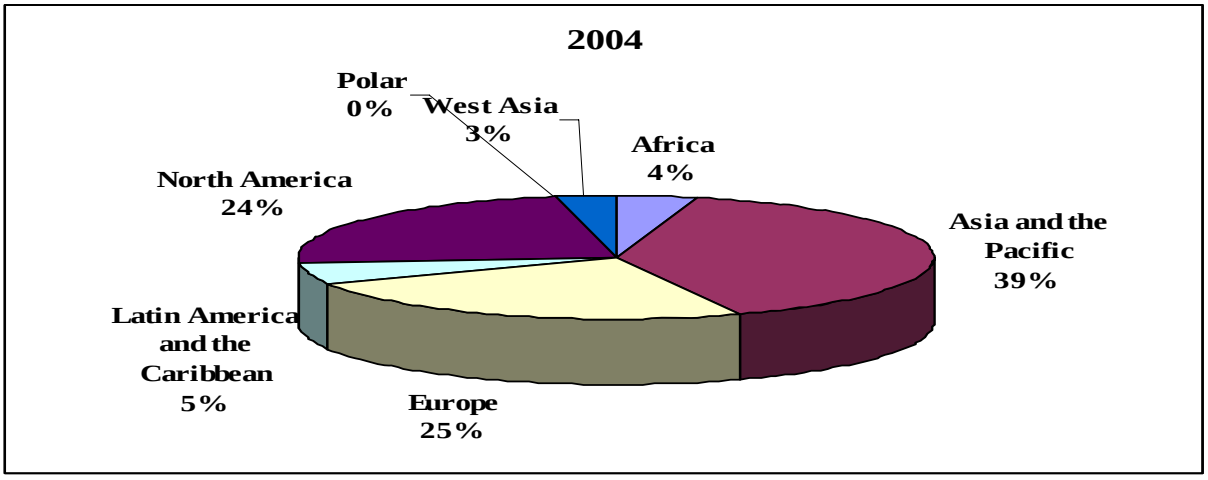


Figure 4 Distribution of total carbon dioxide emissions (metric tons) by region



Source: UNEP Global Environment Outlook Data Portal

such poor and less developed countries are faced with a dire need to lift millions out of poverty and malnutrition which implies that the *opportunity costs* to them of dealing with climate change are higher than for richer countries. Resources will have to be diverted away from poverty reduction towards climate change policy actions. The need for a financial compensating mechanism whereby rich countries transfer resources towards poorer countries for their

sustainable development becomes more pressing. In effect the international aid architecture and issues relating to enhancing aid effectiveness and relieving the debt burden of developing countries become more relevant. Failure on the part of developed countries to assist the developing countries in addressing their sustainable development challenges will create worldwide implications. As the poor get more desperate in poor countries, illegal immigration may rise along with increases in risks of violent conflict, terrorism and insecurity, illegal activities and increased brain drain in developing countries.

Increased inequality between rich and poor within countries

Governments in developing countries will have to allocate resources in order to mitigate the impact of climate change and adapt to its effects. Significant amounts of resources will have to be allocated towards disaster preparedness and coping with the aftermath of a disaster. This represents a diversion of resources from more productive uses such as investing in infrastructure, technology, productivity and the social services. In addition, a few developing countries will also face pressure from developed countries to limit their own industrialization and development processes in order to limit their carbon footprint and GHG emissions. This will imply that developing countries will need to constrain their economic growth rates and hence constrain the creation of resources for poverty alleviation and the creation of jobs. Poor people, unlike their rich neighbors, cannot afford insurance, meaning that they will be ill-prepared to cope with the costs of natural disasters such as floods or hurricanes likely to become more intense with climate change. As a result, countries will need to face the consequences associated with potential increased poverty and inequality within their borders (such as social unrest, increased crime and violence, spread of diseases, loss of human capital and loss of potential production, increased urbanization and creation of slums, increased social security payments, increased environmental degradation including destruction of forests where firewood is a source of energy for the poor). There is a vicious circle involving poverty and environmental degradation that needs to be emphasized. When people are poor or destitute, they are very dependent on environmental resources such as cutting down trees and burning coal for cooking or selling, depleting marine resources (corals and seafood) for subsistence, poaching animals including rare species or using public spaces for sanitation. Increased poverty and destitution will create further stress on the environment while a depletion of environmental resources further undermines the livelihood of the destitute. Communities living in coastal or low-lying areas and involved in agriculture and fishing will be especially vulnerable as climate change heightens the probability of disasters such as floods, large sea waves and bad weather. Climate change will impact on food prices; rising food prices will disproportionately affect the poor and the nutrition of children with a negative impact on education and health.

THE NEED FOR ECONOMIC SOLUTIONS: ECONOMIC TOOLS, ECONOMIC POLICIES AND INTERNATIONAL AGREEMENTS

"Prudence and care about the future of our children requires that we act now. This is a form of insurance against possibly very large losses"(UNDP HDR 2007).

"The dilemma is this: how to cut a deal that has both the developed and developing in it, recognizing that the obligations on the one can't be the same as the obligations of the other," (Blair, 2008).

