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How Should Global Society Address Climate Change? - The Kyoto Protocol and Its Future

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Abstract
This research paper explores how global society should address climate change, focusing on the Kyoto Protocol and its future.
In the introduction, the paper presents three challenges that we face in addressing climate change; uncertainty, trade-off between environment and economy, and political conflict. The paper tries to work out how to address climate change with these three challenges in mind.

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-The Kyoto Protocol and Its Future-

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Contents

Executive Summary

This research paper explores how global society should address climate change, focusing on the Kyoto Protocol and its future.

In the introduction, the paper presents three challenges that we face in addressing climate change; uncertainty, trade-off between environment and economy, and political conflict. The paper tries to work out how to address climate change with these three challenges in mind.

In Section 2, climate change itself is analyzed thoroughly; the current situation, its mechanism, anticipated consequences, and future scenarios. Especially, Figure 1 shows that greenhouse gas emissions (GHG) should be the fundamental cause that we tackle first. About the consequences of climate change, influence on food supply, biosphere, and sea-level rising is introduced. However, even the most reliable international organization of climate change, the International Panel on Climate Change (IPCC), predicts only broad range scenarios, not doing precisely; hence skepticism toward the scientific background behind climate change still remains strongly.

Section 3 examines how the international community has addressed climate change, focusing on successive rounds of the Conference of the Parties (COP). Also, the paper introduces the United Nations Framework Convention on Climate Change (UNFCCC) as the first international framework for climate change and refers to a reason of its failure.

Section 4 examines the Kyoto Protocol in detail. The paper explains the history and goal of the Kyoto Protocol briefly and presents the participating countries. The full list of the participating countries is showed in Appendix 4. Also, some basic rules of the Kyoto Protocol are described; the split of Annex 1 (industrialized) and Non-Annex 1 (not industrialized), emission reduction targets, and conditions for the Protocol's effective. Finally, the paper introduces and analyzes the Kyoto Mechanism. This mechanism is Kyoto's main feature and designed to help Annex 1 countries reduce GHG emissions and achieve their reduction targets efficiently.

Following the former section, Section 5 examines the position of stakeholders under the Kyoto Protocol. They are categorized into six groups: countries supporting the Kyoto Protocol (Group 1), countries with difficulties in achieving their targets (Group 2), countries with big margins for emitting GHG (Group 3), countries which have already withdrawn from the Protocol (Group 4), countries which are not obliged to reduce GHG emissions, although they are large emitter of GHG (Group 5), and countries which face the risk of coastal erosion resulting from rising sea levels (Group 6). The paper introduces the European Union, Japan, Russia, the United States, Australia, China, India, and Bangladesh as an example of each group.

Section 6 does SWOT analysis about the Kyoto Protocol before considering the next framework after the Kyoto. Firstly, extensibility, enforceability, and the Kyoto Mechanism are analyzed as strength. Secondly, some weaknesses are analyzed;

ineffectiveness resulting from the withdrawal of the United States, no responsibility for more developed countries in spite of their increasing emissions, and a weak scientific background. In addition, the paper points out that the Kyoto Protocol produces inequity feelings between not only Annex 1 countries but also Non-Annex 1 countries. Thirdly, the paper analyzes opportunities of the Protocol. For example, science and technology have advanced through establishment of the Kyoto Protocol, and along with this advancement uncertainties are getting clearer. Also, its establishment has enhanced public awareness for climate change. Further, the Protocol will encourage emission reduction activities in not only governmental sectors but also private sectors. Finally, the paper indicates threats toward the Kyoto Protocol; growing GHG emissions in developing countries, unfairness in economic competition, and another international framework for climate change (the Asia Pacific Partnership on Clean Development and Climate).

Section 7 presents what the next framework after the Kyoto Protocol (Post-Kyoto) should include, sorting into three categories; enforceability, equity, and incentive. As for enforceability, not only quantitative and mandatory targets but also penalty will enhance enforceability. About equity, Post-Kyoto should address inequities referred as Kyoto's weakness and environmental justice, which climate change intrinsically has. Finally, this section argues that Post-Kyoto needs to create strong incentives to reduce GHG emissions in order to motivate both public and private sectors' reduction activities.

Section 8 proposes concrete approaches of Post-Kyoto based on the analysis of the former sections. Approaches are categorized into five groups: same approaches with the Kyoto Protocol, re-classification of participating countries, new types of approaches, countermeasures for stakeholders in a weak position, and necessary research and development for Post-Kyoto. The key of this section is how Post-Kyoto obligates some responsibilities to developing countries through re-classification and new types of approaches. Various approaches are proposed for enhancing effectiveness and equity of Post-Kyoto.

Based on all the analysis done in the paper, Section 9, the conclusion, re-analyzes three challenges of climate change; uncertainty, trade-off between environment and economy, and political conflict, which are mentioned in the introduction. Further, finally Section 9 argues the way forward, introducing the result of latest COP discussion in Nairobi, Kenya.

1. Introduction

Climate change is one of the most important and urgent environmental problems that the international community has to address. Also, climate change is a very difficult environmental challenge to tackle effectively, positively, and expeditiously. First of all, this introduction part will explain why climate change is a big challenge for global society, pointing out three main difficulties as follows.

Uncertainty

First, the mechanism of climate change has yet to be revealed completely. There are many scientific arguments to be cleared in climate change. Therefore, the international community has not reached agreement on how it should tackle climate change. This uncertainty is one of the reasons why the United States withdrew from the Kyoto Protocol. It is central to the difficulty of tackling climate change.

Trade-off between environment and economy

Second, climate change is related with all of 3E Problem: Energy Security, Economic Growth, and Environmental Protection. Especially, its relation to economy is a difficult challenge. This is because greenhouse gas (GHG) emissions are widely considered to be a main factor for climate change, but they mainly generate through economic activities. Further, most people believe that reducing GHG emissions could retard economic growth and generate additional costs. When society tries to address climate change, it is indispensable to overcome the most popular challenge for environment problems: the trade-off between economy and environment.

Political conflict

Third, there has been a conflict between developed and developing nations in addressing climate change. Current climate change problems should be attributed to past economic development by developed nations, which did not care about the environment. However, developing nations are also suffering from climate change. For example, Bangladesh is losing its national land area due to rising sea levels resulting from global warming. On the other, developed countries are requiring that developing countries should also own some responsibilities for mitigating climate change. This is because developing countries cannot grow their economy without caring about the environment, as developed countries did in the past. However, developing nations naturally hesitate to take responsibilities because they do not want to retard economic growth. Thus, while climate change is a common challenge in the world, it is difficult to engage all the international community in the collective action. Climate change is one of the most difficult political challenges that the international community has ever faced. September 9th-15th in 2006 issue of The Economist magazine describes this difficulty as "Because it (climate change) is global, it is in every country's interests to get every other country to bear the burden of tackling it. Because it is long term, it is in every generation's interests to shirk the responsibility and shift it onto the next one".[1]

[1] The Economist, September 9th-15th 2006

This report tries to work out how the international community should address climate change with these three difficulties in mind. The next section will analyze climate change itself in detail.

2. Climate Change

As mentioned in the introduction, the mechanism of climate change has not yet to be revealed completely. Its various factors are still controversial. However, many organizations and researchers consider that GHG emissions and global warming resulting from them should be the main factor of climate change. The current international framework for climate change, the Kyoto Protocol, obligates industrialized nations to own responsibilities for reducing GHG emissions. Further, there is no paper saying that GHG emissions do not relate to climate change at all. At present, the only determinate causal correlation between climate change and GHG emissions is not clarified completely. This paper, based on these facts, defines GHG emissions as a main factor for climate change. Plus, it will take the standpoint that "man-made" GHG emissions are now threatening the stability of climate. This is because due to the fact that levels of CO2 have increased from around 280 parts per million (ppm) before the Industrial Revolution to around 380ppm now,[2] it is clear that human activities, especially economic activities, have been accumulating GHG emissions. The Intergovernmental Panel on Climate Change (IPCC) reported in 2001 that "the balance of evidence suggest a discernible human influence on global climate", citing "new and strong evidence that most of the warming observed over the last 50 years is attributable to human activities".[3]

(1) Current Situation of Climate Change

As for the current situation of climate change, IPCC's Synthesis Report stated:

> … The Earth's climate system has demonstrably changed on both global and regional scales since the pre-industrial era, with some of these changes attributable to human activities. Human activities have increased the atmospheric concentration of greenhouse gases and aerosols since the pre-industrial era. The atmospheric concentration of greenhouse gases (i.e., carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and tropospheric ozone (O3)) reached their highest recorded levels, primarily due to the combustion of fossil fuels, agriculture, and land-use changes…. Globally it is likely that the 1990s was the warmest decade, and 1998 the warmest year, in the instrumental record (1861-2000). The increase in surface temperature over the 20th century for the Northern Hemisphere is likely to have been greater than that for any other century in the last thousand years. Insufficient data are available prior to the year 1960 in the Southern Hemisphere to compare the recent warming with changes over the last 1,000 years. Temperature changes have not been uniform globally but have varies over regions and different parts of the lower atmosphere…. Changes in sea level, snow cover, ice extent, and precipitation are consistent with a warming

[2] The Economist, September 9th-15th 2006; at the current rate of increase, levels of CO2 have will have reached 800ppm by the end of this century.
[3] The IPCC, Climate Change 2001: Synthesis Report Summary for Policymakers

> climate near the Earth's surface. Examples of these include a more active hydrological cycle with more heavy precipitation events and shifts in precipitation, widespread retreat of non-polar glaciers, increases in sea level and ocean-heat content, and decrease in snow cover and sea-ice extent and thickness…. Observed changes in regional climate have affected many physical and biological systems, and there are preliminary indicators that social and economic systems have been affected. Recent regional changes in climate, particularly increases in temperature, have already affected hydrological systems and terrestrial and marine ecosystems in many parts of the world…. The rising socio-economic costs related to weather damage and to regional variations in climate suggest increasing vulnerability to climate change. Preliminary indications suggest that some social and economic systems have been affected by recent increases in floods and droughts, with increases in economic losses for catastrophic weather events. However, because these systems are also affected by changes in socio-economic factors such as demographic shifts and land-use changes, quantifying the relative impact of climate change (either anthropogenic or natural) and socio-economic factors is difficult.

Appendix 1 demonstrates the current situation of climate change in detail. Also, Appendix 2 shows the latest status of GHG emissions in industrialized nations based on UNFCCC's press release on October 27th, 2006.

