Mounting evidence indicates that humans are significantly influencing the global atmosphere, leading to global climate change. Nations strive to better themselves over time, and efficient allocation of resources driven by a well functioning market is often cited by economists as an effective means to achieve this goal. Yet markets can have failures that result in the misuse of resources (a less than optimally efficient use), leaving society worse off over time. Degradation of critical non-market ecosystem goods and services, such as a functional carbon cycle that creates a global climate considered relatively stable for the support of human life, can leave society in a worse condition in its efforts to achieve a better state. Climate change arises as a tragedy of the global atmospheric commons as individual nations and peoples ineffectively attempt to better themselves while degrading an essential global resource shared by all. Yet, using an ecological economics approach, this chapter highlights the possibility of moving towards sustainable development as we face global climate change. Safeguarding our global atmosphere will require concerted international effort and a renewed environmental ethic.

Global Climate Change as a Reality

*In reality, lifting people out of poverty and creating a sustainable environment are not conflicting aims; these goals are actually mutually supportive in a multitude of positive ways.*

— Roundtable on Poverty and Climate Change in the U.K. (2008)
Global climate change is happening and growing evidence indicates that humans are contributing significantly to global climate change by releasing extensive amounts of greenhouse gases into the atmosphere. The Intergovernmental Panel on Climate Change reports that “warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level, global GHG (greenhouse gas) emissions due to human activities have grown since pre-industrial times, with an increase of 70 percent between 1970 and 2004, and most of the observed increase in global average temperatures since the mid-twentieth century is very likely due to the observed increase in anthropogenic GHG concentrations” (IPCC 2007).

With the industrialization and economic growth of nations, greenhouse gas emissions have increased greatly over time as many nations have utilized energy intensive production to fuel growing economies. Affluent nations such as members of the G8 (Canada, France, Germany, Italy, Japan, Russia, the United Kingdom, and the United States) release relatively large amounts of greenhouse gases. In 2004, the United States alone produced about 22 percent of global carbon dioxide emissions from burning fossil fuels (EIA 2008). Recent research also indicates the magnitude of China’s GHG emissions, estimating that China surpassed the United States as the largest global emitter of carbon dioxide in 2007 (Auffhammer & Carson 2008). As the World Resources Institute (2008) highlights, however, while China and the United States emit approximately the same amount of greenhouse gases, China’s per capita emissions are only 20 percent of those of the United States.

Global climate change will adversely impact people and cultures across the world by affecting critical freshwater supplies, land use, and human settlements affected by sea-level rise, food security, and human health risks linked to heat stress and increased transmission of tropical diseases (Harper 2008, Bates et al. 2008). Increased scarcity and competition for critical natural resources essential to meeting basic human needs are likely to create conflict and threaten political stability and peaceful relations within and across nations (Fingar 2008). The G8 nations and key developing countries, including China and India, have now acknowledged global climate change as “one of the great global challenges of our time” and G8 nations have pledged to try to halve greenhouse gas emissions by 2050 (Abramowitz 2008). Yet, with grow-
ing understanding of the potential significant adverse impacts of global climate change, why do nations engaged in global trade and market economies continue to prolong implementation of GHG mitigation efforts to pursue development paths now, which can ultimately undercut the objective of achieving a better standard of living?

In organizing the international conference *Facing Climate Change with a Renewed Environmental Ethic*, the Toda Institute, with its global mission of promoting peace, directly addressed climate change as a “great global challenge” by calling together scholars from across the world to formulate ideas and actions for effectively addressing climate change and promoting peace. This chapter discusses the problem of global climate change from an economic perspective and highlights an ecological economic approach to climate change policy and action based on a renewed environmental ethic.