Any sustainable solution to the climate change problem will need to involve the stabilization of GHG emissions in the future within a clearly-defined international climate change policy. Current levels of CO_2 and other greenhouse gases (in terms of CO_2 equivalents) in the atmosphere amount to 430 parts per million (ppm) and are set to increase to 550 ppm by 2035 if current rates of growth in GHG emissions persist. This compares to 280 ppm before the industrial revolution, placing them at levels not reached over millions of years (IPCC)[16]. Given that such emissions are irreversible and that removing them from the atmosphere will take centuries, the best course of action for humanity right now is to **stabilize** the amounts of CO_2 and its equivalent in the atmosphere at levels that will contain future increases in global temperatures. The stabilization of GHG emissions can involve several components:

(a) Reducing GHG emissions by limiting their production through man-made activities (via "command and control" measures such as quotas, technical or emission standards and regulation) and/or through increasing the costs to emit GHG for the culprits (via price or market-based measures such as pollution taxes and creation of carbon markets).

(b) Removing GHG emissions from the atmosphere through the spread of carbon sinks.

(c) Limiting GHG emissions from industrial and manufacturing processes through research, scientific and technological development and carbon sequestration policies that lead to low emissions or emissions-removal technologies.

In addition to stabilizing GHG emissions, through mitigation measures, there is as well a need for adaptation measures to prepare countries in adjusting to the costs and consequences of climate change. In this section, focus is laid on the economic tools and policies that governments can implement as part of climate change mitigation measures. Each measure entails distributional welfare consequences and will create "losers" and "winners". Whether these measures can get implemented or not will depend a lot on political will by decision makers, their abilities to convince voters and businesses of the necessity of such measures as well as enacting proper compensatory mechanisms for "winners" to share their gains with "losers".

[16] The United Nations Development Programme in its Human Development Report 2007/08 argues that emissions should be stabilized to 450 ppm to control global average temperature increase to 2ºC and that any increases above this threshold imposes serious disaster risks and "tipping point" effects.

Success at stabilizing GHG emissions will critically depend on individual countries pursuing, on a continuous basis, credible and attainable climate change policies within an internationally coordinated and agreed-upon framework with well-defined goals and targets. While targets for GHG emissions reductions will have to be set and enforced at a global, national or regional level, countries will need to use a mix of economic instruments to contribute towards achieving the global targets. National climate change policies will need to be linked to internationally agreed GHG emissions targets. Efficiency considerations will imply that each country should have the flexibility to pick the most cost-effective means that are adapted to its national circumstances to reach these targets.

One can immediately see the challenges behind implementing a solution on climate change. First, global targets for GHG emissions will need to be agreed upon by the international community which is what the Kyoto protocol and its successor are aiming at. However on what criteria should the targets be set? How to account for incomplete information in setting up the targets? What is the correct time horizon for reaching the targets? How frequently should the targets be revised to account for updated information? How to achieve efficiency in decision-making in the face of uncertainty? These are just a few economic-related questions that merit attention.

Secondly, sub-targets by regions and countries will need to be agreed upon with some regions and countries accepting to bear a greater brunt of the burden than others. The development needs of the less developed nations will need to be balanced against the needs of the developed nations to maintain high standards of living for their populace. Present generations will also need to take into account the interests of future generations. Should countries that had emitted the most GHG in the past be made to bear most of the burden? Or should it be countries that can reduce GHG at the least cost? Should the burden be shifted to future generations because the latter would most likely benefit from technological development that would reduce the costs of cutting down on GHG emissions? The old debate between equity and efficiency rears its head here.

Thirdly, national governments will need to implement national climate change policies that are deemed acceptable by local businesses and populations in order to contribute to the achievement of the global targets. Again at a national level, issues will surface regarding the distribution of costs and benefits across sectors, population segments and generations. All of this will require enormous amounts of negotiation, compromise, consensus-building and credible commitments by the international community.

