Ministry of the Environment
Japan

Climate Regime Beyond 2012: Key Perspectives (Long-Term Targets)

2nd Interim Report

May 2005

Sub-Committee for
International Climate Change Strategy,
Global Environment Committee,
Central Environment Council,
Ministry of the Environment, Japan

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1. Preface

- The Sub-Committee for International Climate Change Strategy was established under the Global Environment Committee, Central Environment Council, Ministry of the Environment, Japan, in January 2004 with the aim of collecting and organizing reference materials for the consideration of a climate regime beyond 2012. The Sub-Committee held its first meeting in April 2004, and issued its first interim report in December of the same year after a total of seven meetings. The interim report gave shape to what is meant by the ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC), and considered the regime required to realize the objective from a systemic perspective.

- In the three meetings it held since April 2005, the Sub-Committee collected and organized reference materials presenting current scientific knowledge concerning long-term targets such as the range of control of temperature rise, and atmospheric GHG concentrations and global emission paths, focusing in particular on materials, including examples of Japanese research, dealing with temperature rise and its impacts due to climate change. This report, the Sub-Committee's 2nd Interim Report, presents the findings of these activities.

2. International Developments Related to Long-Term Targets for Controlling Climate Change

2.1 Ultimate Objective of UNFCCC and Long-Term Targets

- The ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC) is the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system," - in other words, the "stabilization of greenhouse gas concentrations in the atmosphere at a level that does not adversely affect natural ecosystems and humankind." This level "should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."

- Various countries have implemented UNFCCC-based measures aimed at contributing to the achievement of the Convention's ultimate objective, and the Kyoto Protocol, which is a concrete framework for GHG emission reduction, went into effect on February 16, 2005.

- Now that the Kyoto Protocol has gone into effect, there is growing debate about the next global climate regime beyond 2012 when the first commitment period of the Protocol ends (hereinafter referred to as "the next regime"). The next regime needs to bring us closer to achieving the ultimate objective of the Convention. Consequently, efforts must be made to specify as far as is possible the direction that the international community should pursue, and to quantify and give concrete shape to the ultimate objective of the UNFCCC.

- The setting of long-term targets is in effect the process of quantifying and giving concrete shape to the ultimate objective of the UNFCCC, and is an attempt to further clarify the targets that the international community has already agreed upon.

2.2 International Developments Related to the Setting of Long-Term Targets

- In its Third Assessment Report issued in 2001, the Intergovernmental Panel on Climate Change (IPCC) provided its assessment of scientific data and evidence concerning "dangerous anthropogenic interference with the climate system," or in other words, the impacts of human-induced climate change (see Tables 2.1 and 2.2). Since then, further new information in this field both from Japan and from the rest of the world has added to our body of knowledge (see Table 2.3).

Table 2.1 Positive and negative impacts of climate change (source: based on the IPCC Third Assessment Report)

1. Projected positive impacts

(Impact on crop yields)
Increased potential crop yields in some regions at mid-latitudes for increases in temperature of less than a few degrees Celsius

(Impact on timber resources)
Potential increase in global timber supply from appropriately managed forests

(Impact on water resources)
Increased water availability for populations in some water-scarce regions

(Impact on human health)
Reduced winter mortality in mid- and high latitudes

(Impact on energy demand)
Reduced energy demand for space heating due to higher winter temperatures

2. Projected negative impacts

(Impact on crop yields)
- General reduction in potential crop yields in most tropical and sub-tropical regions for most projected increases in temperature
- General reduction, with some variation, in potential crop yields in most regions in mid-latitudes for increases in annual-average temperature of more than a few degrees Celsius

(Impact on water resources)
Decreased water availability for populations in many water-scarce regions, particularly in the sub-tropics

(Impact on human health)
Increase in the number of people exposed to vector-borne diseases (for example, malaria) and water-borne diseases (for example, cholera) and an increase in heat-stress mortality

(Impact on human settlement)
Widespread increase in the risk of flooding for many human settlements (tens of millions of inhabitants in settlements studied) from both increased heavy precipitation events and sea-level rise

(Impact on energy demand)
Increased energy demand for space cooling due to higher summer temperatures

Table 2.2 Relationship between climate change and extreme climate events (source: IPCC Third Assessment Report)

Likelihood that events have already occurred (latter half of 20th century)	Projected changes in extreme climate phenomena	Likelihood of occurrence (21st century)
Likely	Higher maximum temperatures, more hot days and heat waves over nearly all land areas	Very likely
Very likely	Higher minimum temperatures, fewer cold days, frost days and cold waves over nearly all land areas	Very likely
Very likely	Reduced diurnal temperature range over most land areas	Very likely
Likely over many areas	Increase of heat index over land areas (a)	Very likely over most areas
Likely over many Northern Hemisphere mid- to high latitude areas	More intense precipitation events (b)	Very likely over many areas
Likely in a few areas	Increased summer continental drying and associated risk of drought	Likely over most mid-latitude continental interiors (lack of consistent projections in other areas)
Not observed in the few analyses available	Increase in tropical cyclone peak wind intensities (c)	Likely over some areas
Insufficient data for assessment	Increase in tropical cyclone mean and peak precipitation intensities (c)	Likely over some areas

(a) Heat index is a combination of daily mean temperature and relative humidity.
(b) For other areas there are either insufficient data or conflicting analyses.
(c) Past and future changes in tropical cyclone location and frequency are uncertain.

Table 2.3 New findings related to climate change

○ **Large-scale disappearance of Arctic ice due to large temperature rise (November 9, 2004)[1]**
(Arctic Council: Arctic Climate Impact Assessment (ACIA))

- Global warming is causing the Arctic ice cap to rapidly melt, with the average extent of sea-ice cover in summer decreasing by 20% over the past 30 years. By the end of the 21st century, it is predicted that Arctic temperatures will rise by 4-7°C, causing summer sea-ice extent to be reduced by more than 50%, and record melting of the Greenland Ice Sheet.

○ **Many impacts already appearing in USA (November 9, 2004)[2]**
(Report on Observed Impacts of Global Climate Change in the U.S.)

- Half of the approximately 150 wild animal and plant species surveyed have been affected by global warming.

○ **Human activity implicated in Europe's 2003 heat wave (*Nature*, December 2004)[3]**

- It is very likely (confidence level > 90%) that human influence has at least doubled the risk of extreme heat waves like that which hit Europe in 2003.

