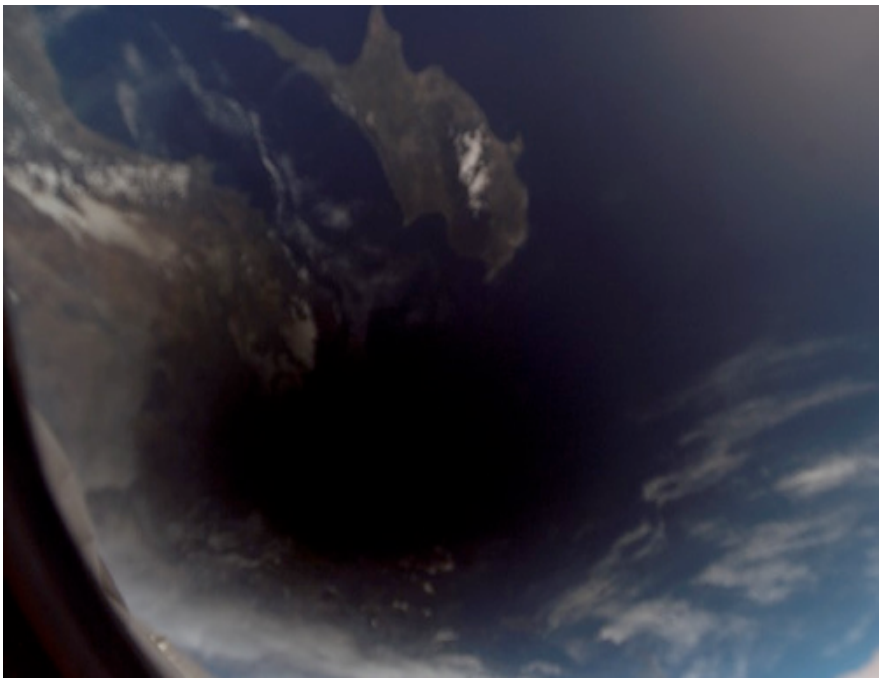
# 10 Things Every Korean Leader Must Know about Climate Change in the 21st Century; plus Four Alternative Futures



**A Report from the Hawaii Research Center for Futures Studies,**

**University of Hawaii at Manoa**

**August 02008**

**Executive Summary**

There is no greater challenge for governments and for all of humanity in the coming decades than dealing with the causes and effects of human-created climate change. Amidst the overwhelming amount of research and opinion on climate change and climate policy, there are several fundamental points that must be understood, internalized, and used as a guide for our individual and collective actions. In this document, HRCFS presents the 10 Things Every Leader Must Know about Climate Change, followed by four alternative futures that map the landscape of possibility resulting from climate change and our response to it.

The 10:

1. **Climate change is real, it is here, and we'd better get used to it**

   "There is broad consensus among climate scientists that global warming resulting from anthropogenic emission of greenhouse gases is a proven fact."

2. **Global Warming leads to Climate Change leads to Global Change**

   But neither of these terms, global warming nor climate change, captures the full scope of the issue. We are entering an era of "global change."

3. **Climate change is global, but its impacts are local**

   Although climate change is an issue of global scale, the effects of climate change will be seen and felt in particular locations and environments by people today and especially by future generations.

4. **It is too late to prevent climate change, but we can stop making it worse**

   If government bodies and citizens had acted appropriately 20+ years ago when the issue was first clearly raised, then we could be well on the way to preventing it, or at least substantially reducing its impacts. Now, all we can and must do is to prepare for climate change, try to ameliorate the most serious impacts, and try not to make it worse than it already is.

5. **Climate change is a critical issue for national security**

   The potential environmental changes forecast for the remainder of this Century are profound and the instabilities generated will challenge the maintenance of national security, however defined, for **all** nations.

6. **Climate change can be good**

   Claiming that climate change is "bad for business" is false. Whoever says it is either ignorant, or lazy, or both.

7. **The Climate must be governed**

   We cannot solve the climate crisis until we recognize that the world has been re-made by our actions. It was our collective irresponsibility that led us to this point, and it will be

our collective responsibility that could save us. We must govern the Earth's climate, the Earth's myriad lifeforms, and evolution itself.

8. **The poor are the most vulnerable; yet the poor are the most prepared**

   Instead of victims of the coming disaster, nations might look to the poor and those in the climate diaspora as guides and mentors to living in a world of scarce resources and climate chaos.

9. **We have the technology**

   Reducing emissions to a sustainable level will require both regulatory action and technological infrastructure development in energy production, distribution and storage. The more we continue to stall, obstruct, and wait, the more we will have to shift from technologies of prevention and stabilization to technologies of remediation and recovery.

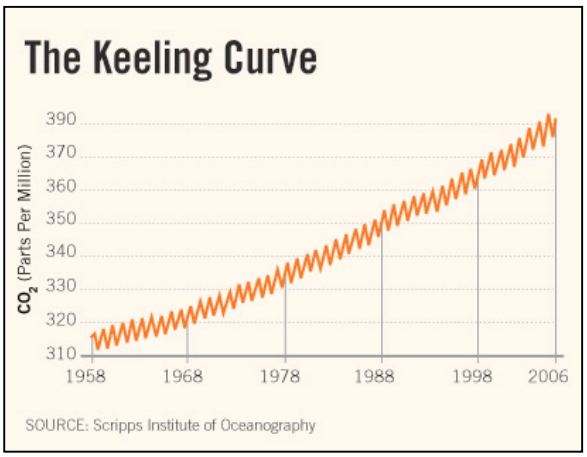
10. **Climate change is a complex, interconnected, systemic phenomenon**

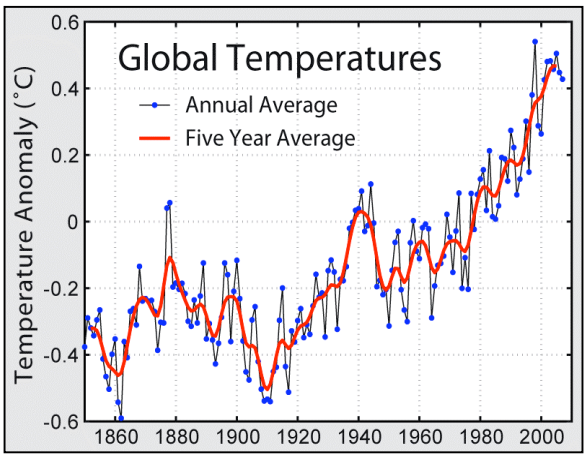
    Trying to address climate change without putting it in framework of global change ignores all the other challenges that humans are now facing. Not only the self-evident first-order impacts, but also the other cascading effects of warming must be understood within the big picture, while being addressed at the local level. A timely and coordinated effort, ranging from the level of the individual right up to the United Nations, is necessary for an effective response.

**1. Climate change is real, it is here, and we'd better get used to it.**

The age of distortion, denial, and equivocation on climate change is over. There is broad consensus among climate scientists and independent researchers that global warming resulting from anthropogenic emission of greenhouse gases has been proven. The preponderance of evidence from land[1], sea[2], ice[3,4], air[5], and space[6] have all confirmed that global temperatures have increased dramatically in the last century, making it the warmest the Earth has been anytime in the history of *Homo sapiens sapiens*, and bringing us close to the warmest the Earth has been in over a million years[7].

Carbon dioxide ($CO_2$) levels detected at Hawaii's Moana Loa Observatory since 01958[8] show a clear and undeniable trajectory. $CO_2$ levels are directly associated with rising air and ocean temperatures:




The recent report of the Intergovernmental Panel on Climate Change[9] states the case clearly:

> 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.

And, to make matters worse, the dire forecasts from the IPCC might be an underestimation of the severity of the disruptions we are facing[10]. A recent survey of over 100 scientific papers suggests that feedback loops and secondary effects of global warming, such as reduced reflection of sunlight from arctic ice, will push temperatures and sea-levels even higher than most current projections[11]. The effect of warming might also push climate systems into chaos, leading not just to warming, but possible rapid cooling and other extreme weather events.