Economic tools and economic policies within climate change policies

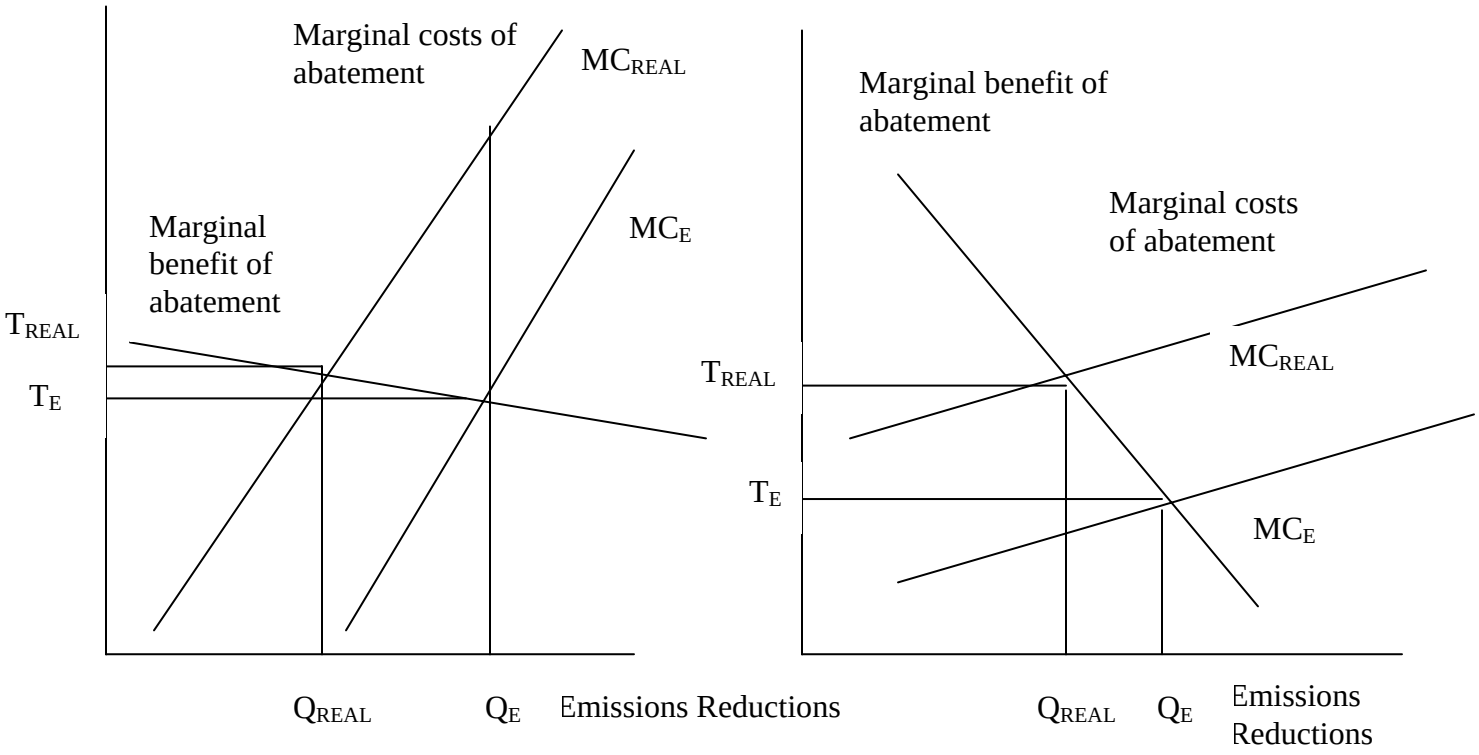
Both developed and developing countries have a mix of economic instruments and policies to choose from in order to reduce or stabilize national GHG emissions. The optimal mix of instruments is likely to differ according to the time frame (short term vs. long term) and will depend crucially on how the total cost and total benefits from abatement evolve as level of emissions rise as well as on uncertainty over these costs and benefits[17] (Source: Stern Review, 2006). In choosing instruments, governments may choose to take into account considerations of

[17] See Stern Review on the Economics of Climate Change , chapter 14 for a fuller exposition.

efficiency (static and dynamic[18]), equity, political feasibility and environmental effectiveness (Lazaro-Touza, 2008). Examples of these instruments are given below.

Figure 5: Marginal cost and marginal benefit of abatement in the short-term ***Figure 6: Marginal cost and marginal benefit of abatement in the long-term***

(Based on Stern Report)



Market-based instruments[19]: Emissions taxes.

As noted in Figure 2 previously, in the presence of a negative externality such as polluted emissions, there is a divergence between marginal private costs and marginal social costs of production. When producers are not made to bear the costs of pollution to society, they ultimately produce at a point that results in an "excessive level" of pollution. Pollution taxes per unit of emissions can be imposed on producers in order to increase their marginal costs of production closer to the marginal social costs of production. The pollution tax has the effect of "internalizing" the externality, in this case polluted emissions, in the decision-making calculus of producers. Pollution taxes provide to producers the incentive to produce less in order to pollute less or else to invest in emissions-reducing technologies that result in less pollution and hence less taxes for them and higher profits.

[18] Static efficiency refers to maximizing economic welfare in the short-run or alternatively picking an economic instrument that minimizes abatements costs to society. Dynamic efficiency refers to picking an instrument that in the long run promotes research and innovation. Environmental effectiveness refers to ability in meeting environmental goal, in this case, attaining the GHG emissions target.

[19] Market-based instruments are instruments that rely on the forces of demand and supply to induce changes in environmental behavior.

Emissions taxes have certain advantages: first, they are an efficient way to reduce emissions. In the presence of proper information, taxes can be charged so that the marginal cost of abating an additional unit of emission is equal to the marginal benefit of abating that unit of emission. From figures 5 and 6, where MC_E is the expected marginal cost of abatement based on available information, the optimal tax rate will be T_E, where net benefits from abatement are maximized. Second, emissions taxes allow governments to raise revenues that in turn can be used to lower distortionary taxes in productive sectors in the economy and stimulate sustainable growth. Such revenues can also be used to subsidize research on clean technologies or alternatives to fossil-fuels. Thirdly, taxes give an incentive to producers to invest in cost-efficient carbon-capture technologies that will allow them to reduce their marginal costs of abatement and reduce the tax rate they need to pay. In terms of figures 5 and 6, this will be represented by a shift down in the MC_E curve, leading to a lower level of T_E. However the design of an "optimal" tax rate will depend on availability of correct information regarding marginal cost and marginal benefit of abatement curves for each industry.