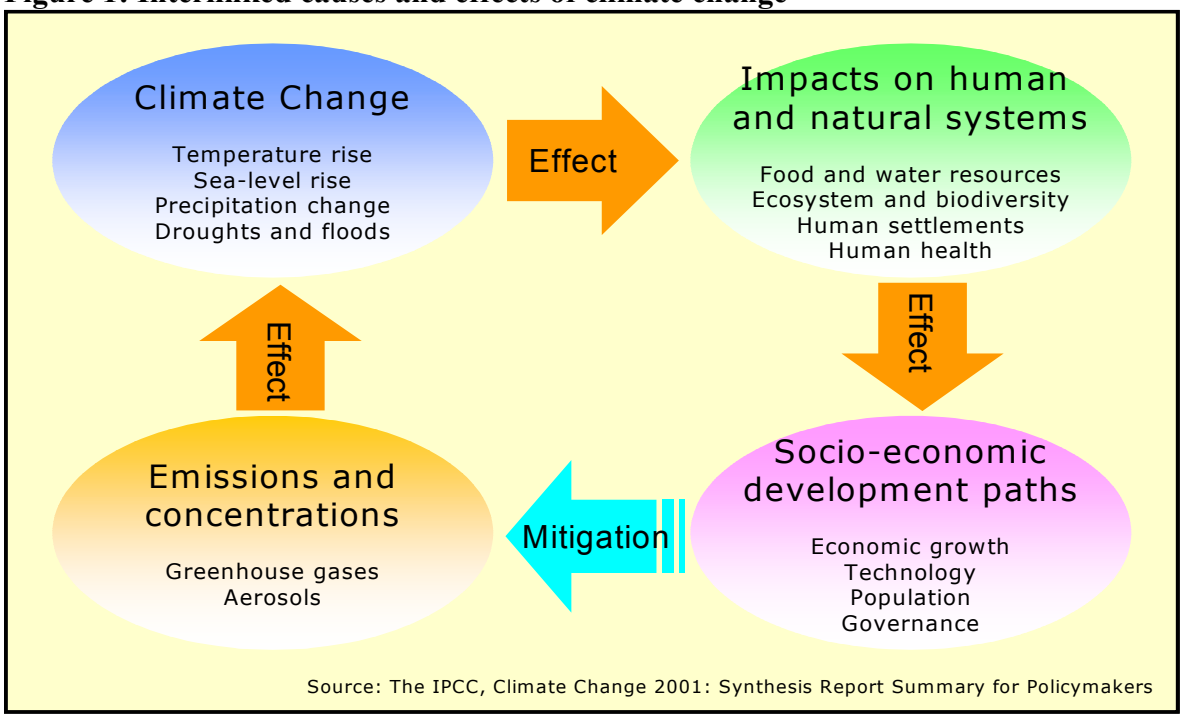
(2) Mechanism of Climate Change

The IPCC report points out that most of the warming events observed over the past 50 years are attributable to human activities. It also states that human activities such as fuel combustion enhance Earth's natural greenhouse effect due to a buildup of GHG emissions. This greenhouse effect is the most important part of the mechanism of climate change. According to Geosystems Sixth Edition, the mechanism of the greenhouse effect should be described as follows:

> CO2 and water vapor are the principal radiatively active gases causing Earth's natural greenhouse effect. Radiatively active gases are atmospheric gases, such as CO2, CH4, N2O, and chlorofluorocarbons (CFCs), and water vapor, which absorb and radiate infrared wavelengths. They are transparent to light but opaque to the infrared wavelengths radiated by Earth. Thus, they transmit light from the Sun to Earth but delay heat-energy loss to space. While detained, this heat energy is absorbed and emitted over and over, warming the lower atmosphere. As concentrations of these infrared-absorbing gases increase, more heat energy remains in the atmosphere and temperatures increase.

Figure 1 is an interlinked causes and effects chart of GHG emissions with climate change, human and natural systems, and our society. According to Figure 1, it is absolutely clear that global society should address the reduction of GHG emissions if it tries to mitigate climate change.

Figure 1: Interlinked causes and effects of climate change



(3) Consequence of Climate Change and Future Scenario

Food supply and the biosphere

Crop patterns, as well as natural habitats of plants and animals, will shift along with climate change in order to maintain preferred climate conditions. Therefore, there will be agriculture losses in some areas, and gains in other areas. For example, some barrens will be a suitable area for agriculture due to temperature rise, but some fertile areas will be an unproductive land.

As for biosphere, temperature rise are letting many plant species already on the move to more favorable conditions with having effects toward total ecosystems. Because several insects are changing their habitat areas, people previously unaffected by diseases like malaria and yellow fever will be at risk for these diseases. IPCC simulations estimate that the proportion of the world's population living within the potential malaria transmission zone would increase from approximately 45% in the 1990s to 60% by 2050 due to global warming.[4]

Melting glaciers and sea-level rise

The most widespread effect of climate change is rapid escalation of ice melt. The additional meltwater is adding to a rise in sea levels worldwide. Sea-level rise will produce a shoreline retreat and have big influence on people's life in coastal areas.[5] Particularly, tragic social and economic consequences will affect small island and coastal countries; disruption of biological system, loss of biodiversity, reduction in water

[4] Harvard Business School, 2002. Global Climate Change After Marrakech
[5] Geosystems Sixth Edition; a 0.3-m rise in sea levels will produce a 30m shoreline retreat on average.

resources, and evacuation of residents. For example, IPCC's scenario indicates that in Bangladesh, for a 45 cm rise in sea level, 10.9% of total land area would be lost.[6] Furthermore, there could be both internal and international migration of affected residents.

IPCC Synthesis Report predicts the future scenarios of temperature rise and sea-level rise as follows.

Temperature Rise Forecasts

- High forecast: 5.8 °C (10.4 °F)
- Middle forecast: 3.6 °C (6.5 ºF)
- Low forecast: 1.4 °C (2.5 ºF)

Sea Level Rise Scenarios

- High forecast: 0.88m (34.7 in.)
- Middle forecast: 0.48m (18.9 in.)
- Low forecast: 0.09m (3.5 in.)

As for future scenarios of both temperature rise and sea-level rise, these huge ranges limit the IPCC's effectiveness to policymakers. Skepticism toward the IPCC's scientific background has led a lot of people to disagree with its findings. For example, the United States utilized IPCC's uncertainty when it withdrew from the Kyoto Protocol. As mentioned in the introduction, this uncertainty is one of the difficulties of tackling climate change.

3. History of Political Action toward Climate Change

The first political framework for climate change, the United Nations Framework Convention on Climate Change (UNFCCC), was produced at the United Nations Conference on Environment and Development (UNCED), known as the Earth Summit in Rio de Janeiro, Brazil, in 1992. 188 nations have signed the UNFCCC so far. (see Appendix 3) The actual implementing body of the UNFCCC is the Conference of the Parties (COP), which is operated by the countries that ratified the UNFCCC.

The UNFCCC aimed at reducing GHG emissions in order to tackle climate change. According to its website, the main objective of the UNFCCC is described as "to achieve stabilization of greenhouse gas concentrations in the atmosphere at a low enough level to prevent dangerous anthropogenic interference with the climate system".[7] It tried to return the emission levels of developed countries to 1990 levels by 2000. Yet, its aim was never achieved because it did not oblige developed countries' "mandatory" efforts toward reducing GHG emissions. Its effectiveness was not enough to mitigate climate change. Rather, it was considered to be a failure. Therefore, several COP meetings after the Earth Summit have followed up the UNFCCC so that it evolves into an effective framework.

[6] Harvard Business School, 2002. Global Climate Change After Marrakech
[7] The UNFCCC website, http://unfccc.int/

The first COP meeting (COP-1) was held in Berlin, in1995, and COP-2 was held in Geneva, Switzerland in1996. These meetings were the preliminary stage for COP-3 in Kyoto, Japan, in December 1997, where the Kyoto Protocol was adopted by consensus. It was the first framework stipulating mandatory targets for reducing industrialized nations' emissions of CO2 and other GHG[8]. Four years after COP-3 in Kyoto, COP-6 was held in Bonn, Germany, in 2001, and the conference participants agreed on the basic rules for implementing the Kyoto Protocol. Finally, at COP-7 in Marrakech, Morocco, in 2001, the participating countries agreed on the important details of the Protocol's implementation. This agreement is called as "Marrakech Accords", which has made considerable progress regarding the implementation of the Kyoto Protocol. Later, COP-8 was held in New Delhi, India, in 2002; and, COP-9 in Milan, Italy, in 2003, followed by COP-10 in Buenos Aires, Argentina, in 2004.

After that, COP-11 was held in Montreal, Canada, in 2005. At COP-11, participants discussed how the international community should address climate change after 2012, which is the end of the first commitment period covered by the Kyoto Protocol. However, the future of a new framework after the Kyoto has turned out to remain unclear after COP-11. COP-11 has just produced a very ambiguous result; "continuation of dialogue". Thus, although COP succeeded in establishing the Kyoto Protocol, there is still much political controversy among post-Kyoto discussions. This situation expresses the difficulty of political challenge mentioned in the introduction.

4. The Kyoto Protocol

(1) History

As mentioned in the former section, the Kyoto Protocol was adopted at COP-3 on December 1997 in Kyoto, Japan, opened for signature on March 1998, and closed on March 1999. It is the first framework stipulating the reduction target of GHG emissions that industrialized nations should achieve mandatorily. However, a lot of unfinished action assignments remained after COP-3; hence important rules about operating the Kyoto Protocol were argued over at following up COP-rounds. At COP-6, the basic rules for the Kyoto Protocol were agreed, and at COP-7, important details about operation of the Kyoto Protocol were negotiated, and this meeting produced "Marrakech Accords". (see Section 3) The Kyoto Protocol finally came into force on February 2005, following ratification by Russia on November 2004.

(2) Goal

Based on the main objective of the UNFCCC, the goal of the Kyoto Protocol is also "to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system".[9]

[8] Methane (CH4), Nitrous oxide (N2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), and Sulphur hexafluoride (SF6)

[9] The UNFCCC website, http://unfccc.int/

(3) Participating Country

According to the UNFCCC, as of October 2006, the Kyoto Protocol covers a total of 165 countries globally and over 60% of total industrialized nations' GHG emissions in 1990.[10] However, the United States, which is the largest emitter of GHG, already withdrew from the Kyoto Protocol. Australia also withdrew from it. Croatia and Turkey have not ratified the Protocol yet although they are classified as an industrialized nation (Annex 1 country). Appendix 4 shows the participating countries in the Kyoto Protocol.

(4) Principle

The Kyoto Protocol has established not only GHG reduction targets for industrialized countries but also an international framework for addressing global warming in cooperation within the international community. At its heart of the framework, the Kyoto Protocol establishes the following principles.

- Countries are separated into two categories: industrialized countries, referred to as Annex 1 countries, which have a responsibility for reducing GHG emissions; and non-industrialized countries, referred to as Non-Annex 1 countries, which have no responsibility for reducing GHG emissions. This is because current global warming resulting from historical GHG accumulation should be attributable to past economic development by industrialized countries. Classification of Annex 1 and Non-Annex 1 countries is shown in Appendix 4.

- Annex 1 countries are assigned the mandatory target of reducing its GHG emissions between 2008 and 2012. The reduction targets are determined based on countries' 1990 emission levels. The individual targets for major countries are listed in Table 1. The total GHG reducion is 5.2% decreasing from 1990 levels.

Table 1: Emission target of each country and group of country

	Reduction Target
EU*1	-8%*1
US*2	-7%
Japan & Canada	-6%
Russia, Ukraine, and New Zealand	0%
Australia*2	+8%

*1 -8% target is for 15 EU countries before the expansion on May 2004 (EU bubble). EU bubble means that EU has only to achieve its target in region-total even if one country in the region cannot achieve its target. Other EU countries and Non-EU European countries have an individual target.