The traditionally deliberate and cautious scientific community has acknowledged the fact of anthropogenic climate change, yet the world's political leaders and a large proportion of the general public have been slow to accept it, and even slower to act, especially in the United States.[12] The disparate pace between rapid climate change and slow political action cannot continue. The sooner policy-makers, leaders, and citizens in Korea understand and fully accept the reality of climate change, the sooner the nation will be able to prepare for and cope with this immense challenge. As Alfonso Pecoraro Scanio, the Italian Environment Minister, put it, "While climate changes run like a rabbit, world politics move like a snail: either we accelerate or we risk disaster."

## 2. From Global Warming to Climate Change to Global Change

Increasing carbon emissions have resulted in a cascade of directly related alterations to the global environment that are all increasing at an accelerating rate:

- Increased atmospheric temperatures
- Increased sea surface temperatures
- Variation in the amount, periodicity, seasonality, and intensity of rainfall
- Decrease in both freshwater and marine pH
- Diversion of "normal" wind directions, intensity and duration

Increasing $CO_2$ levels and rising global temperatures will be the catalyst for increased climate uncertainty and extreme weather events. While average temperatures are rising globally, climate modeling also suggests that we should be prepared for periods of cooling, flooding, drought, storms, winds, and snow in various locations. We are experiencing rapidly growing global and local weather irregularities and uncertainties, compared to the exceptionally pleasant and more predictable weather patterns of the last 200 years.

Even a small sample of the effects of global climate changes on local weather is striking. Cyclone numbers and strength have increased significantly over the past 35 years, especially in the northern Pacific Ocean[13]. According to a recent study, "up to 20% of world's population [1.2 billion people] live in river basins that might inevitably be affected by increased flood events in the course of global warming[14]." Wildfires in U.S and around the world are more frequent, longer-lasting, and more destructive, chasing millions from their homes and costing billions of dollars[15]. Forest fires are doubly troublesome, because not only are they initially destructive, but they also release more $CO_2$ and other greenhouse gasses into the atmosphere and rob the planet of one of its most important methods of carbon sequestration.

Geological evidence supports the determination that climate and weather throughout the Holocene Age (roughly the past 10,000 years) has been comparatively stable and moderate. However, as early as 01896, Svante Arrhenius recognized and described the effect of $CO_2$ and other "greenhouse gases" as a significant factor in capturing and holding the heat of solar radiation. Subsequently, the term "global warming" was popularized throughout much of the latter half of the 20th Century, leading to the United Nations Conference on Environment and Development in Rio de Janeiro in 01992. A more accurate term, "global climate change," that evolved from that meeting recognizes that warming alone is an insufficient description in that it fails to recognize the effects of elevated atmospheric concentrations of greenhouse gases on other weather phenomena and other impacts of increased carbon emissions, such as "acid rain" and shifting rain patterns.

But neither of these terms, global warming nor climate change, captures the full scope of the issue. We are entering an era of "global change." This term is more encompassing and accurate, and provides a better context for examining the range of alterations that extend well beyond weather and pH-levels, and includes access to food, water, and other resources, reproduction and demographics, habitat sustainability, global movements and migrations, international trade and exchange, and virtually every aspect of life on Earth.

**3. Climate change is global, but its impacts are local.**

The cause of such great fear and urgency in the climate change discourse derives from the unprecedented dimensions of the problem. It is hard to fathom that the *entire ecosystem of planet Earth* could be so radically altered as the result of human activity. Many people have difficulty imagining that relatively small, local actions can have such huge affects on global processes, even when accumulated.

The global scope of this change is only possible because of the extreme efficiency of industrialized processes in turning sequestered carbon into fuel, and releasing $CO_2$ into the atmosphere. Climate change, therefore, is a byproduct of human culture and economics. While human alteration of the environment certainly has ancient roots (e.g., early regional extinctions of some wildlife species due to overexploitation, such as the loss of the cassowary from New Zealand and flightless geese in Hawaii), there is also a human history of recognition of cultural responsibilities to maintain natural systems and conditions through agricultural practices, prohibitions on taking specific species or other kinds of limitations (e.g., the Dogon of Mali's respect for trees and prescriptions for reverence prior to felling, placing them on a status with revered elders; in Hawai'i, traditional *kapu* systems (prohibitions on taking) in specific areas of forests or fishing prohibitions limiting seasonal take to preserve nursery stock, and amakua [family deities that are protected, such as sea turtles or sharks], and other customs[16]. One could hope that the latter practices of environmental stewardship will prevail regarding greenhouse gases, but the general global paucity of effective political action coupled with the inertia of global environmental as well as economic processes doesn't support optimism.

Although climate change is an issue of global scale, the effects of climate change will be seen and felt in particular locations and environments by people today, and especially by future generations. Drowning polar bears, melting glaciers, and flooded rivers are becoming common images of our changing climate, but the real tragedy of climate change will have a human face, a face representing every race and nation.

The magnitude of climate change will vary both spatially and temporally, with continental regions and higher latitudes generally warming more than coastal regions and the non-continental tropics. Minimum nighttime temperatures are expected to increase more than daytime maximums, and winter temperatures are expected to increase more than summer temperatures. Some areas will experience more intense precipitation events and increased humidity while others have an increased risk of drought. Australia is currently suffering a prolonged period of drought that has not been experienced there in a century. This is due, in part, to global climate change[17]. Generally, globally averaged evaporation and precipitation are projected to increase. However, because of the great diversity of global topography, patterns of rainfall will vary considerably more than temperature patterns, especially at the local level. "Warming will alter other aspects of climate relevant to disease, particularly humidity and precipitation[18]."

A new understanding of the interconnectness of global and local scales is taking hold, and a startling pattern is emerging. Massive hurricanes, epic flooding, plant pestilence, and disease epidemics are no longer seen as isolated, local events. What were previously considered unfortunate occurrences, or "acts of god," are increasingly often being traced back, through the complex reverberations of climate change, to human activities[19]. Carbon emissions are the main source of global warming, but deforestation, overdevelopment, and other human activities also exacerbate the impacts of climate change.

Every locality will be affected differently by climate change[20]. Some places will see little significant difference in climate, while others, like Kiribati in the South Pacific, will become uninhabitable.

In Korea, the Gangwon Province is already highly susceptible to floods. Global climate change, including increased rainfall in the region, combined with upriver deforestation and commercial and residential development in the floodplain makes for increased risk of destructive flooding in the region[21]. In other regions, drought conditions and reduced or altered streamflow may occur[22].

It is necessary for Korea to devote a substantial portion of public and private monies to research on local impacts, with as fine-grained a focus as possible--it is essential that impacts be assessed at the level of an electoral district for politicians to understand how it affects their own constituents, and for proof that action must happen now to avoid the worst scenarios.

**4. It is too late to prevent climate change, but we can stop making it worse.**

We've barely crossed the threshold of acknowledging human-caused global warming, yet we are already too late to take any action to completely prevent a significant, and generation-length change in the Earth's climate. Even if we somehow stopped all carbon emissions instantly at this moment, *thermal inertia* would continue, raising the temperature of the oceans by as much as 0.6ºC, continuing melting of icecaps and sea-level rise, and greatly affecting the overall climate[23].

Many former carbon skeptics and stakeholders in the status quo, who have finally come to accept the reality of climate change, are now latching on to thermal inertia studies to argue against major shifts in carbon emissions policy such as the Kyoto Protocol. "If it isn't going to stop warming over the next 30 years, why do anything at all?", runs the argument. This is, of course, an absurd and irresponsible position. While it seems to be the case that warming and climate change will continue to occur because of our past action, regardless of what we do today, the level and degree of temperature increase are still to be determined. Climate scientists have developed a battery of models to study the affects of global warming on climate processes such as ocean currents, wind patterns, and ecological sustainability, but there is no current way to accurately predict when certain crucial tipping points will be reached--tipping points which could cause massive climate shifts or ecological collapse. A difference of one-half degree may not seem like much, but the impact of this difference could be enormous.

Recent research by NASA Climate scientist James Hansen suggests that a $CO_2$ level of 350 parts per million (ppm) in the atmosphere is a critical threshold, which we must not exceed if our current ecological systems are to function sustainably. 350ppm is well above the 275ppm that existed in the pre-industrial climate, but it is also much lower than the 550ppm-450ppm levels that were deemed "acceptable goals" for the atmosphere, and that emissions policies have previously targeted. The rapid environmental and climate change in response to relatively small increases in carbon has led Hansen and others to reduce the sustainable benchmark to 350ppm[24].