In the debate on the superiority of quantitative pollution targets over pollution taxes and vice versa, the literature recognizes that, in the presence of uncertainty, pollution taxes are the better instrument in the short-term while quantitative limits on pollution are recommended in the long term (Source: Stern Report). (Figures 5 and 6 illustrate.) In the short term the marginal benefit of abatement curve is likely to be flat as marginally reducing emissions are unlikely to yield high incremental benefits owing to the large stock of GHG emissions. However, such marginal benefits are likely to be higher in the long term as the stock of GHG emissions is cut down. The long term marginal benefit of abatement curve is therefore steeper than the short term one. Reducing emissions marginally is costlier in the short term than in the long term due to poorer technology. The long term marginal cost abatement curve is thus steeper in the short term than in the long term. Under imperfect information due to uncertainty, it is very likely that the marginal costs of abatement curve will not be correctly estimated, whether in the short or long term. MC_E in figures 5 and 6 refer to the expected marginal cost curve based on available information while MC_{REAL} refer to the actual cost curves. In the short term (see figure 3) setting a quantitative emission limit based on a wrongly estimated marginal cost curve (i.e. Q_E based on MC_E) rather than on the correct curve (i.e. Q_{REAL} based on MC_{REAL}) leads to a bigger inefficiency loss as compared to setting the pollution tax wrongly (T_E instead of T_{REAL}). The opposite holds true in the long-term case (see figure 6).

Market-based instruments: Cap and Trade

Tradable permits, which are specified in the Kyoto protocol are in essence a combination of a "command and control" quantitative limit on emissions and a pollution tax. First, a target or **cap** on GHG emissions needs to be established either at a global or national level and, second, the global or national target of emissions is divided across countries or producers within a country. The latter is given a "permit" to pollute up to a certain amount, beyond which they need to pay a tax per unit of excess emissions. In addition, the permits are tradable, that is countries and firms can participate in a trading system that allows them to buy or sell their emission

permits at a single price within the trading system[20]. The sum of allowable emissions within the trading system cannot exceed the cap or target that was originally set. This is an instrument that allows for environmental effectiveness since a target for GHG emissions is set as well as allowing for efficiency with the creation of a market for emissions guided by a market price. As explained in Section ii, a key economic driver of climate change is the absence of a market and absence of property rights over clean air emissions. A tradable permit system remedies that market failure as it creates a market for polluted emissions and indirectly puts a price on clean air. Moreover the tradable permit system allows firms or countries that face different marginal costs of abatement to trade so that firms that have a higher marginal cost of abatement can buy additional rights to "pollute' and vice versa. This ensures that pollution is reduced in a cost-efficient way by firms that face the lowest marginal costs of abatement. In addition, firms have an incentive to invest in emissions-reducing innovations that allow them to sell their permits. However certain issues arise for the efficient functioning of the cap and trade system. How to determine the target or "cap"? Which firms or which countries in which sector for what kind of emissions should be allowed to participate in the trading system? How should permits be initially allocated, should they be given for free or auctioned? How long or short should the compliance period be? The system implies monitoring and compliance costs. In order for the system to work, it should be possible to accurately measure and monitor the emissions released by parties in the trading system as well as enforce penalties for violating emissions limits. Certain features can be introduced in the tradable permit programme to reduce costs of compliance by firms. These include offsets (e.g. the Clean Development Mechanism under the Kyoto Protocol) as well as "banking" (setting unused limits for future use) and "borrowing" (postponing compliance to a later date in return for more stringent emissions limits) (Source: Pew Center on Global Climate Change).

Direct or **"command and control"** measures and regulation. Command and control measures will include setting up standards on buildings, appliances and machinery and industries. These standards can be in the form of quantitative limitations on emissions of certain gases; specification of technological standards to promote use of emissions-saving technological processes during production; or energy-efficiency requirements. Regulatory measures of this kind impose an information burden on regulatory authorities. For such measures to be efficient and politically feasible, the regulatory authorities will need good prior knowledge of production processes and costs for each industry. The setting of standards or limits could be influenced by lobbying pressures by businesses that want to protect their profits, thereby compromising on environmental effectiveness and unfairly advantaging some industries over others. There are also compliance and monitoring costs to be borne by the regulatory authorities. However "command and control" measures can introduce incentives for producers to invest in cost-effective and emissions-reducing technologies in order to save on their abatement costs and be able to produce more at lower levels of emissions.

Research and scientific and technological development

Another component of climate change policy is the development of so-called clean technologies that can contribute to lesser emissions. Combating climate change requires actions

[20] An example of an emissions trading system (ETS) is the European Union ETS that allows trading of carbon dioxide emissions. It is the largest ETS in the world.

on both the demand and supply fronts in terms of mitigation. On the one hand, there is a need to induce behavioral changes on the part of producers and consumers through incentive mechanisms that affect the costs of using GHG emitting products and technologies (such as pollution taxes, tradable permits, regulation, removal of subsidies on fossil fuel use, low taxes on low-energy intensive goods and services). There is a need to encourage energy conservation both by users and suppliers of energy in key energy-intensive areas such as transport, electricity generation and general household consumption. On the other hand, there is a need to increase the supply of alternatives to GHG emitting products and technologies. There is a need to dole out incentives to the private sector to encourage innovation, development, and investment in energy efficient technologies.