*2 US and Australia withdrew from the Kyoto Protocol

Source: UNFCCC and the Ministry of Environment, Japan

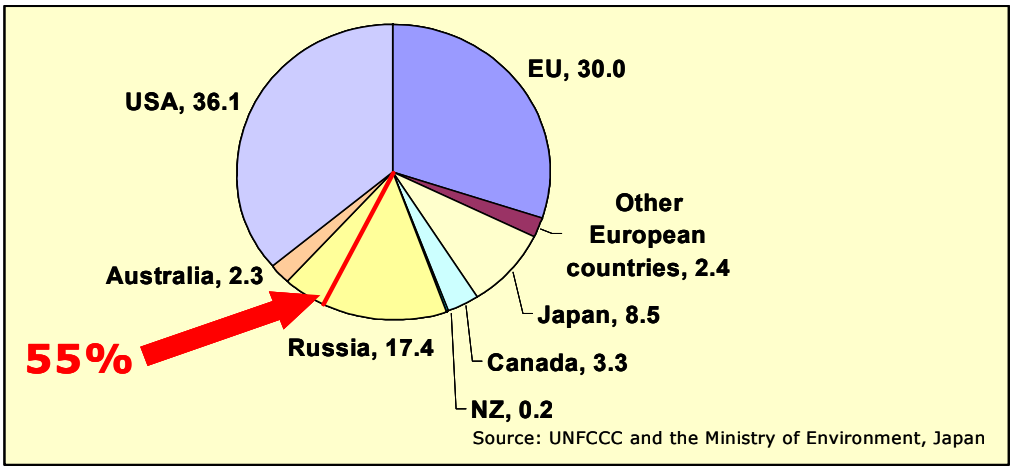
[10] The UNFCCC website, http://unfccc.int/

- In order for the Kyoto Protocol to go into effect, both of the following conditions should be met. Figure 2 shows that the first condition is met and Appendix 4 shows that the second condition is met.

  (1) The Kyoto Protocol should secure the support of Annex 1 countries that account for at least 55% of total Annex 1 countries' 1990 emissions.

  (2) The Kyoto Protocol should be ratified by at least 55 countries.

Figure 2: Ratio of GHG emissions in Annex 1 countries



- Annex 1 countries can offset their GHG emissions by increasing the amount of GHG removal from the atmosphere by carbon sink activities such as afforestation and reforestation. The amount of GHG removed from the atmosphere through these activities generates credits known as removal units (RMUs).
- Each Annex 1 country has an upper limit of carbon sink based on its forest area; for example, the Kyoto Protocol allows Japan to reduce its GHG emissions by 3.9% with carbon sink.

- If an Annex 1 country fails to meet its reduction target, it must make up the difference in the second commitment period, plus a penalty of 30% of the non-achievement amount.

(5) The Kyoto Mechanism

The Kyoto Protocol establishes three innovative mechanisms known as the Kyoto Mechanism: the Clean Development Mechanism (CDM), Joint Implementation (JI), and Emission Trading. These three mechanisms are designed to help Annex 1 countries reduce GHG emissions and achieve reduction targets at less cost and more efficiently. Any Annex 1 countries that have ratified the Kyoto Protocol can use the Kyoto Mechanism, provided that they comply with its methodological and reporting obligations. In addition, a government, which tries to utilize the Kyoto Mechanism, must show evidence that the utilization of the Kyoto Mechanism is supplemental to domestic efforts, which should be main in achieving their targets. However, there are no quantitative upper limits for the utilization of the Kyoto Mechanism.

Clean Development Mechanism (CDM)
Under the CDM, an Annex 1 country can implement a project that reduces GHG emissions in a Non-Annex 1 country. As a result of a project, Annex 1 countries will gain resulting certified emission reductions (CERs). Annex 1 countries can factor in these units in their reduction targets or deal with them with other Annex 1 nations freely. The CDM is also designed to help Non-Annex 1 countries promote sustainable development through introducing environment-friendly technologies. Thus, the CDM has two purposes: (1) to help Annex 1 countries achieve their reduction targets stipulated in the Kyoto Protocol and (2) to support the sustainable development of Non-Annex 1 countries. By means of the CDM, Non-Annex 1 countries will be able to pursue both technological and economic development with reduced environmental impact, and Annex 1 countries will be able to obtain, at relatively low cost, CERs. However, a project that utilizes technologies about nuclear energy cannot be acknowledged as a CDM project although nuclear energy generation produces much less CO2 than fossil fuel energy.

Joint Implementation (JI)
Under the JI, an Annex 1 country implements a project that reduces GHG emissions or increases RMUs in the region of another Annex 1 country. A JI project is implemented between Annex 1 countries, unlike the CDM. As a result of a project, Annex 1 countries will gain resulting emission reduction units (ERUs) or additional RMUs. As well as the CDM, Annex 1 countries can factor in these units in their reduction targets or deal with them freely and a project that utilizes technologies about nuclear energy cannot be acknowledged as a JI project.

Emission Trading
Under Emission Trading, an Annex 1 country can transfer some of the emissions under its assigned amount, known as assigned amount units (AAUs), to another Annex 1 country that finds it relatively more difficult to meet its reduction target. It can also transfer CERs, ERUs, and RMUs, which are acquired through CDM projects, JI projects, or carbon sink activities.

5. Stakeholders' Position in the Kyoto Protocol
This section will examine how each country or group of countries tackles or deals with the Kyoto Protocol. Countries concerned should be categorized into the following six groups;

1. Countries supporting the Kyoto Protocol like EU countries,
2. Countries with difficulties in achieving their targets such as Japan and Canada,
3. Countries with big margins for emitting GHG like former Soviet Union countries,
4. Countries which have already withdrawn from the Kyoto Protocol such as the United States and Australia,
5. Countries which are not obliged to reduce GHG emissions, although they are large emitter of GHG such as China, India, Brazil, and other More Developed Countries (MDCs), and,

6. Countries which face the risk of coastal erosion resulting from increasing sea levels like the Alliance of Small Island States (AOSIS).

The situation of each group is studied as follows, introducing the European Union, Japan, Russia, the United States, Australia, China, India, and Bangladesh.

(1) European Union (Group 1)

The European Union has consistently been the most enthusiastic advocates of the Kyoto Protocol, negotiating hard to get wavering countries on board. For example, Germany, which has taken an environmentally friendly stance on GHG emission reduction, was strongly opposed to the Kyoto Protocol's allowing countries to invest in less expensive projects such as the CDM and JI overseas in order to get credits toward their reduction targets. Germany especially wanted to limit trading "hot air". "Hot air" is the negative term for a credit that occurs anyway in former Soviet Union countries due to the defect of the Kyoto Protocol. This "hot air" will be available at low prices in an international carbon emission market. It was not until COP7 at Marrakech that this opposition faded under pressure from Japan, Canada, and Russia.

In 2002, the European Union established a system of emission trading in an effort to meet its tough target. This European emission trading system started running on a trial basis in 2005. But there are still many hurdles to be cleared if the system is to be fully operational by 2008, as planned. For example, the process for allocating emission credits is not yet complete. Also, the system will cover only about 40% of Europe's GHG emissions as it stands.[11]

On the other hand, the position of the European Union is not free from controversy through the negotiation of the Kyoto Protocol. One criticism is that, rather than reducing 8%, the European Union should reduce GHG emissions by 15% as they said during the negotiation. In addition, reduction targets for Eastern European countries, the former Warsaw Pact countries, have already been achieved as a result of their economic restructuring. The 1990 baseline level is too easy and unfair, compared with other developed countries.

(2) Japan (Group 2)

Under the Kyoto Protocol, Japan is assigned the target of reducing its GHG emissions by 6% from 1990 levels. Japan is the only Asian country that is classified in Annex 1 and is obliged to reduce GHG emissions. However, the Japanese industrial arena was strongly opposing the Protocol. One reason is that Japan is the most advanced country in the world in terms of energy efficiency. Actually it has less room to reduce GHG emissions than other countries. For example, GDP (in US dollar) per kilogram of energy (measured in oil equivalent) in 1994 was 9.6 in Japan, compared with 6.1 in Germany, 3.2 in the United States, 0.7 in China, and 0.6 in Russia.[12] Relatedly, Japan's CO2 emissions intensity (measured in metric tons of CO2 emissions per US $1,000 of GDP) is the lowest

[11] John Browne, Beyond Kyoto
[12] Harvard Business School, 2002. Global Climate Change After Marrakech

among major countries: 0.30, compared with 0.49 in Germany, 0.82 in the United States, 5.27 in China, and 5.43 in Russia.[13] This is because Japan has invested heavily in improving energy efficiency in fossil fuel energy production as Japan has very limited, almost zero, natural resources. Also, the Japanese industrial arena has another concern that the Japanese industry will be at a disadvantage when competing economically with the United States, which is exempt from shouldering the cost of GHG reductions as long as it remains outside the Protocol.

Considering this domestic background, the Japanese government responded to the Kyoto Protocol's negotiation with a stern attitude. Also, behind the government's tough negotiating lies the fact that, as the result of the withdrawal of the United States, Japan held the key to success or failure of the negotiations. Without Japan's agreement, a breakdown would have been unavoidable. Based on this advantageous position, the Japanese government pursued a strategy of making use of its bargaining power to extract broad concessions and seeking to avoid committing any diplomatic errors that would cause Japan to endure a barrage of criticism for having killed the Kyoto Protocol. Finally, the European Union relented on the use of forest absorption and decided to allow Japan to use it to achieve 3.9% of the 6% cut in GHG emissions.

Thus, Japan's attitude toward the Kyoto Protocol was not aggressive, rather pitiful as a country whose name crowns the treaty. They just started to fully address domestic GHG reduction efforts in 2005. Table 2 shows Japan's policy for achieving its reduction target.

Table 2: Japan's policy for GHG reductions

Actions	Reduction
CO2 Reduction	0.0%
Methane & Nox Reduction	-0.5%
CFC Reduction	+2.0%
Life Style Change & Technology Innovation	-2.0%
Forest Absorption or Sink	-3.9%
Kyoto Mechanism (CDM, JI, Emission Trading)	-1.6%
Total Reduction	**-6.0%**

Source: The Ministry of Environment, Japan

However, the strategy above is already not viable. This is because the strategy is absolutely based on the fact that Japan reduces its GHG emissions by 6% from 1990 levels. However, Japan's GHG emissions have been increasing by about 8% from 1990 to 2005 due to economic expansion; hence Japan practically should reduce GHG emissions by about 14% from the current emissions.[14] As a result, the Japanese government is now looking for a way to reduce GHG emissions in foreign countries: CDM, JI, and Emission Trading. Thus, the Japanese government is forced to re-examine its strategies for GHG reduction, and utilization of the Kyoto Mechanism is getting important more and more.

[13] Harvard Business School, 2002. Global Climate Change After Marrakech
[14] Mainichi Shimbun, February 16th 2006

(3) Russia (Group 3)

Russia ratified the Kyoto Protocol on November 2004, and the international community paid much attention to this process. This is because Russia's ratification was absolutely necessary for satisfying 55% of Annex 1 countries' 1990 CO2 emissions and enforcing the Protocol. The reduction target of Russia stimulated in the Kyoto Protocol is 0% from 1990 emission levels. It has no difficulty in meeting its commitments, as its current emission levels are substantially below its targets. This reason will be discussed below.