○ **Avoiding Dangerous Climate Change conference (UK, February 1-3, 2005)[4]**

- Compared with the IPCC Third Assessment Report (2001), there is greater clarity and reduced uncertainty about the impacts of climate change. In many cases the risks are more serious than previously thought. If concentrations were to rise to 550 ppm CO2 equivalent, then it is unlikely that warming would be limited to 2°C above pre-industrial levels.
- Different models suggest that delaying action would require greater action later for the same temperature target and that even a delay of 5 years could be significant.
- To stabilize GHG concentrations, technological options for significantly reducing emissions over the long term already exist. Large reductions can be attained, using a portfolio of options whose costs are likely to be smaller than previously considered.

○**) Receding Himalayan glaciers, disappearance of Kilimanjaro's ice (March 2005)**
(WWF report)[5]

- Receding Himalayan glaciers, and disappearance of Kilimanjaro's ice cap could cause serious water shortages.

○ On the occasion of negotiating the Kyoto Protocol in 1996, the European Union set a long-term target of limiting temperature rise to 2°C compared with pre-industrial levels, and it still remains committed to this target. At European Council, the EU has stated its views on the amount of GHG emission reduction required of developed countries by 2020, and at EU Environment Minister-level discussions, it has also stated its views on the reduction required of developed countries by 2050, respectively, to achieve this target (see Tables 2.4 and 2.5). In the USA, a resolution submitted to the Senate calls for the setting of long-term targets, etc. (see Table 2.6)

Table 2.4 Key points of EU Environment Council Conclusions on climate change (March 10, 2005)

■ The global nature of climate change calls for the widest possible cooperation by all countries in accordance with their common, but differentiated responsibilities. ■ In order to have a reasonable chance to limit global warming to no more than 2^{o}C compared with pre-industrial temperatures, stabilization of atmospheric GHG concentrations well below 550 ppmv CO2 equivalent may be needed. ■ Recent scientific research and work indicate that limiting global warming to the 2^{o}C target will require global GHG emissions to peak within 2^{o}C, followed by substantial reductions in the order of at least 15% and perhaps by as much as 50% by 2050 compared to 1990 levels. ■ The EU looks forward to exploring with other Parties possible strategies for achieving necessary emission reductions, and believes that, in this context, reduction pathways by the group of developed countries in the order of 15-30% by 2020 and 60-80% by 2050 compared to 1990 levels should be considered.

Table 2.5 European Council Presidency Conclusions (March 23, 2005)

■ To achieve the ultimate objective of the UNFCCC, average global surface temperature increase should not exceed 2ºC above pre-industrial levels. ■ The widest possible cooperation by all countries and their participation should be ensured in exploring options for a post-2012 regime in the context of the UN climate change process. ■ Developed countries should consider GHG emission reductions in the order of 15-30% by 2020, compared with 1990 levels, and beyond, in the spirit of the conclusions of the Environment Council. These reduction ranges are to be viewed in the light of future work on how the objective can be achieved, including the cost-benefit aspect. ■ Consideration should also be given to ways of effectively involving major energy-consuming countries, including those among the emerging and developing countries.

Table 2.6 U.S. Senate Feinstein and Snowe Joint Resolution (Introduced February 16, 2005)

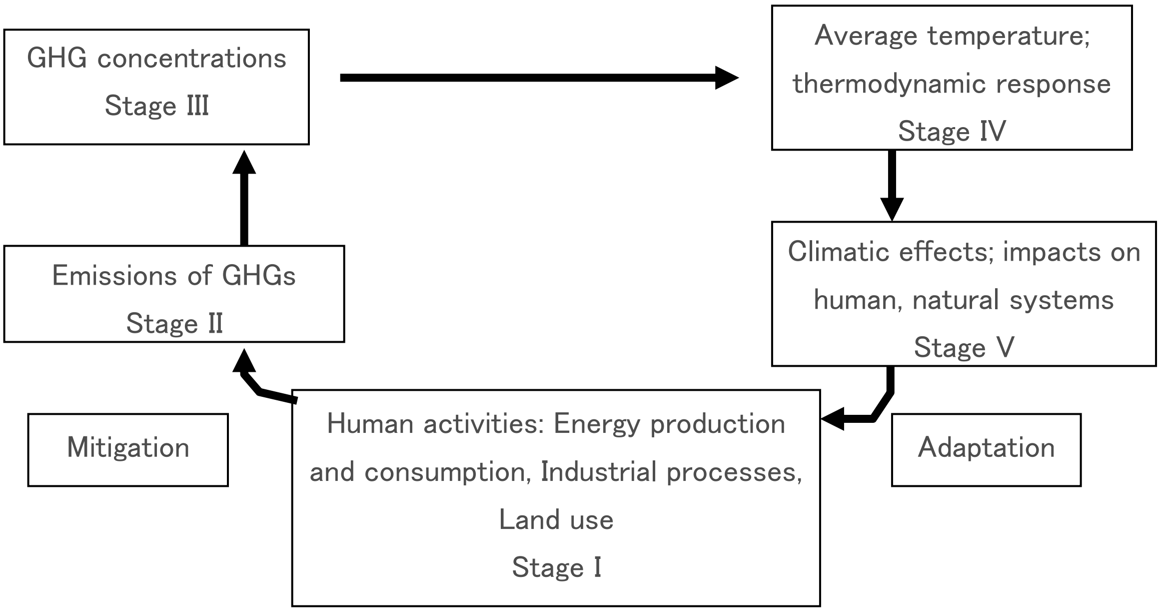
Resolution introduced by Senators Dianne Feinstein (Dem), Olympia Snowe (Rep) and 12 other senators, calling for the United States to act to reduce GHG emissions by: (1) carrying out reasonable and responsible actions to ensure significant and meaningful reductions in emissions of all GHGs; (2) generating climate-friendly technologies by enacting and implementing policies and programs to address all GHG emissions to promote sustained economic growth; (3) participating in international negotiations under the UNFCCC to achieve significant, long-term, cost-effective reductions in global GHG emissions; and (4) supporting the establishment of a long-term objective to prevent the global average temperature from increasing by greater than 3.6 degrees Fahrenheit above pre-industrial levels. Note: A joint resolution requires the approval of both houses of Congress and the signature of the President, just as a bill does, and has the force of law if approved.