Unfortunately, measurements of $CO_2$ in the atmosphere are already at 380ppm. This means we cannot only halt the growth of carbon emissions, as the U.S has proposed to do by 02025, we must significantly **reduce** current emission levels, and do it now. Although the U.S. is by far the largest emitter of carbon, its obstructionism in the international arena and non-action on the domestic front, has not only exacerbated the carbon problem, but also given other nations a valid excuse not to implement more stringent emissions policies in their own countries. Whether an Obama or McCain administration follows Bush, it will have a much stronger, more comprehensive, and more responsible set of policies on climate change. But, the rest of the world cannot wait on the U.S. to lead, or wait for guidance from Washington.

If government bodies and citizens had acted appropriately 20+ years ago when the issue was first clearly raised, then we could be well on the way to preventing it, or at least substantially reducing its impacts. Now, all we can and must do is to prepare for climate change, try to ameliorate the most serious impacts, and try not to make it worse than it already is. We must stop as quickly as possible doing the many things that are driving climate change. Equally importantly, we certainly must not start doing things--such a burning more coal to solve our energy problems--which will simply make climate change and other environmental problems worse.

We must quit delaying: address the issues quickly, comprehensively and well.

**5. Climate change is a critical issue of national security**

The anthropogenic climate changes we have been experiencing over the past half-century, while seemingly slow and incremental, are in fact unprecedented in human history in terms their rate of change. The potential environmental changes forecast for the remainder of this Century are profound and the instabilities generated will challenge the maintenance of national security, however defined, for **all** nations.

Climate-caused shifts in agricultural patterns and output will reorder traditional regional surpluses and shortages and food distribution may be affected by disrupted infrastructure (river and marine, roadways and rail). Poverty, coupled with decreased nutrition and changes in ranges of pathogens and vectors, may increase the susceptibility of humans and livestock to disease. The Consultative Group on International Agricultural Research estimates a 20% decrease in food production in Asia in coming decades as a result of climate change[25]. Decreases in fisheries production per unit of catch effort have also been noted. "In Asia, as a whole, per capita water availability has declined by between 40% and 65% since 01950.[26]" According to the World Bank, by 02025 most states in the region (China, South Korea and Thailand) will be facing serious water shortages unless strong action is taken.[27]

Poverty, regional decreases in access to food and livestock feed, and the shifting ranges of infectious diseases combine to place additional pressure on populations to cross borders. The legitimacy of the governments in those countries unable to maintain living standards may be challenged both by their domestic populations and from other nations, resulting in instabilities, and possible internal or regional conflict. Climate refugees could outnumber economic or political refugees in the coming decades[28].

Throughout history, the most significant factor destabilizing domestic and international security has been unequal access to resources. As nations suffer social and economic pressure resulting from climate change, expect an increased movement of people within and between nations, whether sanctioned by governments or not. Whether the flow will be into or from Korea cannot be stated with certainty, but given the Republic of Korea's relative economic strength, net inward population pressures may be likely. Korea's policies on immigration, and appropriate social and economic responses, would need to address these changes. Therefore, analysis of current relevant policies in light of such potential pressures may be warranted.

Furthermore, there may be increased calls for governments to consider more drastic political decisions to secure the resources that their populations need, whether by initiating overt military action, or through political or economic measures. This is especially true if there is a perception that climate change is an intentional or unintentional economic or social weapon. (Yoweri Museveni, the President of Uganda, for example, labeled climate change an "act of aggression" by the developed world against developing African countries and demanded compensation[29], and Kaire Mbuende, a representative to the United Nations from Namibia, compared developed countries' emissions of greenhouse gases "low intensity biological or chemical warfare.[30]") In any case, predicted climate change will increase international competition in most areas, stressing political systems and exacerbating those factors already serving to challenge stability.

As with other countries of similar size, there is little that the Republic of Korea, by itself, can do to alter global climate. It must, therefore, be able to adapt quickly and efficiently to evolving environments to minimize social, economic, and political threats to national security. However, while most nations have had the tendency to become more insular during periods of stress, such

an isolated approach to climate change would be counterproductive. The present and near-future global challenges we face represent an opportunity for nations to *address a common threat cooperatively*, thus decreasing the potential for international conflict. This can best be accomplished now, rather than later, through increased diplomacy, joint initiatives and planning.

Lastly, perceptions are critical to national security. The more that Korea can do to reduce emissions, increase energy efficiency and decrease the present and future climate-related suffering of both its citizens and its neighbors, the more secure it will be. The climate crisis provides an opportunity for Korea to become a regional, if not global, leader in unifying actions to anticipate, mitigate and adapt to the adverse impacts of global climate change.

**6. Climate change can be good**

In any alternative future, there are winners and losers. There are many ways to construct a vibrant economy around appropriate solutions to climate change. Claiming climate change is "bad for business" is simply false. Whoever says it is either ignorant, or lazy, or both.

The Stern Review, a rigorous study of the economic impact of climate change prepared for the British government by Lord Stern, recommends a global investment of 2% of world gross domestic product in order to avoid or mitigate the impacts of climate change. That is roughly 1.61 trillion (U.S.) dollars in investment.

Climate resiliency and mitigation industries will flourish. Shifting coastlines and new coastline building regulations could mean a massive wave of new ocean-front and higher-ground construction. If buildings are not moved, then dikes, dams, levees, fjords, floodgates, and hydraulic engineering will be necessary. Salvage efforts and recovery industries will spring up everywhere. Climate retrofitting and green building techniques and materials will be in high demand. New shipping lanes, including though the Northwest passage, and new access to previously inaccessible resources will also create new opportunities for profit.

Agriculture is clearly one of the most vulnerable and sensitive industries to climate change. But, at least in some areas, climate change may have a positive impact on agricultural yield. Using current climate change models, economists Olivier Deschenes and Michael Greenstone estimate that climate change will not adversely affect yields on major crops and will lead to a $1.3 billion dollar (4%) increase in annual profits for U.S. farmers[31].

The green/clean/renewable energy market has shown remarkable growth in the last few years. A recent report by Lux Research shows "that the amount of venture capital put into clean energy investments last year was $1.5 billion, up 141 percent from the $623 million of 02005, and that in the same period, initial public offerings by companies in this sector rose to $4.1 billion, from $1.6 billion in 02005[32]." So much growth, in fact, that some are already worried about a green energy "bubble."

Renewable energies such as wind, solar, wave, and geothermal are already important sources of energy for homes and businesses, but when emissions treaties with teeth are implemented, the entire transportation infrastructure will need to shift to low emissions (likely non-petroleum-based) energy solutions. This market is already ripe for investment and innovation. Brazil has been at the forefront of the biofuel industry. Sometimes called "the Saudi Arabia of biofuels," the Brazilian industry provided 700,000 jobs in 02003 and cut oil imports by and estimated $50 billion dollars[33].

Opportunities also exist in catering to new lifestyles emerging in the face climate change. Shorter work weeks, less travel, and local-centered economies point to growth in telecommunications technologies and products for the home and home office. Nomadic architecture and self-contained, self-powered forms of transportation could flourish as well.

These areas for economic opportunity are based on more or less smooth adaptations to the conservative climate change estimates. If rapid, highly destructive climate chaos ensues, while changing the rules of the economic game, there will still be opportunities to improve the long-term human condition, and rectify entrenched hierarchies and inequalities in our current system. In other words, if the world we have built were to be destroyed, we should plan to build it again,

only better and with greater benefit to all. Global inequities between the rich North and poor South, between industrialized and developing societies could be abolished.

Within the crucible of dramatic environmental, economic, political, and social disruption, we, as humans, might use our collective ability for imagination and innovation—the "ultimate resource" as Julian Simon called it—to design a new way of life that replaces greed, human suffering, environmental destruction, and conflict with an foresight, generosity, ecological balance, and peace.