The breakup of the former Soviet Union into 15 successor states, including Russia, in late 1991 brought the Russian economy into chaos throughout the early 1990s. Between 1990 and 1998, as Russia moved from a centrally planned economy toward a market-based economy, the Russian economy shrank by one-third. Consequently, its CO2 emissions decreased as well. From 1990 to 1998, CO2 emissions decreased by 42%.[15] However, now the Russian economy has been growing rapidly, with GNI per capita rising from US $1,710 in 2000 to US $4,460 in 2005.[16] GHG emissions will also increase by 19% over 1998 levels till 2010 in parallel.[17] Nonetheless, Russia has a 42% safety cushion because the Kyoto's targets are decided, using 1990 as the base year. As a result, under the Kyoto Protocol's framework Russia will benefit from selling emissions credits to other countries.

Furthermore, most JI projects are expected to concentrate into Russia and Eastern European countries. This is because there is large possibility of cutting GHG emissions by improving energy efficiency and industrial processes in the former communist countries. Through the JI also, Russia will benefit under the Kyoto Protocol.

Moreover, Russia's large contribution toward satisfying 55%, resulting from the United State's withdrawal, gave it additional leverage in the Marrakech discussion, for Russia's acceptance was definitely required for the Kyoto's legal enforcement. Russia re-negotiated about credits for its vast forests covering about half of its land area. From the previously agreed credit of 17 megatons of carbon per year, Russia was succeeded in increasing 33 megatons of carbon per year. As a result, more and more Annex 1 countries with difficulty in achieving their reduction targets will ask for Russia's emission credits; that is "hot air".

Thus, it might be Russia who will benefit utmost under the framework of the Kyoto Protocol. However, it is highly debatable whether Russia will benefit greatly from selling emission credits to other countries.

(4) United States (Group 4)

The United States is the largest GHG producing country, accounting for 25% of the world's GHG emissions in 1999.[18] At the 1997 meeting in Kyoto, COP3, Bill Clinton agreed to the requirement that the United States would reduce its emissions to below 7% of 1990 levels from 2008 to 2012. However, subsequently Bush Administration has

[15] Harvard Business School, 2002. Global Climate Change After Marrakech
[16] The World Bank website, http://www.worldbank.org/
[17] Harvard Business School, 2002. Global Climate Change After Marrakech
[18] Harvard Business School, 2002. Global Climate Change After Marrakech

withdrawn from the Kyoto Protocol because it considers that the Protocol would result in serious harm to the American economy. Since his election was greatly dependent upon the industrial arena, his administration is significantly influenced by pressures from industrial lobbyists. Also, President Bush strongly opposes the split between Annex 1 countries and Non-Annex 1 countries. Especially, he expresses his strong dissatisfaction against China, which is the world's second largest emitter of GHG but is entirely exempt from the requirement of the Kyoto Protocol. Further, the Bush Administration believes that the 7% figure could be misleading; when considering emission growth resulting from the economic expansion between 1990 and 2012, the United States has to reduce its GHG emissions by more than 30%.[19] Moreover, President Bush also expressed strong doubt over the science behind the Kyoto Protocol's reduction targets. Therefore, the Bush Administration espouses a different approach toward global warming, not pursuing the Kyoto Protocol.

On the other hand, there is rising awareness that the United States needs at least to re-engage effectively in the global negotiating process, to chart the course for post-Kyoto discussions. Greater pressure toward the federal government to get serious about climate change comes from state-level and some industrial arenas. For example, a total of 21 states and the District of Columbia have adopted a renewable energy mandate. Nine northeastern governors are designing a CO2 cap-and-trade programme. Furthermore, multi-national companies have already been surviving under GHG limits outside the United States. Many CEOs understand that some environmental regulations can drive innovations and lead to competitiveness, and realize that they might lose business chances if they fail to address environmental problems appropriately.

(5) Australia (Group 4)

Australia as well as the United States withdrew from the Kyoto Protocol, although it was granted a target of 8% increase of GHG emissions. This decision reflects that the Australian government will protect its primary industries such as coal and iron stone, on which Australian economy heavily depends. Also, the Australian Prime Minister, John Howard, criticized China and India for being exempt from bearing reduction obligations in spite of their booming economy.

Further, the Government takes the view that Australia is already doing enough to cut emissions; the Australian government has recently pledged US $300 million over the next three years to reduce GHG emissions.[20]

However, whether or not Australia will return the next framework after the Kyoto might be dependent on the United State, because Australian diplomacy basically tends to follow the United States. Actually, the Australian government, along with the United States, agreed to sign another framework for climate change: Asia Pacific Partnership on Clean Development and Climate, which was established under the initiative of the United States, with aimed at a post-Kyoto framework.

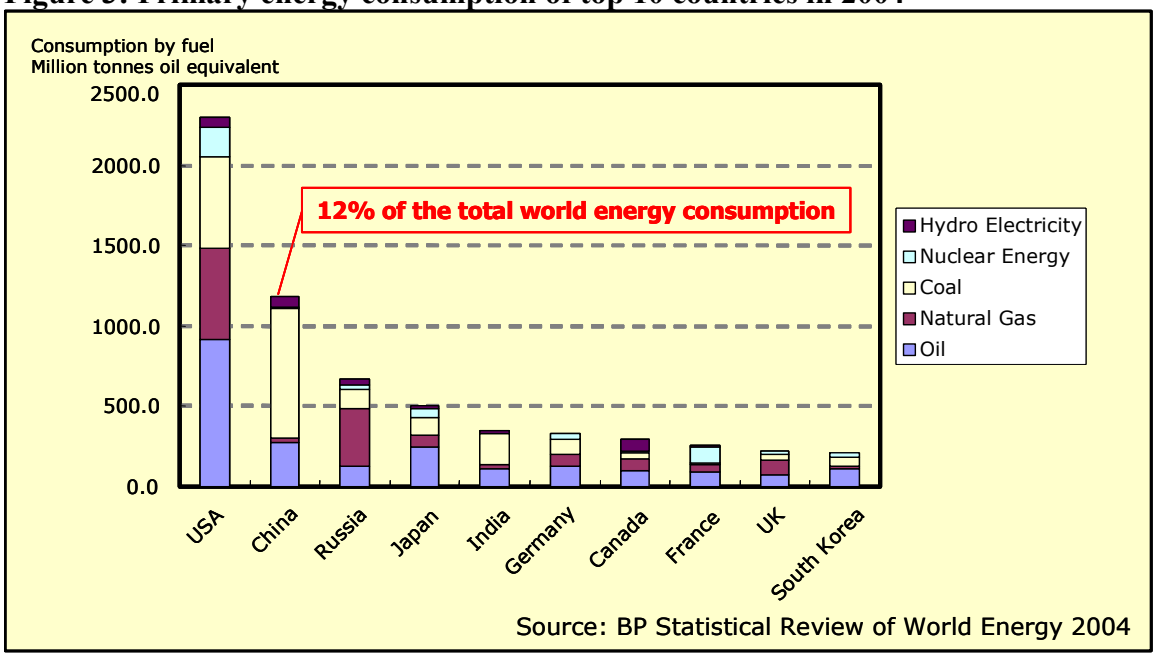
[19] Harvard Business School, 2002. Global Climate Change After Marrakech
[20] Wikipedia, http://en.wikipedia.org/wiki/Kyoto_protocol

(6) China (Group 5)

China's exemption from mandatory emission reductions under the Kyoto Protocol due to its classification as a Non-Annex 1 country has been a source of contention with other nations. Many countries blame China for enjoying the place of a developing country and not owing any responsibilities toward GHG reduction. This is because China is currently the second largest emitter of GHG in the world, being responsible for 11% of 1999's worldwide emissions.[21] Nonetheless, evidenced by some indicators like a GNI per capita of US $930 in 2000, China clearly remains a developing country. [22]

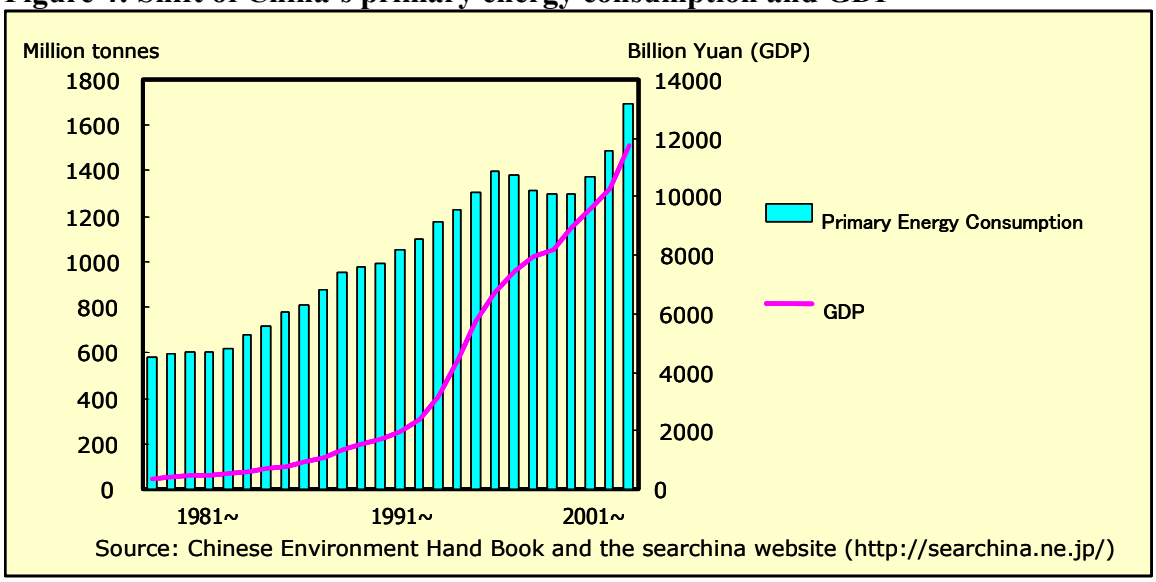
China's GDP has more than quadrupled since 1978 and has increased by more than 8% since 1999, reaching US $2.2 trillion in 2005.[23] China's GDP in 2005 is already larger than that of the United Kingdom. Along with this rapid economic growth, China's energy consumption has also been increasing sharply. Figure 3 shows the top 10 countries of primary energy consumption in the world in 2004. As the table shows, China is the second-largest energy consuming country, accounting for 12% of the total world energy consumption. Also, as Figure 4 shows, China's energy consumption has been increasing significantly, along with its drastic GDP growth. Along with this economic expansion, China's GHG emissions are also expected to expand more and more. China will become the biggest GHG emitter in the world in 2015.[24]

Figure 3: Primary energy consumption of top 10 countries in 2004



[21] Harvard Business School, 2002. Global Climate Change After Marrakech
[22] The World Bank website, http://www.worldbank.org/
[23] The World Bank website, http://www.worldbank.org/
[24] The Economist, September 9th-15th 2006

Figure 4: Shift of China's primary energy consumption and GDP



The Chinese government insists that the emissions level of any given country should be determined based on a per capita emission and rejects any responsibilities for reducing GHG emissions. This position might be similar to that of India. Due to their large populations, both China and India would benefit from setting emissions caps based on an emission per capita. With its population of 1.3 billion in 2000, China produces only one-tenth as much CO2 emissions per capita as the United States. On the other hand, the criticism for China is also reasonable because it does not own any responsibilities for reducing emissions despite the second-largest GHG emissions.