**The Global Climate Commons and Market Failures**

The global atmosphere is inextricably linked to the survival of the myriad species that have evolved over millennia on the planet. The effect of the atmosphere on global climate is critical for the existence and continued survival of humankind. One can view the atmosphere as a critical resource for society that serves as both an environmental source of essential chemicals and thermoregulation and as an environmental sink where society emits chemicals that circulate through biogeochemical and hydrologic cycles. So once aware of the global climate change problem and potential devastating damages, why do nations continue to allow the alteration of a functioning and supportive atmosphere to a state that is causing global climate change?

Global climate change represents a classic example of a tragedy of the commons. The global atmosphere is a non-exclusive public good and the assimilative capacity of the atmosphere to process GHG emissions is a rival good. There are significant costs of climate change due to altering the chemical composition of the global atmosphere beyond its assimilative capacity and the costs do not affect any one nation entirely. Yet, benefits of the burning of fossil fuel as an energy source can accrue specifically to nations. Thus, a nation-state would logically continue to burn fossil fuels as long as the benefits accrued were more than the cost of climate change to that particular nation alone. Under this logic, there would result a race to destruction as each nation attempts to become better off from burning fossil fuels that result in positive net benefits to a particular nation, but in the end alter the global atmosphere (common
resource) by ignoring the cumulative costs of emitting greenhouse gases. Furthermore, nations that were incurring large external costs of global climate change without the benefits of burning fossil fuels would now have a perverse incentive to ramp up fossil fuel production without an agreement on the shared use of the global atmosphere in order to increase net benefits. For example, remote Pacific island nations that reap relatively few benefits from extensive global carbon emissions face large potential external social costs from GHG emissions and global climate change. Island nations such as Nauru and Kiribati face rising sea levels that literally threaten the existence of the ground they walk on and the freshwater they drink due to salinization of wells by rising waters.

Overexploitation of public goods and common pool resources is not a new issue for society, as evident in other global resource issues such as fisheries and rangelands. In theory, markets serve to allocate resources efficiently and optimize net social benefits given firm property rights that allow persons consuming a good or service to express demand with a willingness-to-pay and producers with a willingness-to-accept to supply the good or service. Market failures occur when social costs such as climate change are not internalized and thus the level of production (energy derived from high carbon-emitting sources) indicated by a market may not be optimal for society. Economists often propose privatization in the case of depletion of a common property resource as a means to internalize costs back to the person(s) causing damage, thereby forcing the decision-maker to incur the true costs of the action. However, creating distinct property lines for non-exclusive goods and services such as fisheries and the global atmosphere is difficult if not impossible and thus requires further options for effective management of the shared resource (Ostrom et al. 1999). So why have nations failed to acknowledge that markets do not account for the cost of climate change, and that an international collaborative effort is required to maintain a global atmosphere that supports humanity? This may require an overview of how many nations assess progress and the economic development of the nation through markets.

**Economic Growth as an Indicator of “Progress”?**

Nations inherently strive to increase well-being over time and increasing gross economic production through increased energy and resource consumption has been utilized as a dominant strategy to try to achieve improvements in societal well-being. As the World Bank (2003) indicates, global energy use traditionally has grown at the same rate as Gross Domes-
tic Product (GDP). GDP is a measure of the annual market value of final goods and services purchased in a nation (plus all exports net of imports). Research within societies and comparative analyses initially indicated a strong relationship between the growth of energy production and increases in measures of economic growth (Cook 1971, Harper 2008). Sociologists examined the relationship between energy growth and measures of social well-being (such as health, education, and nutrition), confirming a positive relationship between energy growth and growth in indicators of social well-being (Mazur & Rosa 1974). However, further studies did not support this notion of a positive relationship between growth in energy intensity and social welfare, as for instance, a case study comparison between the United States and Sweden (Schipper and Lichtenberg 1976).