2.3 Why Japan Needs to Consider the Setting of Long-Term Targets

- In view of the global scale of the likely impacts of climate change, the issue of climate change requires a global response. Now that scientific knowledge has accumulated, and other nations and regions are proposing long-term targets, it is important that Japan too give serious consideration to the significance and challenges of setting its own long-term targets such as the range of control of temperature rise for GHG emission reduction.

  Note: The setting of short and medium-term targets and divizing concrete policies should be considered in light of long-term targets. In the event that long-term targets are framed in terms of range of temperature rise or atmospheric GHG concentrations, such numerical targets represent upper limits that should not be exceeded, with the period by which such targets are achieved being dictated by GHG emission paths, climate system behavior and so forth. In the event that long-term targets are framed in terms of such policy targets as GHG reduction, we envisage short-term targets applying to the period from the present up to around 2020, medium-term targets to the period up to 2030-2050, and long-term targets to the period up to around 2100.

- Long-term targets can be set for any of the five stages of climate change - human activities (energy production and consumption), GHG emissions, atmospheric GHG concentrations, global mean temperature rise, and climate change impacts (see Figure 2.1). We have focused our consideration of long-term targets in particular on climate change impacts, global mean temperature rise, and atmospheric GHG concentrations.



Source: Pershing, J. and F. Tudela (2003)[6]

Figure 2.1 The Climate Change Cycle

3. The Significance of Establishing Long-Term Targets

- Although the Kyoto Protocol is the first step toward achieving the ultimate objective of the United Nations Framework Convention on Climate Change, it does not necessarily follow that the climate change problem will be resolved when the first commitment period of the Protocol concludes in 2012. The international community is being challenged with a question as to which direction the ensuing second and third steps should take and where to set the target. Long-term targets hold significance as indications of the direction to be taken in establishing the next regime. Setting a clear direction to be followed also contributes to the realization of a low carbon emitting economy on a worldwide scale and to an assurance of the attainment of UNFCCC's ultimate objective.

- As clearly noted in the first interim report of this sub-committee, long-term targets have significance from the standpoint of global risk management as well. Clearly-defined long-term objectives would help the international community become more cognizant of the inevitability of the impacts, to an extent, brought by climate change and clarify the roadmap for establishing the measures for reduction of greenhouse gas emissions and adaptation to climate change. Sharing of a common recognition throughout the world in this manner in the midst of a call for the establishment of the effective next regime would also accelerate the progress of international negotiations in which major powers participate.

- In addition, at a national level, the setting of long-term targets would give a message to citizens that would bear substantial meaning from the aspect of arousing public opinion and promoting concrete actions.

- Furthermore, long-term objectives also have meaning from the standpoint of implementing sustainable climate change measures. While the future direction pertaining to climate change remains as uncertain as it is now, we cannot expect adequate public works investments that incorporate measures to address climate change and large-scale private investments that contribute to such measures. In order to promote a broad range of such measures as private investments, technological development and creation of institutional systems, it is indispensable to send out reliable policy signals based on the well-established long-term targets.

4. Conditions Precedent to Debating Long-Term Targets

- In order to examine the long-term objectives, it is necessary to clarify "when, where and how" to capture and observe the effects of climate change. More specifically, it is necessary to examine them after the following preconditions have been clarified.

  - The type of gas in question
  - The benchmark for evaluation (The question of "When?" in establishing a reference base for discussion.)
  - The geographic scope of evaluation (The question of "Where?" when establishing a geographic scale for discussion, i.e., is it global or regional?)
  - The index for evaluation of dangerous levels (The question of "How?" in establishing an index for evaluation.)

- Although much international discussion and research related to long-term targets is already underway, there are many instances where these preconditions are not necessarily clarified, with a result that the issues are confused.[1] Thus, in this report we presuppose to organize scientific findings through:

  - Covering all GHGs, referring, as necessary, to the impacts caused by six of

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[1] There is debate concerning the benchmark point of evaluation, for instance, in regard to whether to set it at a point before the Industrial Revolution (around 1750); in the pre-industrial era, i.e., before the society was industrialized (about 1850); at 1990 or elsewhere. In regard to the period prior to the Industrial Revolution and pre-industrialization, however, actual global average temperature levels can be considered almost equal.

those as identified in the Kyoto Protocol (carbon dioxide [CO_2], methane [CH_4], nitrous oxide [N_2O], sulfur hexafluoride [SF_6], hydrofluorocarbons [HFCs] and perfluorocarbons [PFCs])

- Using the pre-industrialization level as a benchmark (around 1850),
- Dealing with the global average temperature, and
- While focusing on the maximum temperature rise.

Accordingly, our point revolves around the temperature rise that presupposes that there was a temperature increase of about 0.6°C during the 20th century.

○ Recently, the following two values are often discussed among scientists as the thresholds of the effects of climate change.

- Type 1 Thresholds: The value beyond which damages the policy makers consider to be intolerable. In other words, the thresholds related to accumulated effects. (e.g., the effects on ecosystems, food production, water resources, coastal regions, meteorological disasters, human health, economic development, etc.)
- Type 2 Thresholds: The value that should not be exceeded in order to maintain the stability of the principal process of the climate system. In other words, the thresholds concerning the occurrence of catastrophic and irreversible damage. (e.g., the shutdown of deep ocean circulation, the collapse of the West Antarctic Ice Sheet, etc.)

In this report, scientific knowledge will be presented with the thresholds of these two types taken into consideration. While decisions concerning dangerous levels in Type 1 Thresholds include an element of value judgment, in Type 2 Thresholds, the difference of value judgment is considered to be small because of the fact that it depends on phenomena with the potential to produce grave and irreversible effects upon humankind.

5. Temperature Increase and Related Impacts Due to Climate Change

○ While it is essential to consider the worldwide consequences of climate change when formulating appropriate responses, the strategy of Japan must be based on an understanding of how Japan will be affected in particular. In this connection, it is important to note that the effects on Japan cannot be understood only within a domestic context; Japan is part of Asia, a region whose nations are closely interconnected in many ways, and where region-wide impacts are anticipated and regional measures to address climate change are important. It is important, therefore, to be aware of regional effects that may occur in Asia due to climate change. For these reasons, we consider how temperature increases due to climate change, and related impacts, will affect not only the world as a whole, but also the Asia region and Japan itself.

5.1 Global Impacts

○ Representative scientific knowledge concerning types of impacts resulting from temperature increases (global averages) are as follows.