(7) India (Group 5)

India is classified as a Non-Annex country 1 under the Kyoto Protocol although its economy has developed sharply in recent years. One of the reasons is that 35% of India's population remains below the national poverty line in spite of its booming economy.[25] Also, its domestic environmental problems are severe; for example, only 30% of its population has an access to improved sanitation in 2002.[26]

At present, India accounts for nearly 17% of the world's population, but only 4% of global GHG emissions.[27] India, however, holds the fourth-largest coal reserves in the world and is expected to contribute an increasing amount of GHG emissions in the near future. It is predicted that China and India together will account for nearly 20% of worldwide GHG emissions by 2010.[28] Therefore, India as well as China should be required to regulate its emissions in the next framework, although it has been unwilling to take a mandatory responsibility for reducing emissions because it does not want to compromise economic development by diverting capital investment to emissions

[25] Harvard Business School, 2002. Global Climate Change After Marrakech
[26] UNICEF and WTO, Meeting the MDG Drinking Water and Sanitation Target
[27] Harvard Business School, 2002. Global Climate Change After Marrakech
[28] Harvard Business School, 2002. Global Climate Change After Marrakech

reduction programs. India still maintains that the major responsibility of reducing GHG emissions should depend on developed nations, which have accumulated emissions.

(8) Bangladesh (Group 6)

While responsible for only 0.1% of the world's GHG emissions, Bangladesh will bear severe consequences of global climate change.[29] Kofi Annan, United Nations Secretary General, said "Sadly, Bangladesh figures prominently on the world stage: it is expected to suffer, more than any other place on earth, the devastating impact of climate change".

About two-thirds of Bangladesh populations are employed in the agricultural sector. Approximately 22% of Bangladesh's land area is a coastal zone that accounts for 24% of agricultural added.[30] Accordingly, not only Bangladesh population but also its economy would be heavily affected by global climate change through rising sea levels. However, Bangladesh is one of the extremely poor nations, not being able to prevent or mitigate the adverse effects of climate change. Its GNI per capita was only US $470 in 2005.[31] Worse, Bangladesh is already suffering from the deterioration of its natural environment such as water contamination with arsenic. Thus, climate change poses Bangladesh further difficulty.

Under the Kyoto Protocol, Bangladesh is classified as a Non-Annex 1 country. Bangladesh ratified the Protocol positively because it is already facing huge risk of climate change. However, its relatively small size and poverty give its diplomats little leverage in the international negotiations. Now Bangladesh and other small island nations with big risk of coastal erosion have established an alliance, the Alliance of Small Island States (AOSIS), in order to strengthen their bargaining power.

6. SWOT Analysis about the Kyoto Protocol

This section will focus on the SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats) on the Kyoto Protocol. Strengths and weaknesses are an internal factor, and opportunities and threats are external factors. Before considering the following framework, it will be necessary to distill some SWOT factors from the Kyoto Protocol.

(1) Strengths

Extensibility

The Kyoto Protocol is the first step to address climate change globally. The international community succeeded in making a significant first step toward addressing climate change globally through the Kyoto Protocol. Although there are many weaknesses and threats (discussed below) against the Protocol, it is a very important starting point of a very long endeavor. The Protocol is not an ad hoc framework; therefore it will lead to a next framework. Actually, COP-12 was held in Nairobi, Kenya in November 2006 in order to discuss the detail of a post-Kyoto framework. Furthermore, the Kyoto Protocol can lead

[29] Harvard Business School, 2002. Global Climate Change After Marrakech
[30] Harvard Business School, 2002. Global Climate Change After Marrakech
[31] The World Bank website, http://www.worldbank.org/

to a system that enables today's diverse and fragmented reduction efforts to be valued on a globally common basis.

Enforceability
The UNFCCC, the former framework before the Kyoto, could produce the only voluntary program; hence it was widely understood as a failed example. However, the Kyoto Protocol has established a set of legally binding emission levels. It obligates mandatory targets to Annex 1 countries and the penalty to countries who cannot achieve their targets. This enforceability definitely enhances the Protocol's effectiveness.

Kyoto Mechanism
Through the Kyoto Mechanism, Annex-1 countries can reduce GHG emissions at a low cost. For example, Japan's technological level of energy efficiency has reached a point at which even large additional investments in technical development can yield only small gains. However, under the Kyoto Mechanism Japan can reduce GHG emissions at low cost by introducing its high technology to developing countries.

Also, the CDM opens the door for participation of developing countries in addressing climate change. The fact that developing countries can reduce their GHG emission through the CDM is significantly important. This is because the participation of developing countries is definitely indispensable for tackling climate change due to their huge potential of emitting GHG.

(2) Weaknesses

Ineffectiveness
The fact that the largest GHG producing country, the United States, is not included in the Kyoto Protocol raises questions about its efficacy. There is a big concern that little progress will be made regarding global warming without the participation of the United States. The IPCC predicts that an average global rise in temperature between 1990 and 2100 is 1.4^{o} C to 5.8^{o} C. However, some researchers report that even if the Kyoto Protocol is implemented successfully and completely, it will reduce that increase by somewhere between 0.02^{o} C and 0.28^{o} C by 2050.[32]

Responsibilities of More Developed Countries
More Developed Countries (MDCs), especially Brazil, India, and China do not have any responsibilities for reducing GHG emissions, although they are increasing GHG emissions sharply along accordingly to their rapid economic growth. This contradiction leads to political conflicts between Annex 1 countries and MDCs and is one of the reasons of the withdrawal of the United States and Australia.

Weak scientific background
President Bush criticized the Kyoto Protocol as "the targets themselves were arbitrary and not based upon science". Its insufficient scientific background is a target of criticism.

[32] Nature, October 2003

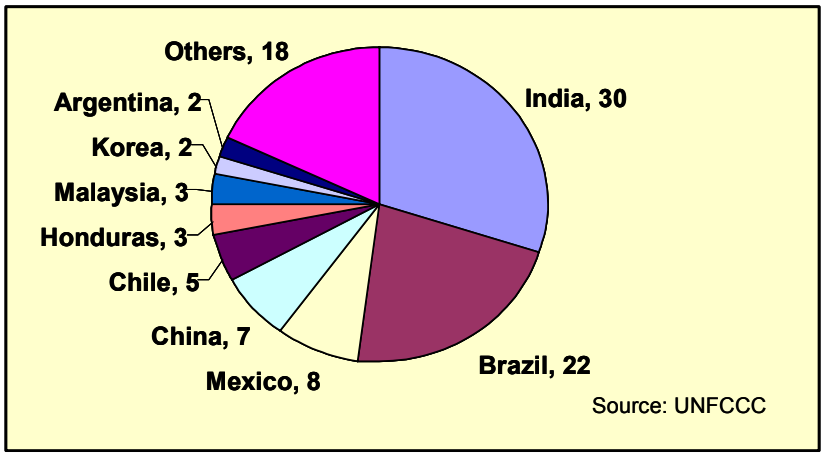
Global temperatures have really risen by about 0.6 ºC since the 19th century.[33] However, even the IPCC does not admit that GHG emissions from human activities are responsible for all the observed warming, although the trend is undoubtedly due to substantial their increase.

Inequity

There are some inequities in the Kyoto Protocol. One example is inequity between Annex 1 countries. The former Soviet Union countries and Eastern European countries will do little to achieve their targets. Their energy efficiency was at their worst in 1990, the base year in the Protocol, as the year was just before their economic structural change. On the other hand, Japan, which has the most advanced energy efficiency technology, can reduce little emissions domestically with big efforts. This is because Japan as a big importer of natural resources have been improving their energy efficiency after the first oil crisis in 1973 and its energy efficiency level in 1990 was the best in Annex 1 countries. Within the Protocol, the efforts that Japan has been making are set aside, and the inactivity of the former Soviet Unions and Eastern European countries is overlooked and can even generate big merits due to hot air and concentrating JI projects.

Also, there is an inequity between Non-Annex 1 countries; most CDM projects will concentrate into Asian and Latin American countries and ignore African countries. In fact, there are much more CDM potential in Asia and Latin America than Africa. As Figure 5 shows, the projects approved so far have actually concentrated in these regions.

Figure 5: Registered CDM projects by Non-Annex 1 countries



(3) Opportunities

Promotion of technology advancement and clarification of uncertainties

Science and technology have advanced on multiple aspects through establishment of the Kyoto Protocol. Along with this progress, uncertainties that climate change presents have been improved, although they are imperfect.

[33] The IPCC, Climate Change 2001: Synthesis Report Summary for Policymakers

Enhancement of public awareness toward climate change
The Kyoto Protocol has enhanced public awareness toward global warming or other environmental issues not just in the developed world including the United States but all around the world.

Promotion of GHG emission reduction efforts in governmental sectors
As the Kyoto Protocol stipulates the quantitative targets, every governmental sector of Annex 1 countries has been implementing various action plans. These efforts will reduce more or less GHG emissions certainly. For example, the Ministry of Environment Japan promotes a summer dress code called "Cool Biz". This new dress code during summer takes away ties from businessmen and aims to save energy by turning up preset temperatures of air conditioners.

Incentives for private sectors reducing GHG emissions
The scheme of emission trading and an international carbon market will encourage private sectors to be active in reducing GHG emissions. Private companies reduce GHG emissions in JI and CDM projects and try to sell acquired reduction units in the market. The private sector's profit-motivated aim will promote the widespread reduction activities in the world.

(4) Threats

Growing GHG emissions in developing countries
GHG emissions from developing countries are expected to exceed those from OECD countries by 2025.[34] However, developing countries (Non-Annex 1 countries) are exempt from reducing emission under the Kyoto Protocol. Worse, population is growing in countries who do not own reduction responsibilities such as the United States, India, China, Brazil, and other Asian and African countries.

Unfairness in economic competition
Annex 1 countries' industries will be at a disadvantage when competing economically with industries of Non-Annex 1 countries or countries that do not ratified the Kyoto Protocol. This is because they are exempt from shouldering the cost of GHG reductions and Annex 1 countries might lose economic competitiveness of this cost.

Another international framework for climate change
As mentioned, the United States and Australia promote the Asia Pacific Partnership on Clean Development and Climate and try to play an initiative role in addressing climate change. If they could take initiative, the value of the Kyoto Protocol would go down.

7. What does Post-Kyoto Need?

The next framework after the Kyoto Protocol (Post-Kyoto) should be effective enough, considering SWOT analysis above. This section will clarify what Post-Kyoto should

[34] John Browne, Beyond Kyoto

include, sorting into three categories below, which are basic factors of environmental regulation: enforceability, equity, and incentive.

(1) Enforceability

At first, Post-Kyoto should achieve enough enforceability for its effectiveness. In order to maintaining enforceability, Post-Kyoto as well as the Kyoto Protocol should stipulate quantitative and mandatory targets and objectives. A final goal may be qualitative like "achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system"; however a concrete target and objective must be quantitative and mandatory.