In recent years, many scholars and economists have increased criticism of utilizing Gross Domestic Product (GDP) as a proxy for societal well-being. GDP counts *all production*, including activities related to environmental pollution and crime, while ignoring income inequality (Cobb et al. 1995, Talberth et al. 2007). Clean up expenditures of major oil spills are counted as an increase in the GDP, as well as harvesting forests beyond sustainable yields. Natural resource depletion is not effectively accounted for and thus short term gains of liquidating natural resources beyond natural growth rates or assimilative capacities to process pollution are highlighted as progress with no consideration of the user costs and sustainability of the production. Ironically, economist Simon Kuznets, chief architect of the GDP, informed the U.S. Congress seventy-five years ago that the “welfare of a nation can scarcely be inferred from a measurement of national income” (Kuznets 1934, Talberth et al. 2007). Prominent economists have reiterated this point that “GDP is not a measure of welfare” (Nordhaus & Tobin 1972) and “GDP can be a hopelessly misleading index of human well-being” (Dasgupta 2005). Scholars have also worked on alternative measures such as the Index of Sustainable Welfare (ISEW, Daly 2005) and the Genuine Progress Indicator (GPI, Talberth et al. 2007), two examples of studies that take into account natural resource depletion and income inequality.

University of Cambridge economist Partha Dasgupta supports use of the indicator of *wealth* per capita with “wealth” defined as the value of an economy’s entire productive base comprising human capital (such as knowledge, skills, and institutions), human-made capital (roads, bridges, and buildings), and natural capital (forests, fisheries, and the global atmosphere) (Arrow et al. 2004, Dasgupta 2005). Dasgupta has indicated that figures published by the World Bank for the depreciation of certain
natural resources (oil, natural gas, minerals, the atmosphere as a sink for carbon dioxide, and forests as sources of timber) indicate that in sub-Saharan Africa both GDP per capita and wealth per capita have declined in the past three decades, while on the Indian subcontinent, even while GDP per capita has increased, wealth per capita has declined (Dasgupta 2005). Ecological economist Herman Daly (formerly at the World Bank) has argued that sustained economic growth in a finite system is not possible and nations are trying to achieve higher GDP with increased production while liquidating natural resources (i.e., natural assets) that are critical complements in production (Daly 1992a, 1992b, 2005). Daly supports sustainable economic “development,” which is an increase of societal well-being over time with resource efficiency, versus unsustainable economic “growth,” which is economic activity fueled by the expansion of more resource/energy throughout (Daly 1996). Sustainable development is achieved with a dynamic economy that increases the qualitative state of people (skills, knowledge, etc.) and humanmade capital (roads, bridges, buildings, etc.) while maintaining productive natural ecosystems (natural capital) to support the economy (Daly 1996).

In terms of energy use, Harper (2008) highlights that macro-level studies and historical data for middle income developing countries identified two main phases of development and energy use: rapid industrialization and consumption highly dependent on increased use of energy from fossil fuels to economic growth becoming less energy intensive with a shift towards service industries and increased energy efficiency. This logic supports the idea that countries that have already industrialized and have increased income can now continue to raise national incomes with energy efficiency and subsequently lower fossil fuel emissions per capita.

In certain cases, resource economists have observed an empirical relationship suggesting pollution rising with income up to a certain point and then falling after some threshold, forming an inverted U-shape relationship (Shafik & Bandyopadhyay 1992, Barbier 1997, Auffhammer et al. 2002). A hypothesis was purported that levels of environmental degradation follow an inverted U-shaped pattern with increasing national income—observed by economist Simon Kuznets for income inequality. This relationship was termed an Environmental Kuznets Curve (see Figure 1). Unfortunately, the notion of an Environmental Kuznets Curve (EKC) for pollutants tends to fuel the idea of “grow first and clean up later,” and that all a nation needs in order to solve pollution problems is to increase income rather than focus attention on the need to address sustainable development and an effective environmental policy (Arrow
et al. 1995, Auffhammer et al. 2002, World Bank 2003). Strong inverted U-shape relationships with income have been observed for local air quality (sulfur dioxide and particulates) (World Bank 1992, Grossman & Krueger 1995, Cole et al. 1997, World Bank 2003), but income turning points for CO2 emissions are high (Schmalensee, et al. 1998) and studies of per capita emissions of CO2 have observed a steady worsening as per capita income increases (Arrow et al. 1995; Holtz-Eakin & Selden 1995; Easterly 1999). Kehoane and Olmstead (2007) indicate that the empirical evidence for an EKC is weak, but there is also a lack of evidence that environmental quality necessarily declines with economic development, leaving the option for society to develop and maintain valuable environmental resources.