The term "third industrial revolution" has been used to describe the need to transit towards low-carbon economies through the development and deployment of Carbon Capture and Carbon Storage (CCS) technologies, and renewable energy technologies (solar, wind, geothermal, bio-fuels). In addition technologies will need to be developed through research to facilitate the adaptation of countries to climate change (such as improvements in water infrastructure, better flood defense systems, development of weather resistant crops). Public policy will have a critical role to play in supporting research and development in technological improvements designed to support climate change mitigation and adaptation. Such public policy support can be in the form of fiscal incentives including grants, legislation in support of the use of green technologies, regulatory reform and preparation of national and regional strategic plans. Financing of technological development will be a critical issue for both the public and private sectors to address in most countries. Revenues raised from environmental taxes and auctioning of emissions permits can be used to support research and development in clean technologies. Public policy can be aimed at promoting public-private partnerships in order to secure financing for research and development and facilitate risk-sharing in clean technological investments.

Clean technological development inevitably needs to be lead by the rich industrialized countries that have the available know-how and resources necessary for it. In the United States, for instance, the National Energy Technology Laboratory (NETL) of the Department of Energy runs a carbon sequestration programme under State funding to develop technologies to capture, purify and store carbon dioxide so as to allow cuts in greenhouse gas emissions to be compatible with continued economic growth. In time it will be important to encourage the transfer of such technologies to developing countries so that the latter can meet their emission targets within the Kyoto accords without sacrificing the economic growth that is needed to allow them to meet their human development needs within the Millennium Development Goal framework. Developing countries will have to put in place the right incentive policies to facilitate such technology transfer (for example, encouraging foreign direct investment via tax breaks, streamlining business regulations, and guaranteeing property rights) as well as coordinate with developed countries for capacity- building in such technologies.

Land-use policies

Land –use changes are among the major sector sources of GHG emissions in addition to power generation and transport. In addition, land use changes are recognized to have impacts on the climate independent of its effects on greenhouse gas emissions (Pielke, 2005). Commercial

logging and urbanization driven by population growth and migration can lead to deforestation and forest degradation. Forests are net carbon sinks and absorb carbon dioxide emissions from the atmosphere. Their preservation therefore is vital in the combat to stabilize greenhouse gas emissions. Economic policies can be used in countries to encourage the preservation of forests and these can range from use and enforcement of land-use planning, designation of special zones for forests conservation, regulations and heavy taxation on commercial logging and forest products and financial budget support for environmental conservation. In the Caribbean, Belize, Guyana and Suriname will be key countries to support in terms of afforestation and reforestation projects given their large forestry areas.

International agreements, regional and national policy frameworks

According to the United Nations Development Programme (UNDP) Human Development Report 2007/08, a stabilization target of GHG emissions at 450 parts per million is needed in order to contain global average temperature increases at the 2 ºC threshold. Any increases above this threshold are thought to pose significant climate-change related disaster risk. To achieve this global stabilization target, there is a need for international coordination especially international agreement on the global target of emissions reduction to be achieved and international agreement on the contribution of each country toward achieving such emissions reductions within a given time-frame. This is in essence what the Kyoto Protocol and the UNFCCC aims to achieve. Within this international agreement framework, each region will need to develop and implement a regional policy framework detailing the actions to be taken by the region to adapt to and mitigate climate change, including the mix of economic policy options to be pursued.

Each country within a given region will need in turn to develop and execute national action plans to implement its commitments agreed within the Kyoto protocol accords and the regional policy framework. Implementation of the international agreements, regional and national policy frameworks will necessitate the use of economic policies and instruments in the form of taxes and subsidies, regulations, planning and creation of rule-based trading markets. Addressing climate change will involve immediate short-term tangible economic costs to countries while the economic benefits are likely to be diffuse and long term. Such trade offs will make it very tempting for short-sighted political policy makers to want to postpone actions and engage in myopic behavior. This is more likely if voters are also short-sighted and their preferences are for short-term welfare gains as opposed to avoidance of long-term welfare losses. The political economy dimensions of the climate change problem imply that a successful implementation of economic policies to address climate change will require endorsement by voters. Voters will resist, for instance, the imposition of environmental taxes or the removal of subsidies on high market priced fossil fuels unless the rationale for such economic policies is explained to them and is tied to their future welfare consequences. In short, in order to successfully implement climate-change related policies, governments will need to engage in public information campaigns aimed at demonstrating the economic costs of climate change to the populace.

At a global level, countries that are likely to lose from mitigation actions such as fossil-fuel exporters and high emission emitting countries, will tend to resist adhering to the provisions

of the Kyoto Protocol while countries likely to gain from climate change mitigation actions, such as SIDS will tend to be in favor. Countries will also find it in their own interest to free-ride on the mitigation actions of others so that they can pursue their own development goals at no cost. If the top five GHG emitters that account for more than 50% of total GHG emissions do not commit toward emission reductions, the incentive for other countries to reduce emissions will be weak. The international political economy dimensions of the climate change challenge imply that international agreements to reduce emissions have a strong likelihood of failure unless such agreements have legally binding commitments for emissions reductions, unless countries that account for a substantial share of such emissions adhere to their commitments, and unless these agreements contain mechanisms that will spread the costs of mitigation across all countries in a way deemed acceptable by all.