**7. The Climate must be governed**

*"People have forgotten this truth, but you must not forget it. You become responsible for what you have tamed. You are responsible for your rose. "*

Saint-Exupéry, *The Little Prince*[34]

There are almost no places remaining on Earth that have escaped influence by human hands. Agriculture, industry, fossil-fuel energy, and the consumption practices of modern humans have transformed the entire ecosystem of planet Earth. Saint-Exupéry reminds us to nurture that which we have tamed. While climate change is surely human caused, it is by no means tamed. On the contrary, what we have created and unleashed is a monster, a force of geological scale, and one with no regard for our responsibility as its creators. Still, we are no less responsible for this climate monster than we are for the cultivated rose.

One of the quintessential human characteristics is to not only to adapt to our environment, but to adapt the environment to ourselves. The amazing technological tools we have created and used to transform our lives and our surroundings have given us an incredible power over nature, a power to steer the course of evolution on this planet, and beyond. Until now, the path we've taken is the result of a mass of unconnected, globally uncoordinated actions. The blind navigation of an ever more powerful vehicle has led us to the brink of environmental and social collapse. What is needed now is a holistic, integrated, and globally responsive set of policies to govern the Earth's ecosystem.

A look at the past behavior of humans in the face of local resource depletion and environmental collapse offers little hope that we are capable, as a species, of pulling ourselves out of the behavior patterns that have created this crisis[35]. We are much better dealing with local, short-term crises, than we are with distributed, incremental, global changes. This is part of our evolutionary heritage, but it is also a product of the forms of culture, exchange and governance that we have designed. As Dator has noted:

> Humanity is nearing the end of a cycle of environmental challenge and technological response. But this time the challenge may be too much for humanity since the cycle is global in scope in many aspects, while still local, if not purely individual in others. Environmental, economic, technological, health, and many there factors are global, but our governance systems are still based, wholly inadequately, on the nation-state, while our economic system ("free-market" capitalism) and many political systems (interest-group "democracy") remain profoundly individualistic in input, though tragically socialistic in output. In both economics and governance, we individualize gains and socialize losses.[36]

An integrated climate agenda does not have to be dictated from a single source at the top of a rigid hierarchy of control. It could be accomplished by *redesigning the economic system*, so as to make actions that have negative or destabilizing impacts on the climate socially, economically, or physically disadvantageous, and to reward actions that are sustainable. We will have to change the rules of the game as it is played today if we are to avoid the worst projections of climate chaos. Our greatest hope is that we already have the technology and the tools to reduce, and eventually eliminate, our carbon emissions. Our greatest fear is that we lack the political will and foresight to act, together, on what we know. Throughout history, we have at times demonstrated

the ability to band together to face a common enemy, to abolish immoral practices, and to prevent imminent disasters. If civilization survives into the 22nd century, we will have overcome our greatest ever challenge, and transformed our way of life in remarkable ways.

We cannot solve the climate crisis until we recognize that the world has been re-made by our actions. It was our collective irresponsibility that led us to this point, and it is our collective responsibility that could save us. We must govern the Earth's climate, the Earth's myriad lifeforms, and evolution itself.

**8. The poor are the most vulnerable; the poor are the most prepared**

Disaster preparation, mitigation, and recovery, average wealth and access to resources, and technological advancement are key factors in terms of who will be most severely impacted by climate change. But the most important factor is location. Poor countries will suffer the most from climate change, predominantly because the poorest countries tend to located along the equator and are already among the hottest places on Earth[37]. These countries' economies are also generally tied to more directly climate-sensitive industries such as farming, fishing, forestry and other natural resource extraction.

Desertification and lack of potable water in Africa and Asia will severely impact large populations in these areas. The prospects of massive flooding, wildfires, and catastrophic drought in poorer countries, especially in urban areas[38]. Ecological collapse would certainly reverse many of the gains in education, wealth, health care and overall quality of life in all nations, but it would be especially hard on developing nations, a recent UN report finds[39]. It recommends that the U.S. and other "rich" nations contribute $86 billion to developing nations for climate prevention, mitigation, and estimated recovery. The call for increased funding and support will only grow stronger as the negative impact and human suffering resulting from climate change are recognized.

Although the urban and rural poor in vulnerable locations along the equator will certainly need the resources and support of other nations (as in a recent proposal for a missionary-like program to bring climate-friendly technologies and knowledge to every corner of the planet[40]), those in the advanced industrialized nations may find themselves turning to developing nations for lessons on how to survive. These people have the most experience coping when basic services collapse; when food, water and energy are scarce; and when political situations are highly unstable and violent. Those who are marginal to the current systems of political and economic power may therefore, paradoxically, be the holders of the most important kinds of knowledge.

Indigenous practices of food cultivation, healing, resource use, and social ordering--considered anachronistic in the post-industrial world--might be the key to our long-term survival. It will also be the scavengers, the subsistence farmers and gardeners, the homeless, those who understand the land and sea, and those who scratch out their daily existence on their wits and "underground" networks of resources, who will come to embody the practices and lifestyles necessary in a collapse society. Instead of victims of the coming disaster, nations might look to the poor and those in the climate diaspora as guides to living in this new world.

**9. We have the technology…**

Reducing emissions to a sustainable level will require both regulatory action and technological infrastructure development in energy production, distribution and storage. A common refrain (or lamentation) in the climate discourse is that "we have the technology" to curb or eliminate all anthropogenic greenhouse gas emissions. While is no single "magic bullet" technology that can solve ALL our climate needs at once, the combined effect of a series of existent technologies, if implemented immediately, would provide the beginnings of a solution. "Humanity can solve the carbon and climate problem in the first half of this century by scaling up what already know how to do[41]".

Unfortunately, to echo another refrain, we don't yet have the leadership and political will to implement this strategy. The longer governments wait to take coordinated action, the larger our overall "climate commitment"; that is, the compounding effects and responsibilities deriving from continued warming, thermal inertia, and other global changes that will continue well after the transition to carbon-neutral technologies and behaviors[42]. The more we stall, obstruct, and wait, the more we will have to shift from technologies of prevention and stabilization to technologies of remediation and recovery.

Today, energy and emissions go hand-in-hand. The main source of atmospheric carbon comes from the waste products of our fossil fuel-based energy production and use. We extract carbon-based fuel from beneath the surface of the Earth, burn it to turn turbines, and send enormous amounts (7 billion tons, and rising) of previously sequestered carbon into the atmosphere. This is a highly inefficient and environmentally destructive process and accounts for 85% of our total global energy consumption. Reduction in energy use, and increased efficiency are both necessary measures to meet emissions goals. In addition, there are several viable alternatives to produce the 10-30 TW of (emissions-free) energy needed globally, if "business-as-usual" energy consumption trends continue. Pacala and Socolow, in a frequently cited article on stabilization strategies, list domains (or "wedges") that could curb the growth of carbon-emissions. They are: increases in energy efficiency, decarbonization of fuels, and biological sequestration in forests and soils[43].

- Increased efficiency

  Some loss and dissipation is to be expected whenever energy is converted from one form to another. It takes time for a newly introduced energy technology to reach its maximum efficiency. Mature technologies, such as large electric generators and internal combustion engines have well-known efficiency ratios and have nearly reached maximum efficiency. Newer technologies, especially wind and solar, still have much more room to increase input-output efficiency, currently only achieving approximately one-third their theoretical efficiency limits[44].

  Automobile power conversion, while having over 100 years to develop, still has much more room for increasing efficiency[45], both mechanically and behaviorally--in the habits and techniques of individual drivers. 14% of the necessary reduction in emissions growth over the next 50 years could be accomplished if automobile fuel efficiency increased from an average 30mpg to 60mpg[46].

  Commercial buildings and residential living spaces are also an easy target for efficiency increases. Well-known techniques, such as better insulation, and utilization of more efficient heating, cooling, and major appliances could "reduce mid-century emissions

from buildings by about one-fourth. About half of the potential savings are in the buildings in developing countries.[47]"

Improved efficiency in large power plants. Coal power plants, while producing about one-fourth of all carbon emissions, operate at only around 30% efficiency. But even more efficient coal plants are not the long-term solution. Transitioning to natural gas, then renewable, emissions-free sources, such as wind, solar, thermal, and wave is necessary.