The UNFCCC, the first framework for climate change, could not yield successful results because, as mentioned, it did not oblige participating countries' quantitative and mandatory efforts toward reducing GHG emissions. This failure clearly shows that legally binding commitments are necessary, rather than those based on voluntary action. Post-Kyoto must not make the same mistake of the UNFCCC; hence it needs to stipulate not only each country's quantitative and mandatory targets but also a quantitative objective such as Kyoto's "5% emission reductions in global scale". The United States and some Non-Annex 1 countries such as China and India oppose quantitative and mandatory targets. However, if global society want to make Post-Kyoto effective enough, both quantitative and mandatory are necessary.

In addition, penalty will enhance enforceability. The Kyoto Protocol imposes the penalty for countries who fail to achieve their reduction targets. (see Section 4) Penalty should not be "too strict" or "too easy". If it is too strict, some countries will reject commitments, and if it is too easy, some countries will not comply with it. Appropriate penalty is necessary for the next framework.

(2) Equity

Post-Kyoto should be as an equitable framework as possible and needs to tackle current inequity problems below.

At first, the Kyoto Protocol internally has some inequity problems. As mentioned, using 1990 as the base year and ignoring country's energy efficiency level, the Kyoto Protocol has an inequity problem between developed countries. Further, the simple split of Annex 1 and Non-Annex 1 produces strong dissatisfaction among industrialized nations; especially MDCs' responsibility should be re-examined thoroughly in the discussion of Post-Kyoto. Moreover, as discussed in Section 6, the CDM is expanding the disparity between developing countries with concentrating in Asia and Latin America and ignoring Africa. Post-Kyoto should face these inequity problems that the Kyoto Protocol presents.

On the other hand, climate change intrinsically poses problems related to environmental justice. Some developing countries such as Bangladesh and other small island nations emit much less GHG emissions than developed nations. However, they are forced to face direct and severe effects of climate change with significantly lower living standards. As seen in other various environmental problems, people in a vulnerable position face more

severe influence in climate change. The Kyoto Protocol does not care about this environmental justice problem. Post-Kyoto should develop a countermeasure for this.

(3) Incentive

In order to motivate not only governmental sectors but also private sectors to take reduction activities, Post-Kyoto needs to create strong incentives for reducing GHG emissions. Especially, incentives for private sectors are important. This is because private sectors' role is getting larger and larger in most of the current environmental problems. In climate change also, encouraging private sectors' activities is important for reducing GHG emissions. Actually, Toyota's hybrid vehicle, Prius, succeeds in reducing CO2 emissions largely.[35] Furthermore, Prius' economically successful experience is motivating other auto companies to develop environment-friendly products and its success will bring huge multiplied effects of reducing emissions. Therefore, Post-Kyoto needs to establish an incentive mechanism that strongly promotes private sectors' reduction activity.

8. Actual Approaches of Post-Kyoto

Based on the analysis of the former sections, this section will explore concrete approaches of Post-Kyoto.

(1) Same Approaches with the Kyoto Protocol

First, Post-Kyoto actions should utilize some of the Kyoto Protocol's approaches. In the Kyoto Protocol, there are some effective approaches to be utilized again under Post-Kyoto.

Attack the root cause

Although there are still uncertainties in the causal relation between GHG emissions and climate change, the Kyoto Protocol establishes targets against GHG emissions in the chain of the climate change mechanism. Post-Kyoto should also intervene at this stage. This is because GHG emissions are considered to be the root cause of climate change at present due to their greenhouse effect. Also, as Figure 1 shows, we should attack GHG emission first to mitigate climate change's impact on our society and economy.

Mandatory and quantitative targets and penalty

Also, Post-Kyoto should employ mandatory and quantitative targets and penalty, which are mentioned as strength of the Kyoto Protocol in Section 6, in order to enhance Post-Kyoto's enforceability. Judging from the failure of the voluntary framework, the UNFCCC, it is clear that nations are not likely to address climate change or reduce emissions unless they perceive the risk of climate change to be in their interest. Therefore, a certain level of compulsion, which reminds participants of great seriousness, is necessary. Furthermore, mandatory targets will encourage establishment of domestic implementation strategies in individual countries. Moreover, compared with a voluntary

[35] Toyota's website, http://toyota.jp; According to the website, Prius' CO2 emission (g/km) is just 65.4, compared with Corolla's 147.0

system, mandatory commitments can provide nations with greater confidence that other nations, all of the participants, will do act, not goofing off. This sense of unity is essential for an international framework to be effective.

Targets and penalty should be not easy or too stringent. Easy targets have no driving effect toward technology advancement. Too stringent targets and penalty will cost too much. Furthermore, if targets and penalty are too stringent, they may discourage countries from joining Post-Kyoto activities.

On the other note, the Kyoto Protocol's enforceability has not been demonstrated yet. For example, some countries will not comply with their targets. Actually, whether Canada can achieve its target is highly questionable. Under the Kyoto, Canada pledged to cut its GHG emissions by 6% from 1990 levels. But the country's emissions are now more than 30% above 1990 levels.[36] Therefore, the international community should verify the Kyoto's practical enforceability when the Kyoto's first commitment period ends. Post-Kyoto should utilize feedbacks from the Kyoto.

Incentives for private sectors

Section 7 refers to the importance of incentives for private sectors in all environmental challenges. The Kyoto Protocol provides incentives to private sectors through the Kyoto Mechanism. In particular, it employs the scheme of emission trading in an international carbon market. Emission trading is considered to be the best policy for encouraging private sectors' activities. Actually, many private companies have been launching CDM projects to acquire reduction credits and sell them in the market. According to the UNFCCC website, as of December 6th 2006, there have been 434 projects registered by the CDM executive board.[37] Post-Kyoto should also employ this scheme and at the same time it should address the challenges that the Kyoto Mechanism presents; for example, establishment of emission caps and a price of carbon is a controversial problem. Furthermore, like tax preference to environment-friendly cars, profits produced by emission reduction activities in the CDM and JI can be eligible for tax deductions. Moreover, as with airlines' mileage programs, a system that private companies can receive tax deductions according to the quantity of emission reductions, can be a strong incentive for private companies.

(2) Re-classification

Enough equity will hold the key for Post-Kyoto to be politically acceptable for broad stakeholders. In other words, a framework that is ratified by many nations achieves enough equity. Therefore, Post-Kyoto should secure broad participants' commitments for enhancing equity. Plus, the more participants accept a commitment, the more effective Post-Kyoto can be. This subsection will propose a re-classification method of participating nations to extract broad commitments.

Too flexible classification is not suitable for a broad-ranging international framework, because greater flexibility comes at the cost of greater complexity and exceptions

[36] International Herald Tribute, December 3rd 2006
[37] The UNFCCC website, http://unfccc.int/

inevitably exist in any frameworks. However, the Kyoto's classification, Annex 1 and Non-Annex 1, is too simple. For example, it is quite questionable that Korea who is a member of OECD and Tanzania whose GNI per capita is just 2 percent of Korea are categorized in the same group.[38] Therefore, Post-Kyoto should re-classify participating countries more flexibly to accommodate various types of countries' situation. Furthermore, more flexibility will increase nations that undertake a reduction responsibility and enhance Post-Kyoto's effectiveness. The paper's proposal for re-classification is as follows.

Group 1: Industrialized countries and major emitters

This group consists of current Annex 1 countries. Group 1 countries own a responsibility of reducing GHG emissions.

Group 2: More developed countries (MDCs)

This group mainly consists of Asian countries and Latin American countries such as China, Korea, Brazil, and Mexico. Group 2 countries own a responsibility of reducing GHG emissions.

Group 3: Countries in a vulnerable position

This group consists of small island countries and coastal countries that are suffering severe effect of climate change already. However, a country that is suffering from climate change's effect but has enough coping capacity such as UK, the Netherlands, and Japan is excluded from Group 3. Group 3 countries do not own a responsibility of reducing GHG emissions.

Group 4: Least Developed Countries (LDCs)

This group mainly consists of sub-Saharan countries and South Asian countries. Group 4 countries do not own a responsibility of reducing GHG emissions.

The standard of classification is one of the most controversial problems. As India and China are insisting, if the classification standard of any given country should be determined based on nation's GNI per capita, Post-Kyoto cannot obligate major emitters with big population like China and India to reduce emissions. However, if the standard is based on nation's total GDP, a small nation that has big economy such as Singapore and Brunei is exempt from an emission reduction commitment. Therefore, countries should be categorized based on their GNI per capita in urban areas. This is because firstly major emission sources are basically located in urban areas and economic levels in urban areas can be an adequate indicator for countries' emission levels. Secondly, urban living standards in MDCs are getting near to those of developed countries; therefore Post-Kyoto can prevent MDCs that have developed urban economy and accompanying enough GHG emissions from being exempt from emission reduction efforts.

Group 1 consists of current Annex 1 countries including the United States and Australia. Group 2 consists of countries whose GNI per capita in urban areas is more than a certain

[38] The World Bank website, http://www.worldbank.org/

level, but current Annex 1 countries are excluded from Group 2. The reason of this division is that Group 2, countries that will be obliged responsibilities for the first time under Post-Kyoto, should own different types of responsibilities from Group 1, which has already assumed responsibilities under the Kyoto Protocol. (discussed below) Other participating countries should be categorized into Group 3 and Group 4 based on their economic situation and the condition of damage by climate change.

Finally, if global society tries to obligate both the United States and China, which are the largest and second-largest emitters, to reduce their big emissions, the only way is to obligate both of them to do so. This is because the United States' participation puts pressure on China, and vice versa. If one rejects a responsibility, this can become a reason for the other's rejection.

(3) New Approaches

The Kyoto Protocol employs only one type of commitment for mitigating climate change; mandatory targets for reducing GHG emissions. However, Post-Kyoto should employ other types of commitment to secure broader support. In particular, MDCs (Group 2) will not undertake any commitments unless their targets are compatible with economic development priority. Therefore, Post-Kyoto should address trade-off between economy and environment through devising new approaches.

Non-binding targets

First, non-binding targets should be proposed to encourage MDCs (Group 2) to accept quantitative emission reduction targets under Post-Kyoto. However, as the failure of the UNFCCC shows, non-binding targets provide a framework with little enforceability and effectiveness, so these non-binding targets serve as a just transitional device. Over the long run, MDCs need to accept binding targets and their mandatory efforts are ultimately necessary for the resolution of climate change. Therefore, Post-Kyoto should develop an elementary, soft path for MDCs' long endeavor. Also, based on the failure of the UNFCCC, Post-Kyoto should give some incentives for countries to achieve non-binding targets. For example, countries that achieve non-binding targets may receive preferential treatment under the post-Post-Kyoto framework.

Performance standards

Performance standards should be established instead of emission reduction targets. They specify mandatory standards relating to energy efficiency or technology advancement. Especially, performance standards for power plants, which are the primary source of GHG emissions, can work effectively. These standards are suitable for MDCs, especially the former Soviet Union countries and Eastern European countries, whose industrial infrastructures have large room for improvement. If standards are set appropriately for each nation's technology levels, they can reduce GHG emissions by being compatible with their economic growth due to their decrease of input materials and energy consumption. However, these standards may lock in technology growth and not provide few incentives for further technological innovation.