A COMMENT ON THE CARIBBEAN

Like other regions, the Caribbean will be impacted by climate change both in terms of economic gains and economic losses. Economic losses are likely to accrue mainly in the costs imposed by stronger hurricanes and from disruptions to agriculture and tourism[21]. Further research on the socio-economic impacts of climate change is needed both at a regional and national level along with research on the cost-effectiveness of proposed socio-economic climate change policies. In this context the ongoing initiative by the (ECLAC), subregional Headquarters for the Caribbean entitled the "Review of the Economics of Climate Change in the Caribbean" (RECCC) that aims at elaborating a Stern- type report for the Caribbean will contribute towards filling an important research gap in the region in terms of the economics of climate change.

There is a clear need for urgent regional and national economic policy actions on climate change in the Caribbean that should be linked to the UNFCCC international climate change policy framework. Several adaptation initiatives have been ongoing in the Caribbean region led by the Caribbean Community Climate Change Center (CCCCC). The Caribbean Planning for Adaptation to Climate Change (CPACC) project (started in 1997) aimed at building capacity for adaptation to climate change in the region, especially in relation to sea level rise. Under the CPACC, 11 CARICOM countries formulated national climate change adaptation policies and implementation plans. Under the Adaptation to Climate Change in the Caribbean (ACCC) project, adaptation studies for specific sectors were elaborated and implemented. The Mainstreaming Adaptation to Climate Change (MACC) project is aimed at fostering the mainstreaming of adaptation to climate change to national and sectoral planning and policies (Source: CARICOM). However there is a need to scale up the formulation of national adaptation and mitigation plans to non-CARICOM countries in the Caribbean region, especially the Dutch-

[21] According to a study by the Stockholm Environment Institute at Tufts University released in 2008, the costs to the Caribbean region for failing to take actions on climate change could amount to losses of 5% of the region's 2004 GDP by 2025 and 10% by 2050. These calculations are based on three types of effects: damages from hurricanes; losses from tourism and damages from infrastructure. The costs of inaction calculated as a percentage of 2004 national GDP by 2025 were between 10-15% for Anguilla, Antigua and Barbuda, Jamaica, Montserrat, Saint Lucia and St Vincent and the Grenadines; between 15-20% for Dominica, St Kitts and Nevis and Turks and Caicos and above 20% for Grenada and Haiti.

speaking Caribbean and Haiti as well as speed up implementation in countries where such plans already exist. Such plans should be accompanied by a diagnosis of national capacity constraints in terms of implementation and national capacity- building plans as well as well-defined resource mobilization strategies for financing their implementation. The CARICOM Secretariat is currently elaborating a regional climate change strategy for the Caribbean region. There will also be a need to integrate the policy recommendations of that regional strategy into the existing policy frameworks of the CARICOM governments of the region.

Given that in a post-Kyoto world developing countries will be expected to contribute to reductions of greenhouse gas emissions, the Caribbean will need to focus both on mitigation and adaptation policies. So far though, greater efforts have been laid on adaptation alone. It is to be noted that 11 Caribbean countries are among the top 90 carbon dioxide emitters per capita in the world (Source: Wikipedia)[22]. Mitigation should focus on transitioning Caribbean countries to low-carbon based economies based on well- defined national energy policies. The promotion of energy-efficiency and use of alternatives to fossil fuels need to become regional and national priorities. Public policy should be aimed at supporting the development and use of renewable sources of energy in the energy sector including bio-fuels, solar, wind and geothermal energy systems; supporting the development of public transport systems to promote energy savings in the transport sector; mandating energy efficiency requirements in various industries including the automotive industry; supporting research and innovation in energy-efficient technologies at knowledge centers; providing incentives for the transfer and adaptation of clean technology from developed countries to the Caribbean and introducing incentives for households and the tourism sector to switch to energy savings habits (for example, encouraging the use of solar-heaters and phasing out of incandescent bulbs). The conduct of energy audits in various industries should be encouraged.

There is a need to push for the integration of disaster preparedness, disaster prevention and risk reduction in existing national and regional programmes. The Caribbean Disaster Emergency Response Agency (CDERA) has a key role to play here in facilitating the adaptive response of the region to climate-change related disasters. Efforts should be geared towards implementing CDERA's Strategy for Caribbean Disaster Management (CDM). The ongoing CDERA project "Adaptation for climate change and disaster mitigation" specifically aims at assisting Caribbean countries in developing adaptation strategies to deal with the impact of climate-change related natural disasters and weather events and strengthening capacities for such adaptation.

Micro-level and macro-level insurance initiatives such as the issue of catastrophe bonds and the pooling and transfer of risks and losses at a national and regional level need to be encouraged to provide safeguards both for households and for economic and productive sectors against losses from climate-change disasters. Participation of Caribbean countries in the World Bank's Global Facility for Disaster Reduction and Recovery (GFDRR) will need to be consolidated. In terms of tourism, the region may need to push ahead with the implementation of the "Regional Policy Framework for a more Sustainable Development of Tourism in the Caribbean" spearheaded by the Caribbean Tourism Organization (CTO). Economic

[22] Based on 2004 data for carbon dioxide emissions in metric tons per capita for 206 countries. See http://en.wikipedia.org/wiki/List_of_countries_by_carbon_dioxide_emissions_per_capita.

diversification away from tourism and agriculture and towards less climate-sensitive sectors needs to be encouraged.