Figure 1 compares the Environmental Kuznets Curve hypothesis with empirical data of CO2 emissions and increasing income levels across countries worldwide in 2000. There is no indication of an inverted U-shaped Environmental Kuznets Curve for carbon emissions, as CO2

![Figure 1](image)

Note: Average CO2 emissions per capita (in metric tons) across national income levels in comparison to a hypothetical Environmental Kuznets Curve (EKC; after figures by Roberts and Parks 2007, p. 147). Dashed arrows (→) represent striving towards the objective of lowering CO2 emissions while reducing poverty and indicate ‘leapfrogging’ the EKC or lowering already high CO2 emissions. Information derived for the year 2000 for 192 nations with data from the Carbon Dioxide Information and Analysis Center (CDIAC, 2003) and the World Bank (see Roberts & Parks 2007, p. 147 and p. 284, note 42). Respective numbers of countries in each income level in the dataset include: low income (61), low-middle income (54), middle income (33), high-middle income (20), and high income countries (24; Roberts & Parks 2007).
emissions continuously grow with increasing income levels displaying high pollution levels in high income countries. The World Bank has reported similar trends in carbon dioxide emissions per capita with averages in 2004 of 0.9 metric tons in low-income countries, 4.0 metric tons in middle-income countries, and 13.2 metric tons in high-income countries (World Bank, 2008). Affluent countries are not displaying reduced carbon emissions, but rather are among the biggest polluters.

Interestingly, the United States under the Bush administration supported utilizing a “carbon intensity indicator (CO₂ emissions/GDP)” as a measure of the impact a country is having from carbon emissions, energy use, and economic growth that indeed displays an inverted U-shape relationship with rising income levels (Roberts & Parks 2007). Unfortunately, the measure is illogical because it directly trades carbon emissions for dollars of GDP growth without considering the benefits of the GDP growth versus the economic costs of carbon emissions. The only identifiable logic of the indicator is to support the notion that GDP growth provides greater benefits to society than the costs of carbon emissions and that nations simply need to grow GDP to lower the negative effect of carbon emissions. Unfortunately, to grow the GDP under current development approaches requires extensive energy and carbon emissions. The inverted U-shape relationship of the carbon intensity indicator is primarily an effect of the large denominator of GDP, and thus rich countries will have low carbon intensity as long as their economies are large and continue to grow rapidly. Therefore, while the proposed “carbon intensity indicator” declines with GDP growth, in reality the problem of global climate change becomes much worse with ever increasing total carbon emissions. Furthermore, the inadequacy of GDP as a welfare indicator highlights the perversity of policy based on a carbon intensity indicator.

Cleanup costs of environmental degradation are treated as increases in GDP, so the carbon intensity indicator would drop as long as a country was increasing its GDP by degrading its environment (i.e., with oil spills) and then using resources to clean up.

Nations often try to rationalize the strategy of continuing high levels of fossil fuel combustion (and subsequent GHG emissions) by coupling the logic of the ever-increasing economic growth model and the Environmental Kuznets Curve hypothesis—thereby reserving pollution abatement and cleanup for the future. In a single year, from 2006 to 2007, China added generating capacity that was equal to the whole of France’s electricity grid and plans to build 500 coal-fired power plants in the next decade (Lim 2007). The United States has failed to join international
agreements to curb greenhouse gas emissions in the short term and remains one of the top two emitters of CO₂ in the world alongside China. The United States has cited the exclusion of China from GHG cutbacks as rationale for lack of U.S. participation with international protocols and yet the U.S. has promoted an ever growing national production fueled by the highest per capita GHG emissions in the world (WRI 2008).