(1) Type 1 Thresholds (Cumulative Effects)

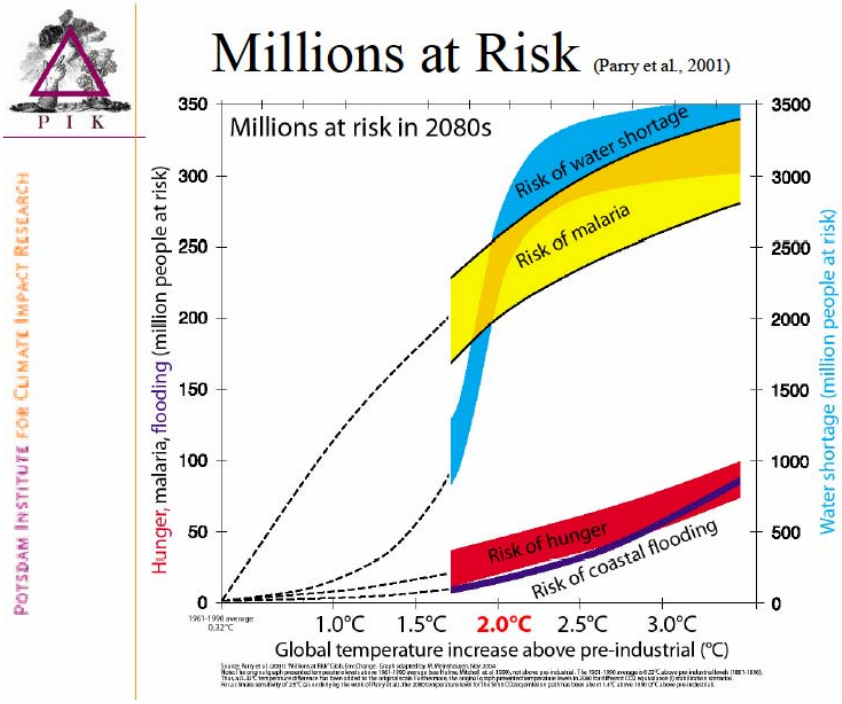
<u>Impacts on Ecosystems</u>

According to the Third Assessment Report of the Intergovernmental Panel on Climate Change (2001), it is projected that a warming of 1°C would threaten the survival of species that currently are living near the upper limit of their habitable temperature ranges, notably in alpine regions and in the southwest of Australia. In addition, according to the same report (2001), major coral bleaching events could occur if average seasonal sea-surface temperatures increase by >1ºC.

<u>Impacts on Water Resources, Coastal Zones and Human Health</u>

Parry et al. (2001)[7] indicate that populations exposed to risks of water shortages, malaria, starvation and coastal flooding would rise drastically if the global average temperature were to rise 1.5-2.0ºC above pre-industrial (1850) levels (see Figure 5.1).

The Third Assessment Report of the IPCC (2001) reports that projections of the mean annual number of people who would experience flooding due to coastal storm surges would increase several fold (by 75-200 million people depending on adaptive responses) for mid-range scenarios of a 40-cm sea-level rise by 2080 relative to scenarios with no sea-level rise.



Source: Parry, et al. (2001)[7]

Figure 5.1 Populations at Risk Due to Different Global Temperature Increases Above Pre-Industrial Levels by 2080

Impacts on Food Production

According to the Third Assessment Report of the IPCC (2001), mean annual temperature increases of 2.5ºC or greater would prompt food prices to increase as a result of a slowing in the expansion of global food production capacity relative to growth in global food demand. Moreover, yields of some crops in tropical locations would decrease with even minimal increases in temperature, because such crops are produced near their maximum temperature tolerance and dryland/rainfed agriculture predominates.

(2) Type 2 Thresholds (Catastrophic and Irreversible Impacts)

Shutdown of Deep Ocean Circulation (Thermohaline Circulation, THC)

Deep ocean circulation plays an important role in Earth's climate. There is a possibility that a weakening of deep ocean circulation patterns may lead to colder climatic conditions in Northern Europe. According to the IPCC Third Assessment Report (2001), most Atmosphere-Ocean General Circulation Models (AOGCM) show only very low probability that there will be full collapse of the thermohaline circulation by 2100. However, O'Neill and Oppenheimer (2002)[8] suggest a limit at 3ºC warming over 100 years from 1990 to avert shutdown of the thermohaline circulation; also, Stocker and Schmittner (1997)[9] and Schlesinger et al. (2004)[10] indicate the possibility that warming in this century could cause a shutdown of deep ocean circulation.

Collapse of the West Antarctic Ice Sheet (WAIS)

It is estimated that a complete collapse of the West Antarctic Ice Sheet (WAIS) would lead to a 4-6 meter rise in sea level. According to the IPCC Third Assessment Report (2001), a complete collapse of WAIS is likely to take at least several thousand years. However, there is a possibility that warming in this century could trigger a collapse of WAIS. O'Neill and Oppenheimer (2002)[8] indicate that disintegration of WAIS could ultimately occur with a global mean temperature 3ºC warmer than today.

5.2 Impacts on Asia

○ The IPCC Third Assessment Report (2001) includes an analysis of impacts due to climate change in the Asian region. The main results of this analysis are as follows.

Agriculture and Food Security

Lack of food security is the primary concern for Asia. Crop production and aquaculture would be threatened by thermal and water stresses, sea level rise, increased flooding, and strong winds associated with intense tropical storms.

Ecosystems and Biodiversity

Climate change would exacerbate current threats to biodiversity resulting from land–use/cover change and population pressure in Asia.

Permafrost melting resulting from global warming would increase the vulnerability of many climate-dependent sectors, affecting the economy in Northern Asia.

Water Resources

Freshwater availability is expected to be highly vulnerable to anticipated climate change.

Extreme Weather Events

Developing countries of temperate and tropical Asia already are quite vulnerable to extreme climate events such as typhoons/cyclones, droughts, and floods. Climate change and variability would exacerbate these vulnerabilities.

Deltas and Coastal Zones

The large deltas and low-lying coastal areas of Asia would be inundated by sea-level rise.

Human Health

Warmer and wetter conditions would increase the potential for higher incidence of heat-related and infectious diseases in tropical and temperate Asia.