Economic opportunities may arise for the region if the right economic and environmental policies are put in place. In the context of the Caribbean, new "green" sectors such as organic agriculture, bio-technology, carbon neutral tourism and renewable energy should be identified for development through foreign direct investment, if needed. The region could also seize the opportunity offered by climate change to start the building of "green" national economies. Barbados has already taken the lead in that respect. It has identified the building of a green economy as one of its five main development pillars over the next 20 years. Regional initiatives in sustainable development need to be fostered.

THE UNITED NATIONS SYSTEM ADDRESSING ECONOMIC IMPACTS OF CLIMATE CHANGE

Climate change has been described as the greatest challenge facing mankind in the twenty-first century. Climate change is a complex, multi-faceted phenomenon. Its complexity is driven by the fact that climate science is subject to uncertainty and the fact that the impacts will be spread across generations and over centuries. Responding to climate change requires first and foremost international coordination and cooperation. The United Nations as the world's foremost institution in the sphere of international affairs has a crucial role to play in addressing the climate change challenge. Five main areas are identified below where the United Nations will have a catalytic role to play in galvanizing the international community in responding to climate change.

Promote sustainable development and the implementation of United Nations Conventions and treaties

The United Nations has a major role to play in fostering the promotion of sustainable development in both developed and developing countries as part of the response to climate change. The United Nations, through its various agencies and bodies, works towards furthering the adoption and implementation of several United Nations conventions, treaties and protocols that promote sustainable development. The United Nations plays a key role in encouraging and supporting member countries to develop regional and national policy-oriented action plans in order to achieve the objectives set out in its conventions, treaties and protocols. For instance, the United Nations can support countries in implementing Agenda 21 and the Johannesburg Plan of Implementation in order to balance goals of economic growth and human development with the goal of sustainability in use of natural resources. For example, the United Nations can further support countries in achieving the targets set in the Montreal Protocol on use of ozone-depleting substances as part of the efforts to mitigate climate change. The United Nations has an important role to play in supporting SIDS in implementing the Mauritius Strategy for the Further Implementation of the Programme of Action for the Sustainable Development of SIDS.

Support the development and transfer of energy-efficient and renewable energy technologies from developed to developing countries

As the UNDP noted in its Human Development Report 2007, rich countries have a historic responsibility in the current stock of GHG emissions. Most of the current stock is the accumulation of past GHG emissions by industrialized countries. Rich countries, it is argued, will have to bear the brunt of emissions cuts. The European Union has pledged to slash its greenhouse gas emissions by 20% (with a possibility of extending to 30%) by 2020 compared to 1990 levels. Developed countries that are parties to Annex I of the Kyoto Protocol are expected in the future to invest massively in the development and deployment of clean, low-GHG, energy-efficient and renewable energy technologies in order to meet their Kyoto targets. Transferring such technologies to developing countries is needed so that developing countries can embark on a low-carbon intensive growth path that will contain their GHG emissions and allow them to pursue environmental sustainability without sacrificing economic growth and the resources that growth creates to finance human development. The United Nations, in particular the UNFCCC secretariat, will have an important role to play in supporting such technology transfers. The Bali Action Plan, adopted at the 13th Session of the Conference of the Parties (COP 13) conference in Bali, Indonesia, in December 2007 aims at enhancing action on technology development and transfer to support action on mitigation and adaptation.

Facilitate international coordination and actions for the continued reduction and removal of GHG emissions from the atmosphere

The United Nations, through the UNFCCC secretariat and the Kyoto Protocol, is expected to keep playing a pivotal role in rallying the international community around the urgent need to stabilize GHG emissions, to commit credibly towards emission reducing targets and agree on a time- frame for achieving such targets. This requires all countries to agree on subordinating their own national interests to the collective interest from the point of view of industrial production and economic growth. As noted in Section II, each country, however, may tend to put its own national interests first in order to protect its own industries and economies. There is also a strong incentive to free-ride on the GHG emissions reducing efforts of other countries. If each country or even a small group of countries prefer to pursue their own national optimal production rather than curtail their industrial emissions in order to achieve the collective or social optimal point of production, then any international agreements on reducing GHG emissions may unravel. Some countries may choose to opt out of the international agreement because the costs of reducing emissions are not being distributed equitably across all countries. The United Nations, as a neutral third-party, has a key role to play in ensuring that countries remain committed to the goal of stabilizing GHG emissions. The United Nations has the role of ensuring that countries keep on negotiating and compromising through dialogue until an acceptable time schedule for reducing GHG emissions by all countries is put in place as part of a long-term collective agreement. This is in essence what the Kyoto protocol and its successive protocols aim to do. The Bali roadmap has set a framework whereby countries can engage in negotiations for a long-term agreement on emission cuts. It is hoped that at the next COP meeting scheduled in Copenhagen in 2009, these negotiations will culminate in countries ratifying a new post-2012 Kyoto protocol. Annex I parties have agreed to cut down emissions by 5% relative to its 1990 levels by 2008-2012 (the first commitment period). It is hoped that at

Copenhagen in 2009, agreement will be reached regarding setting up a second commitment period for reducing emissions. Ideally this should involve agreeing on a new emissions pathway for global cuts of the range of 50-85% until 2050, in line with IPCC recommendations. Agreement is also needed in terms of setting up fair and transparent criteria for allocating emissions reducing targets across countries, taking into account the varied obligations and capabilities of different countries. The UNFCCC will play an instrumental role in facilitating dialogue and decision-making in this context among all parties to the Convention.