Major environmental problems arise with economic development based on an ever growing economy and the logic of an Environmental Kuznets Curve at the national and global level—as highlighted by global climate change. First, the EKC assumes that environmental pollution damage is reversible and that levels of degradation can be lowered or mitigated through future actions. In the case of the global atmosphere and climate change, economic development that causes extensive pollution at first, may not present the option to clean it up later if the degradation is irreversible (Solomon et al. 2009). The long residence time of carbon dioxide in the atmosphere (approx. 100 years) poses significant challenges and leaves limited options for future pollution abatement (Roberts & Parks 2007). Second, if one views the EKC only at the national level, specific nations may seem to be lowering environmental impact within the country, but in essence the environmental pollution is now released by other nations as the producers of products consumed through global trade. Again, ignoring cumulative impacts of nations will lead to development that fails to consider the true social costs of fossil fuel consumption and the effects of climate change.

Recent developments provide hopeful evidence that climate change policy may be changing for the top two largest emitters of carbon dioxide in the world. The World Resources Institute (2008) reported that China is now implementing an aggressive energy intensity target and a national renewable energy standard that highlights policies aimed at slowing greenhouse gas emissions growth. In the United States, the Obama administration has indicated support for regulating total carbon dioxide emissions and has asked the U.S. Environmental Protection Agency to review the policy of allowing states to regulate carbon dioxide emissions with more stringent auto standards than federal standards. Linking natural resource depletion, national security, and adverse impacts of global climate change, President Obama stated, “I want to be clear from the beginning of this administration that we have made our choice: America will not be held hostage to dwindling resources, hostile regimes and a warming planet” (Thomas et al. 2009).
Neoclassical Economics versus Ecological Economics

Most economists agree that well functioning markets serve to allocate resources efficiently, but the failure to properly reflect true social benefits and costs can lead to market failures that result in a less than optimal state for society. The benefit-cost approach in economics is based on premises of anthropocentrism (nature that is of value to humans), consumer sovereignty (the consumer’s willingness-to-pay as indicative of utility through relative tradeoffs), individual valuations that are budget constrained, and social valuation estimated from the simple algebraic summation of individual variations (Randall 1987, Hussen 2004). However, neoclassical and ecological economists vary greatly on issues of distribution and the scale of the economy and its relation to the issue of effective policy approaches to global climate change (Daly 1992a, Tacconi 2000).

Neoclassical economists view human capital (such as knowledge, labor, skills, etc.), humanmade capital (manufactured products such as bridges, buildings, roads, etc.), and natural capital (natural resources) as fully substitutable, so that the economic growth of nations is not hindered by the scarcity of natural resources because there exists the possibility to fully substitute for natural capital with human and humanmade capital. As Brown and Panayotou (1992) highlight, resources are limited, but resource use is infinitely squeezable and the correlation between growth and environmental degradation may be a spurious one. Neoclassical economists argue that consumers and producers respond to changing relative incomes, prices, and constraints. If market signals are allowed to reach individuals and include all the social benefits and costs of individual actions, then response by individuals to problems will be economically efficient and best for society (Coase 1960, Hussen 2004, Harper 2008). Concerning global climate change, however, individuals and individual nations are not acting in consideration of true social costs and benefits, and this results in inefficiency and global degradation of the atmosphere.