Table 5.1 Sensitivity of Selected Asian Regions to Climatic Change

Change in Climatic Elements and Sea-Level Rise	Vulnerable Region	Primary Change
0.5-2ºC (10- to 45-cm sea-level rise)	Bangladesh Sundarbans	-Inundation of about 15% of national land area -Increase in salinity
4ºC (+10% rainfall)	Siberian permafrosts	-Reduction in continuous permafrost -Shift in southern limit of Siberian permafrost by 100-200 km northward
>3ºC (>+20% rainfall)	Water resources in Kazakhstan	-Change in runoff

~2ºC (–5 to 10% rainfall; 45-cm sea-level rise)	Low-lying areas of Bangladesh	-About 23-29% increase in extent of inundation

Source: IPPC Third Assessment Report (2001)

5.3 Impacts on Japan

- According to the IPCC Third Assessment Report (2001), mid- to high-latitude regions of the Northern Hemisphere have experienced the greatest rise in temperature during the latter half of the 20th Century. Over the one hundred year period of the 20th Century, while global average temperature rose 0.6ºC, average temperatures in Japan rose by one degree. In the future, with the advance of global warming, the extent of temperature rise in Japan is anticipated to exceed the global average.

- Scientific knowledge is being accumulated regarding the levels of temperature rise and sea-level rise as well as their effects in Japan.

Future Climate Change

Based on the results of the Earth Simulator developed by the Center for Climate System Research (CCSR) of the University of Tokyo, the National Institute for Environmental Studies (NIES) and the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) (2004), in an economy-focused scenario (with carbon dioxide concentrations rising to 720ppm in 2100), the daily mean temperature of summer days in Japan (June through August) will be 4.2ºC higher compared to now, the annual average precipitation will increase by 19%, and, except in some areas, the number of "tropical" days (days with high temperatures of 30ºC or above) will increase by approximately 70 days; the frequency of heavy rain is also expected to increase.

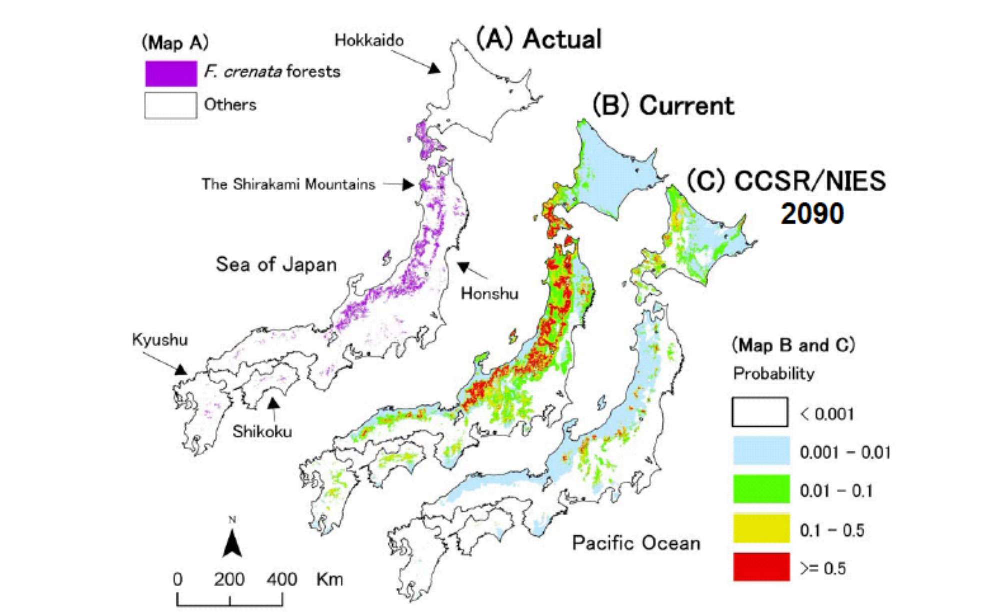
Impacts on Coastal Zones

According to the study "The Impacts of Global Warming on Japan – 2001"[11] a rise of sea level of 1 meter would result in the eroding of 90.3% of the total area of Japan's sandy coastlines; moreover, it has been estimated that a rise of sea level of 1 meter would require raising the height of dikes to 2.8 meters along sandy seashores exposed to the open ocean, and 3.5 meters along inland sea areas.

Impacts on Beech (*Fagus crenata*) Forests

According to estimates by the Forestry and Forest Products Research Institute of Japan, in a scenario for 2090 in which temperatures have risen 3.6ºC above current temperatures, areas in Japan with a 50 or more percent probability of distribution of beech (*Fagus crenata*) forests are expected to decrease by nine-tenths (Matsui et al., 2004).[12]

In this estimation, the temperature in 2090 is based on a down-scaled version of the results from the CCSR/NIES global circulation model (GCM) using the method employed by Yokozawa et al. (2003).[13]



(A) Actual distribution and predicted probability distributions of beech (Fagus crenata) under (B) the current climate and (C) the CCSR/NIES climate change scenario in the 2090s (modified from Matsui et al. 2004).

By Dr. N. Tanaka (Forestry and Forest Products Research Institute)

Figure 5.2 Predicted Impacts of Climate Change on Beech (*Fagus crenata*) Forests

Table 5.2 Climate Change Sensitivities/Thresholds (Temperature Increases)

Temperature Increase	Examples of Impacts	Sectors Affected
1.0–1.9ºC	-Increase of 10-40% in peak flow volumes for most rivers during flooding -Loss of habitat for rock ptarmigan (*Lagopus mutus*) of 40-60% -Decrease in alpine grassland communities and sub-alpine coniferous forests -Increase in sales of summer commodities of approx. 5%	-Water resources and aquatic environments -Terrestrial ecosystems -Terrestrial ecosystems -Industry and energy
2.0–2.9ºC	-Coniferous forests reduced to one quarter of current area -Two more generations of diamondback moth pests per year	-Terrestrial ecosystems -Agriculture, forestry and fishery
3.0-3.9ºC	-Water demand increase of 1.2-3.2% -Increase in annual carbon loss of 30% -Seasonal shift from C3 to C4 plants 2-3 weeks earlier.	-Water resources and aquatic environments -Terrestrial ecosystems -Agriculture, forestry and fishery
4.0ºC or more	-Crabrass germination possible year-round	-Agriculture, forestry and fishery

Table 5.3 Climate Change Sensitivities/Thresholds (Sea-Level Rise)