- Decarbonization of fuels and renewable energy

Decarbonization means the reduction of carbon emission per unit of primary energy and includes the use of non- or lower-carbon-based fuels, as well as carbon capture and storage (CCS). Carbon capture and storage consists of two stages, the first is a precombustion process in which hydrogen and $CO_2$ are produced and the hydrogen is burned to create energy (already occurring in hydrogen plants), and the second is geologic carbon storage, in which waste $CO_2$ is manually injected into underground reservoirs.

The range of alternative and renewable energy options are too numerous to list in full, but include solar, thermal--both geo and ocean, wind, tidal, nuclear, and biomass. They are currently contributing less than 1% of total global energy output. A massive increase in scale and reduction in production costs is necessary for renewable energy to become attractive. However, with rising petroleum costs, increased political pressure, and technological innovations, renewable energy sources are entering the pool of viable options. Some examples of renewable energy technologies that are currently being utilized will provide a sense of the available technologies on the market today.

- Tidal power. The world's first tidal-power system has been connected to Northern Ireland's National Grid. The twin-turbine system, using tides instead of wind, will provide 1.2 megawatts of power, without emissions or ecological damage[48]. As intial costs come down, tidal power is an attractive, clean, and completely renewable energy option.

- Wind Power. Like tidal power, wind farms harness clean and safe environmental forces to transfer energy. As a sign of the viability of wind power, the State of Texas, long the center of the U.S. oil industry, has just approved the construction of a $4.93 billion wind energy transmission system, connecting wind farms in the western part of the State with population centers in the East, and alleviating of the logistical bottlenecks to the wide-spread use of wind power[49].

- Wave power. Harnessing the potential two trillion watts of energy from waves has been a design challenge. New technologies are now ready for implementation. One such device, called the Anaconda, has enormous potential. It "floats horizontally just below the ocean's surface, tethered to the ocean floor at one end, facing oncoming swells, with a turbine attached, at the other. A wave hitting the tube creates a bulge in the water inside. The bulge travels down the tube with a speed that depends on the diameter of the tube, wall thickness, and elasticity of the material…The tube is designed so that the speed of the bulge is the same as the speed of the wave. The wave travels outside the tube alongside the bulge, making the bulge bigger and bigger, so that it drives the turbine with maximum power.[50]"

- Nuclear Power. A diverse array of advocates across the political spectrum have been touting a reinvestigation and possible recommitment to nuclear power, especially in the United States. But, while the next generation of nuclear power plants would be more efficient and (according to some estimates) safer, there are several factors that make nuclear power a poor choice to replace fossil fuels, in light of the other options readily available. Here are three. Firstly, nuclear power plants would follow the same centralized energy model that has prevailed over the last 100 years, creating vulnerabilities that all centralized systems inherently possess. Secondly, these plants, like those already in existence, would be primary targets for terrorists and war planners. This would require a massive security infrastructure to be in place and constant vigilance requires. And finally, nuclear fission produces radioactive waste that is no more easily housed or protected than current nuclear waste. Besides being another possible terrorist target, it is a major health hazard for hundreds of human generations to come. We need an energy infrastructure that is flexible, resilient, and safe. Nuclear power, while reducing our carbon emissions, is, in our opinion, not the best option.

- Solar power. The great nuclear fission reactor in the sky sits 92 million miles from Earth, but offers a reliable source of energy--energy that has fueled life on this planet for billions of years. Photovoltaic (PV) cells have been in existence for decades, but have yet to reach efficiency, distribution, and cost levels to accelerate its implementation. Recently, however, MIT scientists have made a discovery that could thrust PV and solar energy into the mainstream. Mimicking a photosynthetic catalytic process, the technology takes the sun's energy to be used to split water into hydrogen and oxygen gases. According to the MIT press release, "the oxygen and hydrogen may be recombined inside a fuel cell, creating carbon-free electricity to power your house or your electric car, day or night[51]."

- Carbon sequestration

Forests are the lungs of the planet, and are an essential part of reducing atmospheric carbon. Forest carbon sequestration strategies include the discontinuation of clear-cutting of the world's forests and the aggressive reforestation and afforestation efforts. Close to 7% of carbon stabilization goals could be met if clear-cutting out tropical forests was completely stopped, with another 7% gained if 250 million tropical acres or 400 million temperate acres were reforested[52].

Soil sequestration is another critical avenue. As Pacala and Socolow report, "when forest or natural grassland is converted to cropland, up to one-half of the soil carbon is lost, primarily because annual tilling increases the rate of decomposition by aerating undecomposed organic matter…Practices such as conservation tillage (e.g., seeds are drilled into the soil without plowing), the use of cover crops, and erosion control can reverse the losses."

Technological solutions to our carbon problem cannot be introduced in isolation. These technologies must be re-informed by enforceable regulatory policies and behavioral changes. Leaders must implement new energy and resource strategies now, in order to reduce the need for massive and de-stabilizing mitigation and remediation technologies, including large scale geo-engineering.

**10. Climate change is a complex, interconnected, systemic phenomenon.**

Increased atmospheric carbon emissions are currently warming the planet at rates and to levels unprecedented in human history. But the non-linear effects of warming on the complex system of the Earth's climate points to dramatic and highly unpredictable[53] changes in global and local weather. Global warming must be understood within the overall process of climate change, and, if some forecasts are correct, climate chaos. The effects of these changes go beyond weather and will touch on almost every aspect of the tapestry of global ecology and web of life.

Oceans

The world's oceans are critical in the uptake of carbon and are estimated to have absorbed 50% of the carbon from fossil fuel emissions and other human activities in the last 200 years. This process has caused the pH-levels in the oceans to fall, bringing about ocean acidification.[54] Acidification threatens marine life in almost every Kingdom and node in the food chain, from zooplankton to coral to fishes and mammals[55]. Thus, it threatens all human activities and systems that depend on the ocean.

Korea, as a culture and economy tied closely to the ocean and its resources, is highly vulnerable to changes in marine ecology and climate. While Korea may be able to avoid or cope with rising global temperatures more effectively than continental equatorial countries, the potential secondary and tertiary impacts of climate change, including wildfires, flooding, increases in sea level, and collapse of fisheries and marine life will severely effect Korea and its people.

Emigration, immigration, and shifting demographics

Climatic factors have always influenced human settlement and density patterns, and continue to do so, with greater impacts not only on immigrants and host populations, but also on the environment, in line with increased human numbers. At some point over the past decade, globally the number of urban dwellers overtook the number of rural ones. Close to 200,000 people per day leave their rural homes for cities, and the number of "squatters" is estimated at 1 in 6, or about one billion worldwide[56]. The United Nations estimates that 35 million new homes are required each year to keep pace with this immigration and to diminish the number living in squalor on the fringes of (mostly tropical) cities, such as Rio de Janeiro, Mumbai, and Nairobi.[57] By definition, they do not own their land and live in areas largely unrecognized by city services, such as access to clean water and sewerage. As a result, disease rates are extremely high. As climate continues to place pressure on limited rural resources, more individuals will likely come to the urban hubs. Similar trends could play out in South Korea.

Korean policymakers should consider what alterations to the social and physical infrastructure would be required, both as the South Korean population moves within the country in response to shifting climatic conditions, and in the event the numbers of those wishing to cross the border into South Korea mount. The impact of climate change on North Korea and China must also be considered and closely monitored. If conditions elsewhere were to deteriorate, the pressures on members of their populations to immigrate to South Korea would likely increase.

Disease and Public Health

Where public hygiene and amenities are lacking, increased urban density in the larger cities creates conditions favoring epidemics of diseases such as cholera. An additional consideration is that in areas fortunate enough to have sewerage, plumbing maybe shared with storm drain

systems. If, as is forecast, episodic rain events will be fewer in number, but greater in volume and intensity, rain runoff could more frequently overwhelm the capacity of the storm drains. Runoff would mix with sewage, flooding streets and neighborhoods and bypassing sewage treatment facilities (especially in low-lying urban areas close to sea level, such as has been experienced in Honolulu[58]). Consideration should be given to installing separate storm water and sewage piping in those areas that may be most affected.