Figure 2 depicts a global economy as a subset of nature consisting of human, manmade, and natural capital (after Goodland 1992, Daly 1992b). The world has experienced a dramatic increase in the human population and of manufactured goods over time while natural capital has been depleted to create manufactured goods and services. For most of history, the amount of humans and humanmade capital was relatively small in comparison to abundant natural capital (Daly 2005). Now, in
the twenty-first century, the human population is six times larger than two centuries earlier and global gross production of goods and services exceeds $50 trillion and is projected to reach $140 trillion by 2050 (World Bank 2003, 2008). Global environmental problems are now evident,

Figure 2

Note: The economy changing over time as a subset of nature (after Goodland 1992). An ecological economics approach to climate change requires maintaining critical natural capital (e.g. the assimilative capacity of the global atmosphere) to foster sustainable development.
including climate change, ozone depletion, desertification, and collapse of global fisheries. Neoclassical economists see little reason for concern with the depletion of natural capital over time because growing human and humanmade capital can substitute for nature to ensure increased well-being over time. Thus, in Figure 2, the economy (the box) could continue to grow indefinitely (outside of the circle) even with the depletion of nature (diminishing shaded area) because production could be fueled by humans and humanmade capital.

Ecological economists argue that there exists critical natural capital (see shaded area) that cannot be easily substituted and thus economic production will diminish over time if critical natural capital is depleted. Ecological economists believe natural capital and humanmade capital are complements in production and less natural capital will lower potential economic production and human well-being. Daly has effectively argued that one cannot have an economically productive fishery with only fishermen (human capital) and boats (humanmade capital), but no fish (natural capital; Daly 1992b, 2005). Ecological economists argue that we need to conserve the remaining finite critical natural capital and focus on sustainable economic development rather than sustained aggregate economic growth fueled in the short-term by liquidation of natural capital. In Figure 2, an ecological economic approach highlights the need to maintain the assimilative and thermoregulatory capacity of the global atmosphere as critical natural capital (shaded area) by changing behavior and economic production so that it no longer degrades this critical natural capital, but develops within natural constraints. In turn, environmental and developmental policy must acknowledge the constraints of nature, such as limited useful energy highlighted by the second law of thermodynamics, and shift towards efficient use of these limited resources in order to maintain and foster sustainable economic development. An ecological economic approach acknowledges that the loss of critical natural systems not captured in markets will, in the long run, hinder human development, and that international efforts should address policy that maintains these valuable natural assets.

Need for a Renewed Environmental Ethic and Effective Climate Change Policy

All arguments on the issue of global climate change, development, and natural resource use are fundamentally ethical. Utilizing benefit-cost analysis in economics to decide natural resource use and the effects on the global climate as a means to achieve development is inherently norma-
tive—based on society choosing “what ought to be.” Philosopher Mark Sagoff (2000) highlights this point by arguing that economists apply benefit-cost analysis based on willingness-to-pay as a decision criterion for natural resources, but fail to use the same criterion to decide whether to use benefit-cost analysis to make such decisions. Resource economist Alan Randall (1987) has stated that “with respect to conservation and preservation issues, the arguments are ultimately ethical. Although a base of sound scientific knowledge is essential to identify the possibilities and predict the outcomes of alternative actions, decisions must be finally made on ethical grounds.” Benefit-cost analysis in economics is an “unabashedly normative criterion” (i.e., subjective, based on human values) based on utilitarian ethical foundations (Randall 1987).

In the face of global climate change, it is apparent that a renewed environmental ethic is needed to maintain the critical functions of the atmosphere that support humanity. An ecological economics approach acknowledges that the global atmosphere is a form of critical natural capital for which there is virtually no substitute and which must be maintained in a natural state that supports humanity for the long term. Thus, an international effort and agreement is needed to establish such a renewed ethic and define a safe minimum standard (SMS; i.e., a minimum assimilative capacity of the global atmosphere for greenhouse gases) to maintain life supporting services. The concept of SMS was developed in order to address issues of species and biodiversity loss (Ciriacy-Wantrup 1952, Bishop 1978), but is applicable to climate change due to characteristics of very long time horizons, great uncertainty, and/or irreversibility (Randall 1987, Castle et al. 1995).