Sea Level Rise	Examples of Impacts	Sectors Affected
30cm or less	-Erosion of 108 km^2 of sandy shorelines (56.6% of the total nationwide)	-Marine
31-60 cm	- Loss of tidal flats of 120 m off-shore with sea-level rise of 40 cm and average tidal range of 2 m -Dramatic increases in overtopping waves on reinforced shorelines with slopes gentler than 70% gradient.	-Marine -Coastal Zone
61-99 cm	-Erosion of 81.7% of total sandy shorelines nationwide -Tenfold increase in wave overtoppings of reinforced shorelines with gentle slopes of more than 70% gradient	-Marine -Coastal Zone
1 m or more	-Erosion of 90.3% of sandy shorelines nationwide -Population residing below average high tide level increased from the current 2 million to 4.1 million, with an increase in value of assets situated below the high tide level from the current 54 trillion yen to 109 trillion yen -Cost for measures related to port facilities and associated coastal structures totalling 11.5 trillion yen -Height of dikes required: 2.8 m along sandy seashores exposed to the open ocean, and 3.5 m along inland sea areas.	-Marine -Coastal Zone -Coastal Zone -Land protection, conservation and human habitation

Source: Tables 5.2 and 5.3 both derived from publication by Prof. Mimura of Ibaraki University.[14]

6. Establishing Long-Term Targets

6.1 Approaches to Establish Long-Term Targets

- As shown in Chapter 5, scientific knowledge has already been accumulated regarding temperature increase and its impacts caused by global warming. Taking into account the scientific knowledge obtained so far, the establishment of long-term targets for limiting the extent to which the temperature will increase can be organized as follows. On the basis of the approach described in Chapter 4, presented below is the scientific knowledge concerning the impacts that would be brought about by several maximum increases in average global temperature, compared to pre-industrial levels (circa 1850).

Temperature increase of 1ºC or less:

There is a strong possibility that there would be some impacts on fragile ecosystems with an increase in temperature of even 1ºC. For this reason, if preventing impacts on fragile ecosystems were a priority, limiting the temperature increase to 1ºC or less is needed. On the other hand, taking into consideration the fact that the temperature has already increased about 0.6ºC over the 20th century and considering such things as the future population dynamics and economic growth of the world, limiting the temperature increase to 1ºC or less would, realistically speaking, be extremely difficult.

Temperature increase of 2ºC or less:

Indications are that negative impacts would appear on a global scale if the temperature increase were to be 2-3ºC. Consequently, limiting the temperature increase to 2ºC or less would prevent negative impacts on a global scale. Furthermore, research has shown that the scale of those negative impacts would increase steeply at around the 2ºC point, and we can see that 2ºC has a definite meaning from the standpoint of effectively preventing large-scale expansion of negative impacts.

(Reference) IPCC Third Assessment Report (excerpt)

For temperature increases of less than 2-3ºC, some regions may have net benefits and some may have net damages. If [the] temperature increases more than 2-3ºC, most regions have net damages, and damages for all regions increase at higher changes in global average temperature.

Temperature increase of 3ºC or more:

Some research indicates that a temperature increase of more than 3ºC exceeds the level at which the stability of the climate system is maintained (Type 2 Thresholds), heightening the likelihood of such things as the shutdown of deep ocean circulation. Because there would be an increased risk that there would be severe and irreversible negative impacts if this level were exceeded, this must be avoided. The research concerning the level at which the stability of the climate system is maintained is limited, however, and further scientific knowledge needs to be accumulated.

○ Taking all this scientific knowledge into account, we think the starting point for studying long-term targets, while noting the points below, should for now be the approach that would limit the temperature increase to 2ºC.

- ◆ Scientific uncertainty still remains. Scientific knowledge concerning the impacts, etc., should continue to be further accumulated in the future.
- ◆ It should be noted that the temperature has already increased around 0.6ºC compared to the pre-industrial era; that, as a result of this, impacts are already evident in every part of the world; and that the temperature increase in the mid- and high-latitude regions of the Northern Hemisphere, which include Japan, has been comparatively greater than for the global average temperature.
- ◆ Given fears that a temperature increase of even 1ºC will produce impacts on some fragile ecosystems, ongoing research and study of how to deal with such impacts should be continued.
- ◆ It should be recognized that greenhouse gases (GHGs) must be reduced on a global scale even to limit the temperature increase to 3ºC.

○ While the above is presented on the basis of the scientific knowledge concerning impacts and the like, the establishment of long-term targets should not be determined solely by science; this must ultimately be decided in the international community. We would like to expect that Japan, while moving forward with a broad-based, constructive domestic debate about these long-term targets, will also play a leadership role in consensus-building in the international community.

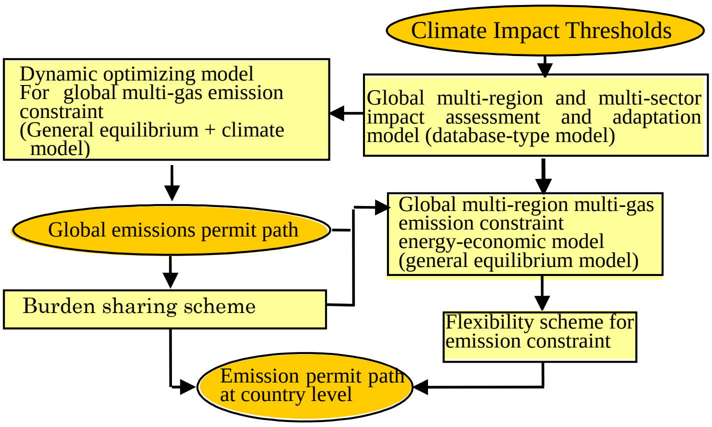
○ It is particularly hoped that from now on the assessment and forecasting of vulnerability, impacts, adaptability and the like will be carried forward on the regional level and on the country level. It is important to think how to advance international consensus building regarding long-term targets based on such knowledge. Japan must thoroughly assess such things as the impacts on itself and continue working on designing an international strategy based on the results. When doing so, it is important to be very mindful not only of the direct impacts that climate change has on Japan, which largely depends on overseas for its food and resources, but also of the indirect impacts it has through trade and the like.

6.2 The Relationship Between GHG Concentrations and Global Emission Paths

○ In line with the above discussion, and with limiting the temperature increase to 2ºC in mind, we present the scientific knowledge concerning the atmospheric GHG concentrations and global emission paths.