Mobilize finance for climate change adaptation and mitigation

Addressing climate change both in terms of mitigation and adaptation will involve several types of costs for countries: first, an opportunity cost in terms of lost production, lost profits and lost economic growth in return for imposing limits on GHG emissions as part of mitigation costs; second, costs resulting from damage and losses due to climate-change related disasters such as more intense floods and hurricanes; third other costs incurred in order to adapt to the economic impacts of climate change. As pointed out in Section III, climate change poses distributional and equity issues. Some countries (such as LDCs and SIDS) have historically contributed modestly to GHG emissions and yet are likely to suffer disproportionate losses due to the potential skewed impacts of climate change. Other countries, that are currently heavily indebted, and yet are vulnerable to climate-change related disasters (including Caribbean countries like Jamaica and Belize) face the prospect of increased indebtedness owing to loans that may have to be contracted in the future to recover from climate change–related disasters. Developed countries, that are donor countries to the international community, may face increased pressures domestically to curtail their commitments on development assistance to developing countries so that their own resources get allocated to fund domestic actions on climate change mitigation and adaptation.

It can be argued that developed countries, given they were significant contributors of GHG emissions in the past, have a moral obligation to support developing countries financially in addressing climate change. The United Nations including the World Bank, the UNFCCC secretariat and other bodies will have an important role to play in terms of mobilizing resources to finance the transfer of environmentally sound technologies to developing countries, finance capacity- building in developing countries in the areas of climate change adaptation and mitigation as well as finance building of resilience to disasters. The United Nations has also a lead role to play in the development of innovative financing mechanisms in climate change funding including through the development of public-private partnerships. Gordon Brown, the British Prime Minister, has called for the creation of a global climate change fund akin to the global fund to fight AIDS, tuberculosis and malaria. In the meantime, the World Bank Group and several multilateral development banks including the Inter-American Development Bank (IDB) have jointly set up climate investment funds intended to disburse grants and loans to developing countries to address climate change. The World Bank has several carbon funds that are financed by developed countries and private companies and are intended for use to purchase project-based GHG emission reductions from developing countries. The UNFCCC, for its part, has several funds to provide access to finance to developing countries for funding climate change- related activities. These include the Special Climate Change Fund, The Least Developed Countries Fund and the Adaptation Fund.

As the response for addressing climate change gathers pace, an increasing amount of financial resources will be needed to finance investments, technology development, adaptation programmes and mitigation targets. The United Nations will be expected to be at the forefront of resource mobilization efforts in the area of climate change. The United Nations can play a critical role in advocating for an international emissions trading scheme as part of the post-Kyoto 2012 accords. Such a scheme is likely to benefit developing countries. Countries with lower marginal emissions abatement costs (MAC) (mostly countries with low levels of development) will be able to sell their emission permits to countries with high MAC (mostly countries with high levels of development) and use the resulting transfers to finance their adaptation and mitigation policies.

Mobilize public opinion on the impacts of climate change and needed policy responses

So far a significant amount of research has been undertaken on climate change, its impacts and the costs and benefits of taking actions to address climate change. However significant work needs to be done to sensitize public opinion on the costs and impact of climate change and the urgency of taking actions to address it. The United Nations, in collaboration with non-governmental organizations and other civil society members, can play a crucial role in raising public awareness about the causes and consequences of climate change. By mobilizing public opinion on the urgent need to take actions to mitigate and adapt to climate change, pressure could in turn be exerted by the public on decisions makers to act accordingly and avoid delaying taking actions on climate change.

CONCLUDING REMARKS: THE NEED TO DEPART FROM "BUSINESS AS USUAL".

Climate change requires an adjustment in the way that business is done. Countries will need in the years ahead to "climate-proof" their economies and mainstream climate change adaptation and mitigation programmes in their national strategic development planning and budgetary frameworks. Businesses will need to adjust their business and production processes in response to climate change. The international donor community will need to integrate support for climate change actions into their aid assistance packages and reflect on how climate change will affect aid effectiveness. Individuals and families will need to reflect on how their actions today will impact on successive generations. Climate change will also require an adjustment in how success and progress are measured and how economic welfare is valued.

So far, economic and business models have emphasized the pursuit of pecuniary profits and the pursuit of economic growth. Companies on Wall Street measure their success based on profit-based financial indicators while countries based their success on economic indicators reflecting growth in pecuniary market-transacted wealth. Climate change requires a shift to a development paradigm that values not only economic growth and the augmentation of financial assets but also one that values environmental assets that cannot be transacted through markets. The use of "green" national accounting methods needs to be encouraged. Economists need to integrate environmental considerations in their welfare maximization calculus and optimal

decision- making. Sustainable development models need to replace economic growth models. The world, as a whole, needs to start paying attention to sustainable development indicators in addition to conventional economic and financial indicators. To successfully combat climate change, a departure from “business as usual” approaches is needed in analysis and policy-making in all major economic spheres.

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