An ecological economic approach would set a global allowable level of greenhouse gas (GHG) emissions, but allow a market and tradable emissions permit system to optimize the net social benefits within the constraint of maintaining critical natural capital. Ecological economist Herman Daly argues such an approach acknowledges the scale of our economy in relation to remaining natural capital by setting a safe minimum standard in which the global economy can operate (Daly 1992a, 1992b). The mainstream economic growth model supported by high levels of fossil fuel consumption would need to shift towards a focus on energy efficiency to optimize social well-being to meet the requirements of the global agreement—and thus maintain a functioning global atmosphere.

Personal awareness of the social costs of greenhouse gas emissions and the contribution of GHGs to climate change can foster individual action,
behavioral changes, and economic demand (of a type more closely reflecting optimal levels of consumption and production) that consider the full costs and benefits of fossil fuel consumption. However, without the full social costs of climate change reflected in market price, the markets will continue to mislead people and result in an overall state that is less than optimal for society. Thus, a renewed environmental ethic is needed with implementation of fewer GHG emissions at many scales of social organization, but implemented at the largest scale with an international agreement setting an upper limit by capping global GHG emissions.

This ecological economic approach based on a renewed environmental ethic calls for mitigation of the damage from global climate change with a global economy that operates within the natural capacity of the atmosphere to support all life. Nicholas Stern, former chief economist for the World Bank, clearly answered the question of whether the validity of this approach was worth it (i.e., cost effective) by reporting that in this century alone the damage from climate change could be twenty times the costs of solving it (Stern 2007). Investing just one percent of the global GDP over the next fifty years could stabilize GHG concentrations at about 25 percent above current levels, and yet failing to act could produce costs of $4 trillion by 2100 (Stern 1997, Harper 2008). The U.S. National Intelligence Assessment on the National Security Implications of Global Climate Change (Fingar 2008) indicated that climate change could affect: domestic stability in a number of key nation-states, the opening of new sea lanes and access to raw materials, and the global economy more broadly with significant geopolitical consequences. The U.S. National Intelligence Council report clearly states that “climate change will worsen existing problems—such as poverty, social tensions, environmental degradation, ineffectual leadership, and weak political institutions” (Fingar 2008).

The entire human population organized as a group of nations is the composite of billions of individuals and their actions. Even mainstream economists acknowledge the power of the individual as an independent consumer expressing her or his relative values for goods and services as a rational self-interested person in markets. Yet, ecological economists are willing to acknowledge that valuing and conserving certain critical natural services may require human decisions and the establishment of an environmental ethic outside of markets (and a willingness to pay) for the betterment of society. An ecological economic approach still respects the power of the individual in markets along with democratic agreement and implementation of an environmental ethic to protect critical natural capital.
Implementing Effective Climate Change Policy

Effective climate change policy based on a renewed environmental ethic will require implementation at multiple scales of social organization from local, regional, and national to international, but firstly and most importantly it will require an international agreement to cap global carbon dioxide emissions in order to eliminate the effects of “exporting” carbon dioxide emissions across nations. Calicott indicates that effectively addressing climate change will require a collective socio-cultural response in the form of policy, regulation, treaty, and law to offset the recalcitrance of fellow citizens that swamp personal efforts to lower carbon emissions (this volume). The same logic and concerns apply to groups of citizens at the regional and national levels. Nations and regions need assurances that development approaches will not be undercut or swamped by other non-cooperating nations releasing large amounts of greenhouse gases. Thus, international standards to limit global and national greenhouse gas emissions must be established to hinder personal actions of individuals, regions, and nations that will result in a tragedy of the atmospheric commons.

Once a limit on global greenhouse gas emissions is determined, the opportunity exists for strategic investments that serve to avoid the environmental damage of past inefficient development paths and to foster efforts to implement a renewed environmental ethic. An ecological economic approach with an international limit on greenhouse gas emissions would attempt to address carbon impacts and reduce poverty by “leapfrogging” the Environmental Kuznets Curve (or by greatly lowering greenhouse gas emissions if the EKC is not evident) and promote equitable economic development without extensive environmental degradation of our critical global atmosphere (see Figure 2).