○ When the CO_2-equivalent concentration is calculated on the basis of radiative forcing as demonstrated in the IPCC Third Assessment Report (2001), the concentration for all GHGs has risen compared to pre-industrial levels, from the CO_2 equivalence of 280ppm to 359ppm in the year 2000 (the CO_2-only concentration rose from 280ppm to 368ppm), while the temperature has increased approximately 0.6ºC.

○ According to recent research, even if all GHGs were stabilized at 550ppm, it is highly possible that the temperature increase will exceed 2ºC; thus, it would be necessary to limit the concentrations well below 550ppm in order to hold the temperature increase to under 2ºC. For example, trial calculations using the Asian Pacific Integrated Model (AIM) showed that a level of around 475ppm (see Notes 1, 2 and 3) was necessary (see Figures 6.1 and 6.2).



The AIM model (AIM/Impact [Policy]) sets future targets for rises in global average temperature and sea level and for GHG concentration in the atmosphere. Using these targets, it estimates optimal GHG emission paths (worldwide) and the relevant burden sharing of emission control for each region. It also estimates the impacts of global warming (physical impacts and economic impacts) by country and by sector, assuming those GHG emission paths.

Fig. 6.1 Features of the AIM model (AIM/Impact [Policy])

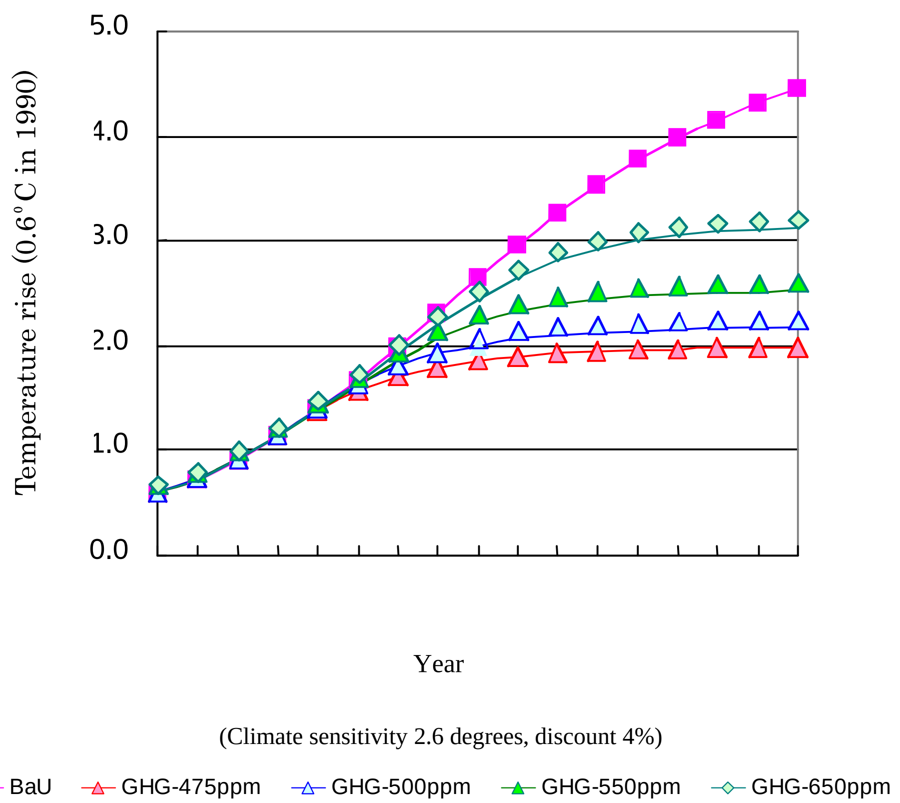


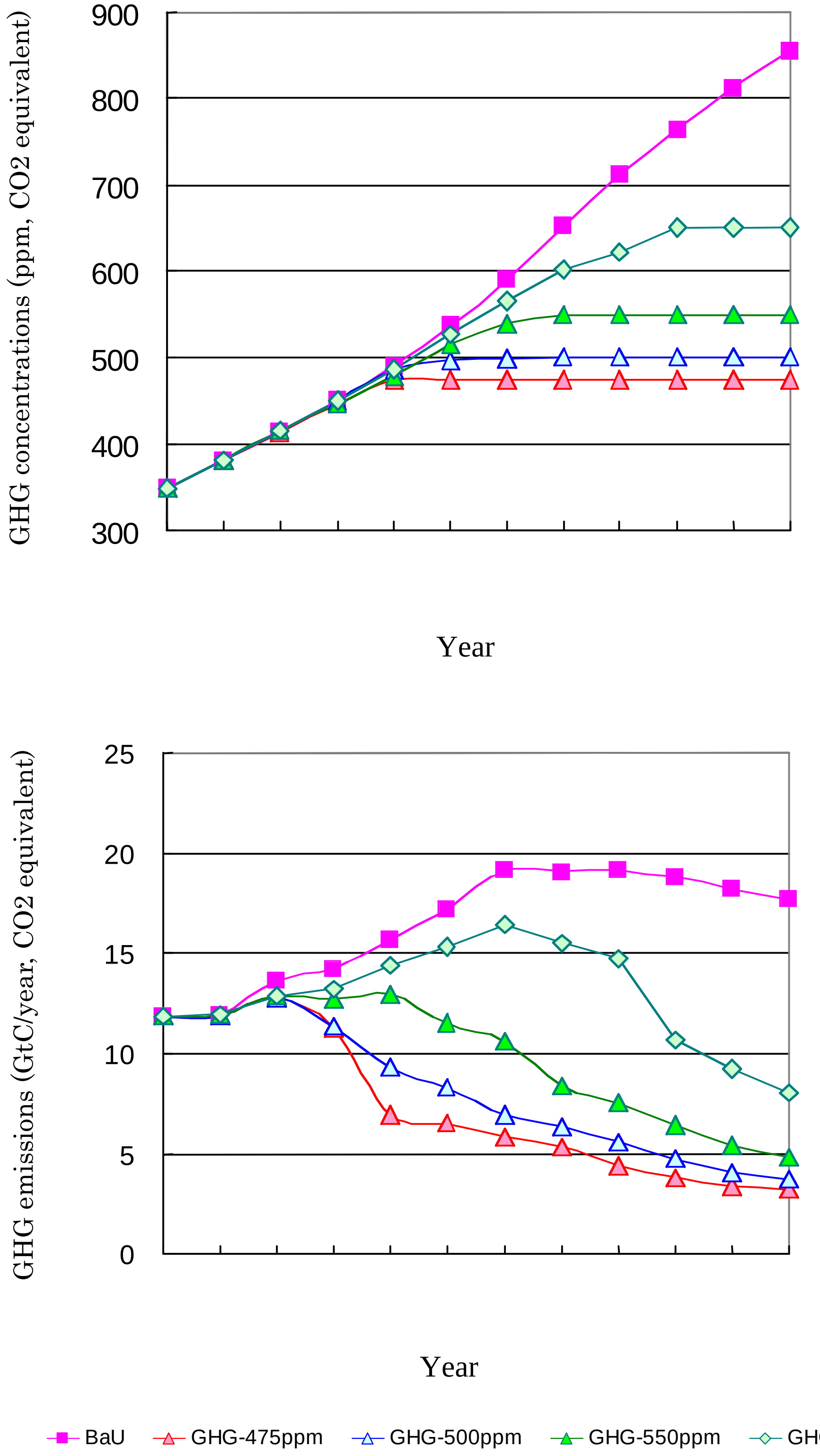
Fig. 6.2 Trial calculations with AIM model on the relationship between stabilized concentration levels and temperature increase