The social and political pressures of mass immigration also have an effect on the human condition and, therefore, on health and disease. "Disease rates tend to be highest among populations affected by war or other political instability that causes mass migration of populations[59]" This relationship has been clearly demonstrated in areas of the African continent, notably Somalia, where the disruptions of wars and the resulting mass movement of people have disallowed planned agriculture, made maintenance of livestock nearly impossible, and, as a result, have decreased overall health as demonstrated by an increase in infectious disease rates. "(Leishmaniasis) proves to be a real sword of Damocles hanging over the population of a country where health infrastructure has been ravaged by 15 years of civil war. Without appropriate treatment, visceral leishmaniasis, one of the three clinical forms of the disease rife in Somalia, has a mortality rate of close to 100%. The situation is all the more serious as the country is already struggling with endemic tuberculosis and malnutrition made worse by the major drought of 2005 and 2006[60]"

Certainly, Korea would not likely face the severe epidemic problems realized on the African continent, but the relationship between possible outcomes of climate change (malnutrition, crowded urban conditions, and the related physical and psychological stress) and a decrease in the ability for people to maintain their immunity to disease must be considered. Increased susceptibility to infectious disease coupled with disruptions in public supplies of potable water and effective sewage treatment associated with climate change can combine to support epidemics.

In addition, almost all of the environmental changes experienced by humans are similarly experienced by most other forms of life across all taxonomic classifications, including pathogens responsible for disease. Some pathogens are affected by climatic change to a greater extent than humans due to their sometimes very narrow environmental tolerances, especially during vulnerable phases of their life cycles.[61] Climatic change, especially warming, can favor pathogen reproduction, transmission and survival, sometimes spreading or shifting their geographic range both horizontally and in elevation.[62]

El Niño -Southern Oscillation events provide excellent opportunities to monitor the impacts of region-wide temperature fluctuations, affecting all trophic levels. Documentation shows they have a "detectable influence" on marine and terrestrial pathogens, including coral diseases, oyster pathogens, crop pathogens, Rift Valley fever, and human cholera[63] Data show that the higher temperatures and increased rainfall associated with El Niño anomalies provide opportunities for vector-borne diseases to expand their range and increase the length of the seasonal period that they can be transmitted.[64]

Public health considerations should be designed into any plan for mitigating the negative impacts of climate change. Measures can be undertaken now to help ensure maintenance of potable water and sewage treatment as the environment changes.

Governance: Structure and Agency

An ongoing tension within all forms of governance, both in theoretical argument and practical application, is the relative weight and importance of structure (institutions, laws, rules, procedures) versus individual and group agency (obedience/disobedience, consent/dissent, participation, cooperation). This is as true for domestic governance as for states acting in the international arena. Designing a productive and efficient structure that accounts for and responds appropriately to the will of individuals and groups is the core of good governance.

In a recent article, Samuel Bowles of the Santa Fe Institute presents several case studies of attempts to modify what was considered harmful or unfavorable behavior. In one case, a child care facility levied fines on parents who were late to pick up their children, in the hope that fines would encourage punctuality. However, the habitually late parents used the fines simply as a purchased right to be late, and even worse, many previously punctual parents began doing likewise. In another case, the Irish government imposed a small tax on environmentally harmful plastic bags. This small tax had the effect of reducing plastic bag use by 94%[65].

As Bowles notes, "Policy-makers could learn valuable lessons from experimental evidence that some mechanisms induce even the civic-minded to act as if they were selfish," and, he continues, "Good organizational and institutional design can channel the material interests for the achievement of social goods while also enhancing the contribution of the moral sentiments to the same ends." As the two examples above indicate, within complex societies and with an array of cognitive biases to contend with, governance design can be tricky. Governance design, especially at the international level, remains in the Dark Ages compared to many other fields of endeavor, and this is directly related to the continuing ineffectiveness of action on climate change.

It is incumbent upon states to find ways to design policy, laws, and regulations to encourage their citizens to reduce their carbon footprint, and to work with each other at the international level to hold rogue carbon emitters accountable.

Trying to address climate change without putting it in framework of global change ignores all the other challenges that humans are now facing. Not only the self-evident first-order impacts, but also the other cascading effects of warming must be understood within the big picture, while being addressed at the local level. A timely and coordinated effort, ranging from the level of the individual right up to the United Nations, is necessary for an effective response. Acting to address each individual effect of climate change and failing to integrate strategy within the broader context of global change may ultimately be worse than taking no action at all.

**Four alternative futures for climate change**

There is not ONE future which can be accurately predicted, but rather a range of possible alternative futures that can be forecast. This approach has influenced scenario planners and futures researchers over the last 40 years. It has proven highly effective at helping organizations and individuals navigate change and is fundamental to all serious attempts to understand and forecast futures.

The alternative futures approach is not only more theoretically and philosophically robust than an approach based solely on modeling existing data, but it widens the scope and field-of-view of the study, compared to other methods. It takes account of shifts already in progress, along with trends "on the horizon" as well as emerging issues "over the horizon", and integrates the potential cross-impacts of these trends and issues in a consistent and coherent fashion within the scenarios that are developed.

Here we present four alternative futures for climate change, which the nation and the people of Korea might be faced with in the coming decades. While the actual future may or may not look like any of these stories, effective foresight demands that one prepare and plan for these and other possible outcomes.

**1: "Enough fingers for the dam"**

The melting icecaps in Greenland and the Arctic cause sea-level rise to hit the coastlines of prosperous North America and Europe much harder and faster than most were prepared for. Small atolls in the South Pacific had been written off as unfortunate early victims of rising oceans, but the massive SeaWall barriers being hastily erected around the major cities of the entire Eastern seaboard of Canada and the United States have become the most recognizable symbol that a new reality has ascended in the West.

The United States, for so long in denial of climate change, and so active in obstructing international emissions initiatives, once again angers the world; this time in its heavy-handed and unilateral "War on Warming." Trying to put aside decades of anger and mistrust, many nations initially hope that the biggest climate criminal will become a climate savior. A "wait and see" attitude rules until the U.S. begins to impose economic sanctions on States that have not met the new, and most stringent carbon emissions standards set by Washington. Internationally it comes as no surprise that developing nations in Asia and Africa are hardest hit, and begin to look even more to China and India for political and economic support.

The U.S. also begins bold (but unilateral) experiments in geo-engineering, with its solar shading project working quite well, but the disastrous ocean de-acidification attempt killing 10% of all marine life in the Gulf of Mexico, and almost leading to a hot war with the Union of South American States.

This new chaotic and tense political landscape, where conflicts arise not over "action vs. inaction", but instead over the kinds of action that ought to be taken, is nonetheless having some demonstrably positive impact by way of greenhouse gas reduction. It has also helped that the lack of cheap energy and the difficulty in shifting the energy infrastructure has had an enormous effect on the consumer lifestyle of the early 21st Century. The carbon footprint of an average

North American has been halved in the last 20 years and it is estimated than in another 5 years, carbon emissions will finally return to 1990 levels.

The ad hoc and uncoordinated efforts of the nations of the world are leading to simmering conflicts, massive migration and climate refugees, and dangerous attempts at technological fixes. Food shortages, water shortages, and energy shortages are common, but not wide-spread or long-lasting. Nonetheless, greenhouse gases in the atmosphere are slowly being reduced, renewable energy is growing, and it appears the worst environmental collapses will be avoided.

**2: "Helter-Shelter"**

Beyond hope that a political answer was possible, leaders in many industrialized nations set out on a mission to develop technological solutions to the climate crisis. With almost limitless funding and sense of urgency surpassing even the development of the nuclear bomb or the race to the Moon, scientists and experts across industries and disciplines fix their efforts upon wrestling nature back into a shape suitable for human habitation. Unfortunately, our best efforts were too little, too late. With carbon and methane pouring into the atmosphere, there was not enough time for the planned geo-engineering technologies to reach sufficient reliability to launch before the worst destruction came. Typhoons, floods, fires, drought, food shortages, mass species extinctions, and sea-level rise overwhelmed the world's capacity to maintain the political, economic, and social infrastructures we had relied upon. Disease and starvation were the largest killers, and within a generation almost half of the world's population had been wiped out. Most others were uprooted, displaced, and trying to re-organize.