Policy change
Another approach is to encourage national governments to employ environment-friendly policies; for example reducing subsidies for fossil fuels, promoting renewable energy, and tax deduction for hybrid vehicles. Although this approach does not have clear, quantitative targets and its effective is obscure, it is accessible for developing countries to assume a responsibility for climate change.

(4) Countermeasures for Countries in a Weak Position

The paper points out that the CDM will expand the disparity among developing countries and climate change intrinsically has problems related to environmental justice. Thus, some developing countries' position is getting worse. Securing strong assistance to countries in a vulnerable position is important for Post-Kyoto to enhance equity. This subsection will explore countermeasures for stakeholders in a weak position through redesign of the CDM and JI.

To begin with, along with re-classification above, CDM projects should be implemented between a Group 1 country and a Group 3 or Group 4 country, or a Group 2 country and a Group 3 or Group 4 country. JI projects should be implemented between two Group 1 countries, two Group 2 countries, or a Group 1 country and a Group 2 country.

In addition, the CDM and JI should reflect country risk. For example, risk of a CDM project in Tanzania is much larger than that of a JI project in the United States. This is because there are much more hurdles, troubles, and uncertainties in CDM projects, which are implemented in developing countries with poor economic infrastructures, compared with JI projects, which are implemented in industrialized nations or MDCs. Therefore, by reflecting each country's risk levels, reduction credits acquired in CDM projects should be evaluated more than JI projects, even though same amounts of emission reductions are produced. If the concept of country risk is introduced to the CDM, some private companies will venture to launch projects in LDCs in search for larger reduction credits, and the disparity in developing countries, which is mentioned in the beginning of this subsection, will decrease.

Currently projects are acknowledged as a CDM project as long as they are designed to reduce GHG emissions and promote sustainable economic growth. Another objective, mitigating damage brought by climate change, should be added to CDM objectives. For example, some projects may aim at mitigating coastal erosion resulting from sea-level rising and can produce corresponding reduction credits through mitigation activities. Thus, Post-Kyoto should support nations that are suffering from climate change effect by adding a damage mitigation approach to the purpose of the CDM.

(5) More Research and Development

This subsection will explore what types of R&D is necessary for Post-Kyoto.

Clarifying the practical risk of climate change
First of all, the relation between extreme weather events and GHG emissions or global warming should be clarified. For example, clarifying the relation between Katrina and

global warming might be one easy way to let the United States return to the Kyoto Protocol. This is because although climate change is a common challenge for the international community, many countries hesitate to engage in collective action and bear the burden unless they perceive the risk of climate change to be in their interest. As discussed many times, although there have been still various uncertainties in climate change, investigations toward Post-Kyoto should focus on clarifying more practical risk of climate change first.

Improving renewable energy's economic competitiveness

R&D efforts toward cost reduction of renewable energy are important. The Energy sector is the primary sources of GHG emissions, which should be addressed as a priority, and GHG emissions from the energy sector can be reduced sharply if economic competitiveness of clean energy is enhanced enough. However, practically every renewable energy sources are disadvantageous, compared with fossil fuels. For example, wind power generates mush less CO2 than coal energy, but its economic advantage is much more disadvantageous than coal.[39] Therefore, more R&D efforts toward renewable energy are essential to render emission reduction activities compatible with economic priority. Consequently, Post-Kyoto can secure commitment for reducing emissions from broad-ranging countries, including developing nations.

9. Conclusion

In the introduction, the paper points out three challenges for climate change. This section will re-examine these challenges based on all the analysis in this research paper.

First, uncertainties have posed various barriers for global society to reach agreement on how it should tackle climate change internationally and cooperatively. Although the Kyoto Protocol is the first international agreement stipulating participants' mandatory efforts, it has many drawbacks, as mentioned. As the fact that the largest GHG emitter does not join it shows, every nation hesitates to implement actual countermeasures for an uncertain problem. In particular, it is difficult for stakeholders to perceive the risk of climate change without catastrophic disasters such as Katrina. Even with these disastrous events, some people will not admit its risk because the causal relation has yet to be revealed completely. Therefore, the paper argues that the practical risk of climate change should be clarified as the first priority, rather than clarifying the complete mechanism of climate change. On the other, global society can determine on addressing GHG emission reductions based on a certain background. It is certain that natural resources such as oil and coal are limited sources; hence the present generation has to save some of them for the future generations. From this perspective, we should shift to renewable energy sources, which emit less GHG emissions. In addition, another importance is that uncertainty is itself a reason to act now for no-regrets. Uncertainty should not become a reason for delaying action. Instead, an international framework should consist of a series of successive commitment periods, which allow targets to be revised based on the progress of science and technology.

[39] The Institute of Applied Energy; compared with coal energy, wind power generates just 3 percent of CO2 emissions, but it costs 1.5 to 2 times as big as coal does.

Secondly, incentives for private sectors and technology advancement play an important part in mitigating confrontation between environment and economy. Private sectors will launch many projects if they consider that they can make profits through GHG emission reductions; hence incentive mechanisms such as the CDM and emission trading scheme should be utilized effectively. Furthermore, economic competitiveness of renewable energy should be strengthened in order to achieve economic growth and emission reductions simultaneously. Technology advancement for this is essential. Country-level policies stipulating minimum amounts of energy generation by renewable sources will be effective for driving this technology progress. In addition, some new approaches toward emission reductions, which are proposed in Section 8 such as non-binding targets, performance standards, and policy change, will be compatible with economic growth policy.

Thirdly, the biggest political challenge is to engage all the international community in mitigation efforts for climate change. Although the Kyoto Protocol entered into force, unfortunately this challenge still remains and rather it increases inequity feelings among global society. Of course no single equity perspective can be a basis for an international framework because of wide variance in national circumstances, however this inequity feeling should be decreased under Post-Kyoto and more countries should join and assume some responsibilities for mitigating climate change. A framework that treats participants as fairly as it can and covers as many nations as possible is the only answer for political challenge in climate change. In doing so, Post-Kyoto can become politically acceptable to broad-raging stakeholders.

Finally, the paper will argue the way forward for climate change. Last month, November 2006, COP-12 was held in Nairobi, Kenya to discuss Post-Kyoto. This round succeeded in extracting concessions from developing countries including China and India and stipulated that continual revision of the Kyoto Protocol was incorporated in Post-Kyoto discussions. These concessions might lead to obligate some responsibilities to developing nations under Post-Kyoto. Therefore, this agreement is very important, because over the long run, developing countries' commitments are absolutely necessary for tackling climate change. Also, their aggressive involvement can put a pressure on the United States and Australia. On the other hand, in response to developing countries' concessions, developed countries will also be required further efforts in the next COP round.

Ultimately climate change, thus, requires unified efforts by the international community, and both developed and developing nations have to make some concessions. Moreover, not political conflicts but a sense of unity is important and a framework for climate change should provide participating countries with confidence that every country bears responsibilities and tackles it. With this unity feeling, the international community can make a big step toward climate change. Success in tackling climate change largely depends on whether or not a global strategy can accommodate each nation's situation. Therefore, Post-Kyoto should develop a framework that promotes both unity and equity feelings among the international community, and I hope that the proposals presented in this paper can enhance the prospects for successful establishment of Post-Kyoto.

Appendix 1: 20th century changes in the Earth's atmosphere, climate, and biophysical systems

Indicator	Observed Changes
Concentration indicators	
Atmospheric concentration of CO2	280 ppm for the period 1000-1750 to 368 ppm in year 2000 (31±4% increase).
Terrestrial biospheric CO2 exchange	Cumulative source of about 30 gigaton carbon (Gt C) between the year 1800 and 2000; but during the 1990s, a net sink of about 14±7 Gt C.
Atmospheric concentration of CH4	700 parts per billion (ppb) for the period 1000-1750 to 1,750 ppb in year 2000 (151±25% increase).
Atmospheric concentration of N2O	270 ppb for the period 1000-1750 to 316 ppb in year 2000 (17±5% increase).
Tropospheric concentration of O3	Increased by 35±15% from the years 1750 to 2000, varies with region.
Stratospheric concentration of O3	Decreased over the years 1970 to 2000, varies with altitude and latitude.
Atmospheric concentrations of HFCs, PFCs, and SF6*	Increased globally over the last 50 years.
* HFCs - Hydrofluorocarbons, PFCs - Perfluorocarbons, and SF6 - Sulphur hexafluoride	
Weather indicators	
Global mean surface temperature	Increased by 0.6±0.2°C over the 20th century; land areas warmed more than the oceans (very likely).
Northern Hemisphere surface temperature	Increase over the 20th century greater than during any other century in the last 1,000 year; 1990s warmest decade of the millennium (likely).
Diurnal surface temperature range	Decreased over the years 1950 to 2000 over land: nighttime minimum temperatures increased at twice the rate of daytime maximum temperatures (likely).
Hot days / heat index	Increased (likely).
Cold / frost days	Decreasd for nearly all land areas during the 20th century (very likely).
Continental precipitation	Increased by 5-10% over the 20th century in the Northern Hemisphere (very likely), although decreased in some regions (e.g., north and west Africa and parts of the Mediterranean).
Heavy precipitation events	Increased at mid- and high northern latitude (likely).
Frequency and severity of drought	Increased summer drying and associated incidence of drought in a few areas (likely). In some regions, such as parts of Asia and Africa, the frequency and intensity of droughts have been observed to increase in recent decades.
Biological and physical indicators	
Global mean sea level	Increased at an average annual rate of 1 to 2 mm during the 20th century.
Duration of ice cover of rivers and lakes	Decreased by about 2 weeks over the 20th century in mid- and high latitudes of the Northern Hemisphere (very likely).
Arctic sea-ice extent and the thickness	Thinned by 40% in recent decades in late summer to early autumn (likely) and decreaed in extent by 10-15% since the 1950s in spring and summer.
Non-polar glaciers	Widespread retreat during the 20th century.
Snow cover	Decreased in area by 10% since global observations became available from satellites in the 1960s (very likely).
Permafrost	Thawed, warmed, and degraded in parts of the polar, sub-polar, and mountainous regions.
El Niño events	Became more frequent, persistent, and intense during the last 20 to 30 years compared to the previous 100 years.
Growing season	Lengthened by about 1 to 4 days per decade during the last 40 years in the Northern Hemisphere, especially at higher latitudes.
Plant and animal ranges	Shifted poleward and up in elevation for plants, insects, birds, and fish.
Breeding, flowering, and migration	Earlier plant flowering, earlier bird arrival, earlier dated of breeding season, and earlier emergence of insects in the Northern Hemisphere.
Coral reef bleaching	Increased frequency, especially during El Niño events.
Economic indicators	
Weather-related economic loss	Global inflation-adjusted losses rose an order of magnitude over the last 40 years. Part of the observed upward trend is linked to socio-economic factors and part is linked to climatic factors.