The assimilative capacity of the atmosphere for carbon is at a threshold and the world can no longer afford economic development fueled by high carbon emissions. Yet, poverty and income inequality, inequitable historic emissions of carbon by now affluent countries, and high levels of vulnerability to climate change by poor regions that pollute the least, all highlight that climate policy based on a renewed ethic is also a matter of environmental justice. Westra warns us against expressing a diffuse concern for the immediate problem of climate change by speaking in a broad way of future generations, and emphasizes that we need to recognize that environmental justice concerns exist now as the first of future generations will come to be in our lifetimes (this volume). Balafrej high-
lights the vulnerability of the African continent and the global inequality of impacts, stating that “the regions that pollute the least are not those that are least vulnerable” (this volume). An effective international agreement must address the inequities of income across nations and propose carbon mitigation and adaptation efforts that attempt to lessen poverty and inequalities while lowering carbon emissions. Nanda reviews such potential for international environmental law to play a role in crafting appropriate mechanisms to support developing countries in their response to adverse impacts of climate change and clearly indicates that this is also a matter of “international human rights law” (this volume).

Goals of alleviating poverty and inequality and lowering greenhouse gas emissions are inextricably linked. Economist and activist Diez-Hochleitner indicates that poverty may be viewed as the world’s worst “pollution” (Diez-Hochleitner and Ikeda 2008). Villamizar strongly argues that implementing a renewed environmental ethic for climate change involves a true conviction to eradicate poverty (this volume). Roberts and Parks (2007) in their work, A Climate of Injustice, argue that there exists the need to help nations upgrade their development pathways, diversify their exports to create stronger and more resilient economies, transition to lower carbon futures, and establish a new shared North-South worldview. A United Kingdom Roundtable Report on Poverty and Climate clearly indicated that a neo-classical economic approach will not be sufficient to accomplish such goals. He states, “[W]hat is clear is that tackling climate change simply through a price mechanism, without having a mechanism for transferring resources to the poor, will only worsen the already serious problem” (Johnson et al. 2008). An ecological economics approach to climate change acknowledges that carbon emissions and poverty levels can be lowered through effective policy, investment, and sustainable development that allow market mechanisms to determine efficient and cost-effective means to achieve international carbon caps and goals of poverty alleviation. The United Nations efforts towards promoting investments and local engagement in creating carbon neutral and climate change resilient territories, along with a collaborative role of non-governmental organizations (see Rogers, this volume), can foster development of low carbon municipalities, regions, and nations while trying to lessen the inequalities of historic inefficient development. Ultimately, lowering carbon emissions, poverty, and potential costs of climate change in turn lowers the risk for international conflict and promotes peace.
Conclusion

It only seems appropriate that the Toda Institute, founded by Daisaku Ikeda, philosopher, peace-builder, and educator, would coordinate an international scholarly effort and call for a renewed environmental ethic for climate change with Ikeda’s notion that “[a] great inner revolution in just a single individual will help a change in the destiny of a nation and, further, will cause a change in the destiny of humankind” (Ikeda 1973). Climate change is a result of the cumulative impact of human-released greenhouse gases and alteration of individual behavior will ultimately be the prerequisite for mitigating global climate change. An international agreement based on sound science to limit GHG release and maintain a functioning global atmosphere would serve as the framework for an environmental ethic and as a call for individual action and ultimately international action. As Aldo Leopold (1949) indicated, an environmental ethic “reflects the existence of an ecological conscience … and … reflects a conviction of individual responsibility for the health of the land. Conservation is our effort to understand and preserve this capacity.” An ecological economic approach to climate change supports market mechanisms and individual consumers to foster efficient means to achieve GHG limits, but acknowledges individuals can agree to an environmental ethic that highlights a conscience of critical natural capital by establishing a GHG emission standard that maintains a functioning global atmosphere for the betterment of humanity.

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