But the mad dash to technological innovation did leave the survivors with some useful tools to build a new way of life. Most people had become nomadic, carrying all the necessities of survival with them as they searched out temporary, stable, habitable land. Solar-powered networks and wireless access stations allowed people to connect to the global net, which had become a useful repository of global weather news and resource location. The web was also the platform for a range of virtual global games. As former luxuries were gone, and the stress of survival high, games allowed people to past the time and relax. On the road, or settled in camps, people constantly played.

There were no remaining monetary systems or recognizable nation-states, but despite the formidable challenges to existence, most human societies did not descend into killing, stealing, or a Hobbesian anarchy. A new kind of civilization was emerging. After a generation of chaos, the climate was slowly reaching a new equilibrium. Barter and sharing became the predominant form of exchange, and when team of researchers from Australia were finally able to mass produce a nano-manufacturing system that could replicate meat, vegetable, and many other materials, a post-scarcity, non-hierarchical, renewable-energy-based society was a re-assuring beacon of hope on the horizon for humanity.

**3: "A New Dark Age"**

Enforceable international treaties on climate change are never fully realized and the desultory policies of the major greenhouse gas polluters do little to curb accelerating temperatures and worsening climate conditions. As vital resources dwindle and weather patterns become more

unpredictable, frequent conflict erupts in distressed areas around the globe. Water shortages and famine strike Africa and the Middle East the earliest and the hardest. With the stakes so high, the fighting is brutal, fierce, and total. Millions are killed in the first years of the wars.

The world's military superpowers use their strength to take by force what they don't already possess. Asia's resources are dominated by China, which faces enormous difficulties in sustaining its billion-plus citizens. The Chinese subdue the continent with direct force and threats of annihilation to those who challenge its actions. Nuclear war seemed a certainty until India finally stepped back. India's population, like that of other regions in Asia, was soon to be devastated by floods, disease, wars, and famine.

The U.S., although still wielding the world's most powerful military, is stretched too thin at home to help its allies abroad. Flooding in the Midwest, fires and drought in the West, and battering hurricanes in the South and East put the country in a state of constant emergency. Infrastructure crumbles and civil unrest racks the nation. The well-armed populace gathers into local militias, protecting limited resources and occasionally raiding and occupying neighboring areas. Everywhere, law and order breaks down.

Europe, gripped in rapid cooling induced by the shifting thermohaline current, avoids the mass killing and destruction that other continents have experienced. But, the more communal, cooperating spirit of Europe is fracturing as mass migrations of Scandinavians plague the southern regions, and food production begins to be insufficient to support the remaining population.

The social fabric of civilization rips apart and the world descends into armed chaos. Climate refugees are denied entry into more stable regions, global guerillas control more and more resources, energy is sparse and erratic, and civilization as we knew it collapses. People seize any land they can protect and fight for survival. A new Dark Age sets in around the planet.

**4: "Declaration of Universal Human Responsibilities"**

Ice-free summers in the Northern hemisphere and frequent warming-related "natural" disasters finally shake the world into action. Popular discontent makes political inaction impossible. Never the vanguard of climate leadership, but encouraged by technological developments in solar, wind and renewable energies, and seizing an opportunity to build its reputation as the *moral* superpower, China leads an increasingly vocal and powerful Asian bloc at the UN. The resulting series of resolutions creates strong and binding treaties for emissions reductions among all member states. The Security Council avoided a U.S. veto by re-negotiating treaties and making special exceptions for U.S. industries.

The U.S. became the only country in the world that was legally allowed to produce and sell beef products—and only within its borders. Around the world, the venerable hamburger became the most hated symbol of American arrogance and global irresponsibility. But in the U.S. and everywhere else, drastic changes to the modern consumer lifestyle were mandated and strictly enforced. Both international and domestic travel were severely restricted and carbon footprint rationing was put into effect. Nations differed in their monitoring techniques, but mandatory implanted RFID tracking chips were the most common tools.

As the world slowly transitioned the economic and energy infrastructure from fossil fuels to renewable energy (the "Gore Shift"), that which was not prohibited was nearly impossible anyway. Luxury goods and consumer goods with high carbon footprints were hard to find, and socially stigmatized. Travel by electric car or train was popular, but air travel on fixed wing planes, which still could not carry the weight of heavy batteries and required liquid fuel, was rare, rationed, and prohibitively expensive.

World economic growth slowed and eventually shrank as lifestyles became slower, more local, and more controlled. Many lamented this reduction in individual freedoms, and small-scale insurrections against the more onerous restrictions of the U.N.'s "Declaration of Universal Human Responsibilities" were occasionally attempted. The radical *Long Shower Brigade* staged the most sensational acts of civil disobedience, until the Canadian government uncovered a bomb plot, and arrested all its leaders.

The draconian carbon control measures were not the most beloved acts in the history of modern governance, but their effectiveness could not be denied. The rising tide of greenhouse gases was stemmed within a decade and the slow march to ecological sustainability was progressing. Thermal inertia and ocean acidification continued to cause climate and marine ecology disruptions, but the Earth showed remarkable healing powers once the carbon tsunami subsided. The UN showed it could bring the nations of the world together to conquer a global challenge and that a more peaceful co-existence was humanly possible.

**Conclusion**

Leaders in Korea and around the world are faced with the most profound challenge we as a species have ever faced. This is a challenge created by our great ingenuity, combined with our hubris and willful ignorance. It is a challenge that we will confront and solve with our great ingenuity, combined with our foresight and courage. Global change and climate chaos could lead humanity along the path to distinct alternative futures. We, who are writing these words, and you reading these words, are responsible for what future comes to pass. So, we must ask ourselves: How will we be remembered?

**Authored by:**

**Jake Dunagan**

**William Kramer**

**Jim Dator**

**Stuart Candy**

**Seongwon Park**

**Hawaii Research Center for Futures Studies**

**2424 Maile Way, Saunders 632**

**Honolulu, HI 96817**

**www.futures.hawaii.edu**

## Endnotes

[1] Gullison, R.E. et al. 2007. "Tropical Forests and Climate Policy" *Science*, vol. 316, no. 5827, May 18, 2007, pp. 985-986.

[2] ABC News, 2008. "Ocean salinity evidence of climate change," April 17. http://www.abc.net.au/news/stories/2008/04/17/2219659.htm

[3] Nghiem, S.V., et al. 2006 "Depletion of perennial sea ice in the East Arctic Ocean" *Geophys. Res. Lett.*, vol. 33, L17501, 29 October.

[4] Bell, R.E. 2008. "The Unquiet Ice" *Scientific American*, February, pp. 60-67.

[5] IPCC, 2007. Fourth Assessment Report, Summary for Policymakers, p. 5

[6] NASA, 2007. "NASA Satellite Data Confirms Climate Change" NASA news release, December 12. http://geology.com/nasa/satellite-data-confirms-climate-change.shtml

[7] New Scientist, "Global Warming Nears a Million-Year High" *New Scientist*, September 26. http://www.newscientist.com/article/dn10159-global-warming-nears-a-millionyear-high.html

[8] http://www.esrl.noaa.gov/gmd/ccgg/trends/

[9] IPCC, 2007. Climate Change Synthesis Report.

[10] Smith, L., 2007. "New $CO_2$ evidence means climate change predictions are 'too optimistic'" http://www.timesonline.co.uk/tol/news/uk/article2719627.ece

[11] MacCracken, M.C., F. Moore, and J.C. Topping, Jr., (eds.), 2008. *Sudden and Disruptive Climate Change: Exploring the Real Risks and How We Can Avoid Them*. Earthscan, London.

[12] Hansen, J., 2008. "Twenty years later: tipping points near on global warming", *The Guardian* (London) online, 23 June. http://www.guardian.co.uk/environment/2008/jun/23/climatechange.carbonemissions.

[13] Webster, P.J.et al., 2005. "Changes in Tropical Cyclone Number, Duration, and Intensity in a Warming Environment," *Science*, vol. 309, no. 5742, 16 September, pp. 1844-1846.

[14] Kleinen, T. and G. Petschel-Held, 2007. "Integrated assessment of changes in flooding probabilities due to climate change" *Climate Change*, vol. 81, no. 3/4, April, pp. 283-312.

[15] Westerling, A.L. et al., 2006. "Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity" *Science*, vol. 313, no. 5789, August 18, p. 940.