Source: The IPCC, Climate Change 2001: Synthesis Report Summary for Policymakers

Appendix 2: Changes in GHG emissions from 1990 to 2004 for Industrialized Nations

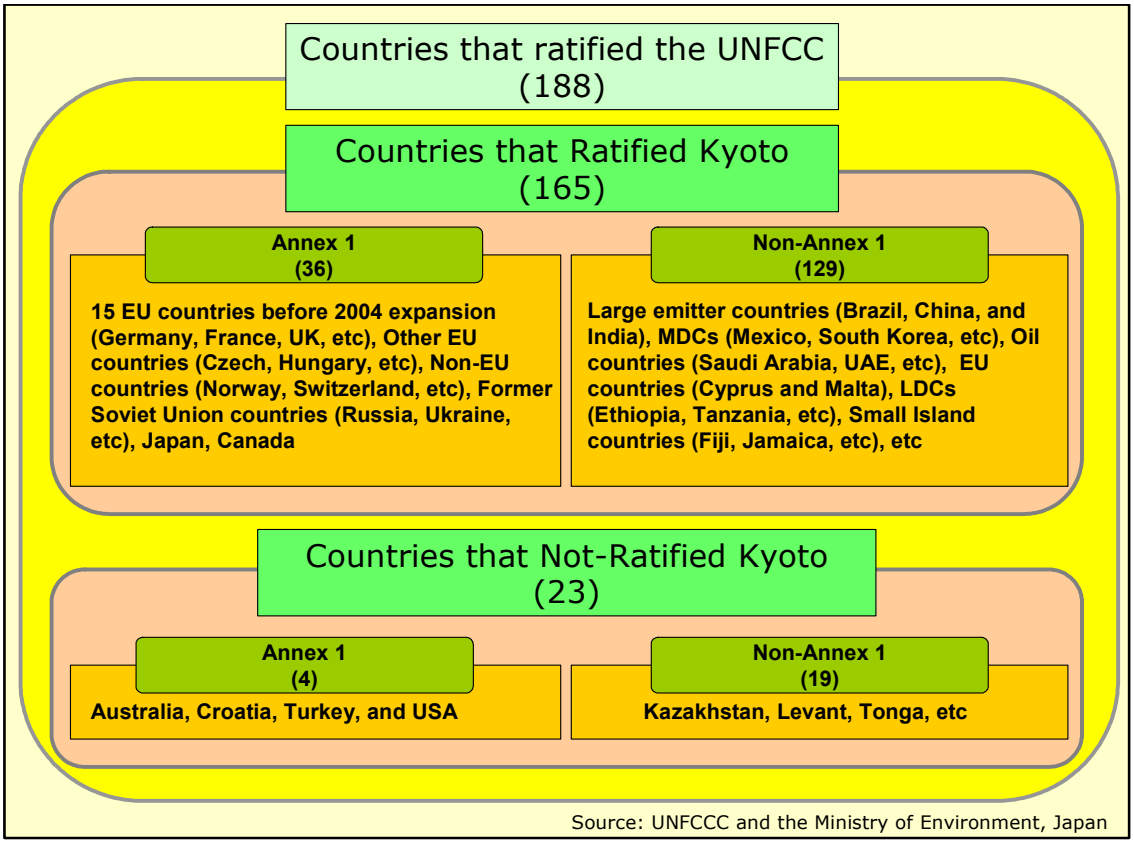
Changes in GHG emissions from 1990 to 2004 for Industrialized Nations

Parties	Total GHG emissions (million tonnes CO2 equivalent)			Changes in emissions (%)	
	1990	2000	2004	1990-2004	2000-2004
Annex 1 EIT Parties	**5551.0**	**3366.9**	**3506.0**	**-36.8**	**4.1**
Annex 1 Non-EIT Parties	**13000.5**	**14147.7**	**14425.6**	**11.0**	**2.0**
All Annex 1 Parties to the UNFCC	**18551.5**	**17514.6**	**17931.6**	**-3.3**	**2.4**
Annex 1 Kyoto Protocol Parties	**11823.8**	**9730.3**	**10011.5**	**-15.3**	**2.9**

Source: UNFCCC

<Note>
*1 EIT parties are countries whose economies are in transition such as eastern and central Europe countries.
*2 The overall emissions of industrialized countries decreased by 3.3%, but this was mostly due to EIT parties' decrease.
*3 Even EIT parties are increasing their emission from 2000 to 2004. Annex 1 countries will need to strengthen their efforts for reducing GHG emissions.

Appendix 3: Countries in the UNFCCC and the Kyoto Protocol



Source: UNFCCC and the Ministry of Environment, Japan

Appendix 4: Countries in the Kyoto Protocol, classified by Annex 1 and Non-Annex 1 countries

Country	Annex 1	Non-Annex 1	Ratio of GHG Emissions in Annex 1 countries
Albania		!	
Algeria		!	
Antiqua and Barbuda		!	
Argentina		!	
Armenia		!	
Austria	!		0.4%
Azerbaijan		!	
Bahamas		!	
Bahrain		!	
Bangladesh		!	
Barbados		!	
Belarus	!		
Belgium	!		0.8%
Belize		!	
Benin		!	
Bhutan		!	
Bolivia		!	
Botswana		!	
Brazil		!	
Bulgaria	!		0.6%
Burkina Faso		!	
Burundi		!	
Cambodia		!	
Cameroon		!	
Canada	!		3.3%
Cape Verde		!	
Chile		!	
China		!	
Columbia		!	
Congo		!	
Cook Islands		!	
Costa Rica		!	
Cuba		!	
Cyprus		!	
Czech Republic	!		1.2%
Democratic People's Republic of Korea (North Korea)		!	
Denmark	!		0.4%
Djibouti		!	
Dominica		!	
Dominican Republic		!	
Ecuador		!	
Egypt		!	
El Salvador		!	
Equatorial Guinea		!	
Eritrea		!	
Estonia	!		0.3%
Ethiopia		!	
Fiji		!	
Finland	!		0.4%
France	!		2.7%
Gambia		!	
Georgia		!	

Germany	!		7.4%
Ghana		!	
Greece	!		0.6%
Grenada		!	
Guatemala		!	
Guinea		!	
Guinea-Bissau		!	
Guyana		!	
Haiti		!	
Honduras		!	
Hungary	!		0.5%
Iceland	!		0.0%
India		!	
Indonesia		!	
Iran		!	
Ireland	!		0.2%
Israel		!	
Italy	!		3.1%
Jamaica		!	
Japan	!		8.5%
Jordan		!	
Kenya		!	
Kiribati		!	
Kuwait		!	
Kyrgyzstan		!	
Lao People's Democratic Republic		!	
Latvia	!		0.2%
Lesotho		!	
Liberia		!	
Libyan Arab Jamahiriya		!	
Liechtenstein	!		
Lithuania	!		
Luxembourg	!		0.1%
Madaqascar		!	
Malawi		!	
Malaysia		!	
Maldives		!	
Mali		!	
Malta		!	
Marshall Islands		!	
Mauritania		!	
Mauritius		!	
Mexico		!	
Micronesia		!	
Monaco	!		0.0%
Mongolia		!	
Morocco		!	
Mozambique		!	
Myanmar		!	
Namibia		!	
Nauru		!	
Nepal		!	
Netherlands	!		1.2%
New Zealand	!		0.2%
Nicaragua		!	

Niger		!	
Nigeria		!	
Niue		!	
Norway	!		0.3%
Oman		!	
Pakistan		!	
Palau		!	
Panama		!	
Papua New Guinea		!	
Paraguay		!	
Peru		!	
Philippines		!	
Poland	!		3.0%
Portugal	!		0.3%
Qatar		!	
Republic of Korea (South Korea)		!	
Republic of Moldova		!	
Romania	!		1.2%
Russia	!		17.4%
Rwanda		!	
Saint Lucia		!	
Saint Vincent and the Grenadines		!	
Samoa		!	
Saudi Arabia		!	
Senegal		!	
Seychelles		!	
Singapore		!	
Slovakia	!		0.4%
Slovenia	!		
Solomon Islands		!	
South Africa		!	
Spain	!		1.9%
Sri Lanka		!	
Sudan		!	
Suriname		!	
Swaziland		!	
Sweden	!		0.4%
Switzerland	!		0.3%
Syrian Arab Republic		!	
Thailand		!	
The former Yugoslav Republic of Macedonia		!	
Togo		!	
Trinidad and Tobago		!	
Tunisia		!	
Turkmenistan		!	
Tuvalu		!	
Uganda		!	
Ukraine	!		
United Arab Emirates		!	
United Kingdom of Great Britain and Northern Ireland	!		4.3%
United Republic of Tanzania		!	
Uruguay		!	
Uzbekistan		!	
Vanuatu		!	
Venezuela		!	
Viet Nam		!	
Yemen		!	
Zambia		!	
	36	**129**	**61.6%**

Source: UNFCCC and the Ministry of Environment, Japan

References

Document

1. The IPCC, 2001. Climate Change 2001: Synthesis Report Summary for Policymakers
2. The UNFCCC, Press release on October 27th, 2006
3. The UNFCCC, the full text of the Kyoto Protocol
4. UNICEF and the World Health Organization, 2004. Meeting the MDG Drinking Water and Sanitation Target
5. The Ministry of Economy, Trade, and Industry Japan, 2005. The Strategy for the Achievement of the Kyoto Protocol
6. National Institute for Research Advancement, 2004. Possibility of the CDM in China
7. Research Group of Chinese Environmental Problems, 2004. Chinese Environment Hand Book
8. The Pew Center on Global Climate Change, 2003. Beyond Kyoto
9. BP, 2004. BP Statistical Review of World Energy 2004
10. Foreign Press Center/Japan, 2001. Japan Gains Concessions on Kyoto Protocol
11. The Economist, September 9th-15th 2006
12. The Nature, October 2003
13. Harvard Business School, 2002. Global Climate Change after Marrakech
14. Robert W.Christopherson, 2004. Geosystems Sixth Edition
15. Tom Daniels and Katherine Daniels, 2003. Environmental Planning Handbook
16. John Browne, 2004. Beyond Kyoto
17. David B. Sandalow and Ian A. Bowles, 2001. Fundamentals of Treaty -Making on Climate Change
18. Truman Semans, 2005. Political Climate Change
19. Jullet Ellperin, 2006. Debate on Climate Shifts to Issue of Irreparable Change
20. Stuart Penson, 2006. UN sets to kick start Kyoto emissions scheme

Website

1. The United Nation Framework Convention on Climate Change, http://unfccc.int
2. The Intergovernmental Panel on Climate Change, http://www.ipcc.ch
3. The World Bank, http://www.worldbank.org
4. The Ministry of Environment of Japan, http://www.env.go.jp
5. The Ministry of Economy, Trade and Industry of Japan, http://www.meti.go.jp
6. The Pew Center on Global Climate Change http://www.pewclimate.org
7. Kyoto Mechanism Information Platform, http://www.kyomecha.org
8. The Institute of Applied Energy, http://www.iae.or.jp
9. NIKKEI NET, http://www.nikkei.co.jp
10. NIKKEI BP, http://nikkeibp.jp
11. Mainichi Shimbun, http://mainichi.co.jp
12. International Herald Tribute, http://www.iht.com/
13. Wikipedia, http://en.wikipedia.org/wiki/Kyoto_protocol
14. Searchina, http://searchina.ne.jp/
15. Toyota, http://toyota.jp
16. BP, http://www.bp.com