[16] Milton, K. 1996. *Environmentalism and cultural theory: Exploring the role of anthropology in environmental discourse*. Routledge, London.

[17] Karoly, D., J. Risbey, and A. Reynolds. 2003. "New research has found that human-induced global warming is a key reason why the Australian drought of 2002 has been so severe." *World Wildlife Federation Bulletin*. January 14.

[18] Houghton, J. et al., Eds., 2001. *Climate Change 2001*: *The Scientific Basis*. Cambridge University Press, Cambridge, England.

[19] Madrigal, A. 2007. "The Local Impacts of Global Climate Change," *Wired Science*, November 27. http://blog.wired.com/wiredscience/2007/11/the-local-impac.html

[20] Watson, R.T, M.C. Zinyowera, and R.H. Moss. 1998. *The Regional Impacts of Climate Change: An Assessment of Vulnerability*. Intergovernmental Panel on Climate Change Working Group II, Cambridge University Press, Cambridge.

[21] Chang, H., J. Franczyk and C. Kim, 2008. "What is responsible for increasing flood risks? The case of Gangwon Province, Korea", *Natural Hazards*, doi: 10.1007/s11069-008-9266-y

[22] Kim, B.S. et al. 2007. "Impact of climate change on water resources in Yongdam Dam Basin, Korea", *Stochastic Environmental Research and Risk Assessment*, vol. 21, no. 4, April, pp. 355-373.

[23] Hansen, J. et al. 2005. "Earth's Energy Imbalance: Confirmation and Implications," *Science*, vol. 308. no. 5727, pp. 1431-1435.

[24] McKibben, B. 2007. "Remember This: 350 Parts Per Million," *Washington Post*, December 28, p. A21.

[25] Consultative Group on International Agricultural Research. 2007. Inter-Center Working Group on Climate Change (working in collaboration with the World Climate Research Program and the United National Environmental Program and the World Bank). http://www.cgiar.org/pdf/climatechange/pdf.

[26] Dupont, A. and G. Pearman. 2006. "Heating up the planet – climate change and security." Lowy Institute Paper 12. Lowy Institute for International Policy 2006. New South Wales, Australia.

[27] Dupont, A. 2001. *East Asia imperiled: transnational challenges to security*. University of Cambridge Press. Cambridge, UK

[28] Sachs, J.D. 2007. "Sustainable Developments: Climate Change Refugees," *Scientific American*, June.

[29] Clark, A. 2007. "Climate change threatens security UK tells UN," *The Guardian*, April 18.

[30] United Nations Security Council Department of Public Information. 2007. "United Nations Security Council holds first ever debate on impact of climate change on peace, security hearing over 50 speakers," UN Security Council 5663rd meeting, April 17. http://www.un.org/News/Press/docs/2007/sc9000.doc.htm.

[31] Deschenes, O. and M. Greenstone. 2004. "The Economic Impact of Climate Change: evidence from Agricultural Profits ad Random Fluctuations in Weather," MIT Department of Economics Research Paper, No. 04-26.

[32] Wald, M. 2007. "Bubble warning for green energy investments" *International Herald Tribune*, May 1. http://www.iht.com/articles/2007/05/01/news/clean.php.

[33] Lovins. A.B., et al. 2004. *Winning the Oil Endgame*, Rocky Mountain Institute, p. 105.

[34] Saint-Exupéry, A. 1943. *The Little Prince*. Harcourt, Brace & World. [alternative translation quoted]

[35] Diamond, J. 2005. *Collapse: How Societies Choose to Fail or Succeed*. Penguin.

[36] Dator, J. 2004. "Assuming 'Responsibility for our Rose'" in Jouni Paavola and Ian Lowe, eds. *Environmental Values in a Globalizing World: Nature, Justice, and Governance*. London: Routledge, Chapter 13.

[37] Mendelsohn, R., A. Dinar and L. Williams. 2006. "The distributional impact of climate change on rich and poor countries." *Environment and Development Economics*. vol 11, pp. 159-178.

[38] Douglas, I. et al. 2008. "Unjust waters: climate change, flooding and the urban poor in Africa" *Environment and Urbanization*, vol. 20, no. 1, pp. 187-205.

[39] UN Development Human Report. 2007. *Fighting Climate Change: Human Solidarity in a Divided World*.

[40] Steffen, A., 2008. "The Outquisition", *WorldChanging.com*, 12 July. http://www.worldchanging.com/archives/008208.html

[41] Pacala, S. and R. Socolow. 2004. "Stablization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies" *Science*, 13 August, vol. 305, pp. 968-972.

[42] Cascio, J. 2007. "Solving the Climate Crisis", *OpenTheFuture.com*, 13 October. http://www.openthefuture.com/2007/10/solving_the_climate_crisis.html

[43] Pacala and Socolow, above note 41, p. 968.

[44] Hoffert, M.I., et al. 2002. "Advanced Technology Paths to Global Climate Stability: Energy for a Greenhouse Planet" *Science*, 1 November, vol. 298 issue 5595, pp. 981-988, p. 982.

[45] Hoffert et al., above note 44.

[46] Pacala and Socolow, above note 41, p. 969.

[47] Pacala and Socolow, above note 41, p. 969.

[48] Sauser, B. 2008. "Tidal Power Comes to Market," *Technology Review*, July 29.

[49] Galbraith, K. 2008 "Texas Approves a $4.93 Billion Wind-Power Project," *The New York Times*, July 19. http://www.nytimes.com/2008/07/19/business/19wind.html

[50] Patel-Press, P. 2008. "Energy from Waves" *Technology Review*, July 14. http://www.technologyreview.com/Energy/21072/

[51] Trafton, A. 2008. "'Major discovery' from MIT primed to unleash solar revolution," July 31. http://web.mit.edu/newsoffice/2008/oxygen-0731.html

[52] Pacala and Socolow, above note 44, p. 972.

[53] de Young, B. et al., 2008. "Regime shifts in marine ecosystems: detection, prediction and management." *Trends in Ecology & Evolution*, vol. 23, issue 7, July, pp. 402-409.

[54] Turley, C. et al., 2006. "Reviewing the impact of increased atmospheric CO2 on oceanic pH and the marine ecosystem." In H.J. Schellnhuber, et al. (eds) *Avoiding Dangerous Climate Change*. Cambridge University Press, pp. 65-70.

[55] Harley C.D. et al. 2006 "The impacts of climate change in coastal marine systems." *Ecology Letters*. February, vol. 9, no. 2, pp. 228-41.

[56] Neuwirth, R. 2006. *Shadow Cities: A Billion Squatters, A New Urban World*. Routledge, New York.

[57] United Nations – Habitat. 2003. *The Challenge of Slums: Global Report on Human Settlements 2003*. London, England.

[58] Blakeman, K. 2006. "Ala Wai awash in sewage after spill". Honolulu Advertiser, 26 March, http://the.honoluluadvertiser.com/article/2006/Mar/26/ln/FP603260342.html

[59] Parliamentary Office of Science and Technology (UK). 2002. "Infectious disease – European Molecular Biology Laboratory (EMBL) Conference." Heidelberg, Germany.

[60] Afrol News. 2007. "Somalia war attracts disease." *Afrol News Service*. December 10. Kroderen, Norway.

[61] Harvell, C.D., et al. 2002. "Climate Warming and Disease Risks for Terrestrial and Marine Biota." *Science*. vol. 296, no. 5576, June 21, pp. 2158-2162.

[62] Le Riche, W.H. and J. Milner. 1971. *Epidemiology as Medical Ecology*. Churchill Livingstone, Edinburgh.

[63] Linthicum, K.J. et al. 1999. "Climate and Satellite Indicators to Forecast Rift Valley Fever Epidemics in Kenya" *Science*, vol. 285, no. 5426, July 16, pp. 397-400.

[64] Githeko, A. and A. Woodward. 2003. "International consensus on the science of climate and health: the IPCC Third Assessment Report." In *Climate Change and Human Health: Risks and Responses*. A.J. McMichael et al. (eds) World Health Organization, Geneva.

[65] Bowles, S. "Policies Designed for Self-Interested Citizens May Undermine 'The Moral Sentiments': Evidence from Economic Experiments" *Science*, vol. 320, no, 5883, Jun 20, pp.1605-1609.