(Note 1) At present, the atmospheric concentration of CO_2 is increasing at a rate of 1.6ppm annually (average value for 1983-2002 – Japan Meteorological Agency). Consequently, even supposing that global CO_2 emissions were limited at the present level, and other conditions are presumed constant, in 74 years the concentration for all GHGs would reach 475ppm and would continue to increase after then as well. If the global CO_2 emissions continue to increase as they are, 475ppm will be reached sooner.

(Note 2) All GHGs: In the trial calculations for the AIM model, "all GHGs" takes into account all factors (including both warming and cooling) with "radiative forcing that causes" climate change, and expresses them as a carbon dioxide equivalence concentration.
Specifically, in addition to the 6 gases that are the subject of the Kyoto Protocol (carbon dioxide [CO_2], methane [CH_4], nitrous oxide [N_2O], hydrofluorocarbons [HFCs], perfluorocarbons [PFCs], and sulfur hexafluoride [SF_6]), it also includes the direct and indirect impacts of such things as chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), tropospheric ozone, and aerosols (sulfuric acid aerosol, black carbon, and organic carbon). Of these, sulfuric acid aerosol and organic carbon, and others are considered to have a cooling effect.
Furthermore, although variations in solar radiation and the alteration of albedo (the reflectivity of solar radiation on earth surface and sea surface) due to changes in land use are among the changes since pre-industrial era, these factors are presumed to have been constant since 1990. (Note: The contribution that variations in solar radiation and changes in land use have made overall to the temperature increase at the global level is insignificant.)

(Note 3) This is equivalent to 456ppm for CO_2 alone and 486ppm for all 6 gases that are the subject of the Kyoto Protocol combined (as of the year 2100).

○ In order to arrive at a GHG concentration that limits the temperature rise to below 2ºC, a major reduction of GHG emissions must be realized early on. For example, according to trial calculations using the AIM model, the concentration of all GHGs will need to be stabilized at 475ppm from the year 2030 onward in order to limit the temperature increase to below 2ºC, and the calculations indicate that, in comparison to the 1990 figures, all GHG emissions worldwide will have to be reduced about 10% by the year 2020, about 50% by 2050, and about 75% by 2100 (See Figure 6.3).

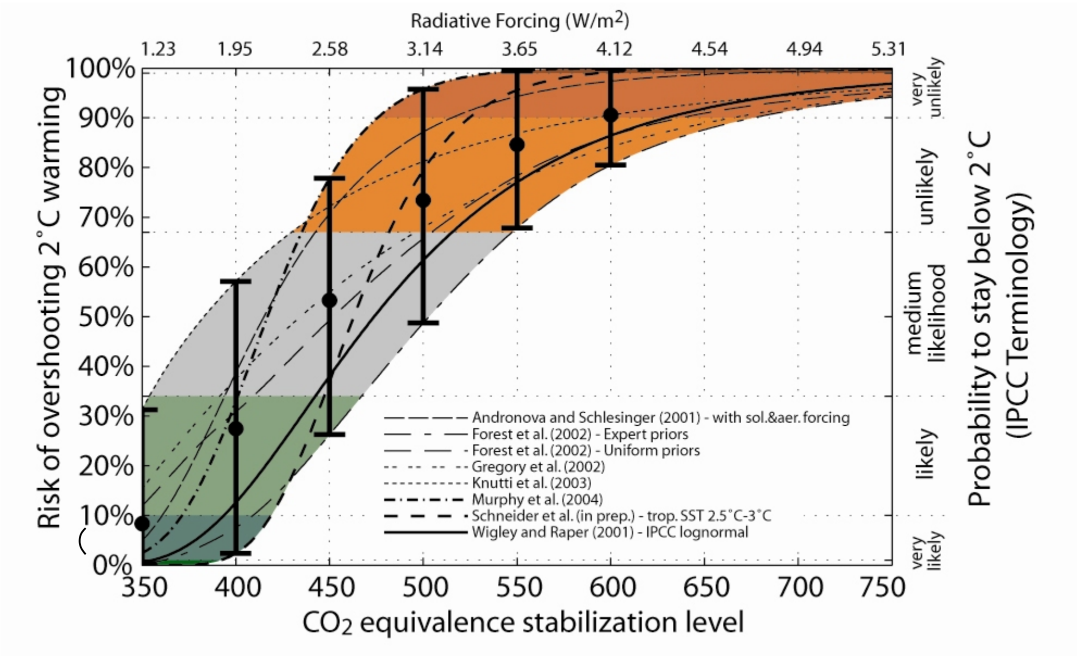


Social welfare function maximized, discount 4%

Estimated rate of reduction for the 6 gases subject to the Kyoto Protocol, plus CFCs, HFCs, and HCFCs.

Figure 6.3 AIM trial calculations for concentration stabilization levels and emission paths

○ Furthermore, there is a need for future, more thorough study of the reduction paths that will be necessary to achieve the GHG reductions. At such time it will be necessary to consider how to deal with the uncertainty associated with climate sensitivity and the like, and with disparities in the cost of countermeasures due to the subject, timing, etc. There are analyses, etc. being done that take uncertainty into account, but there is a need to move forward with further research (see Figure 6.4).



Source: Meinshausen (2005)[15]

Figure 6.4 Example of a trial calculation of the relationship between concentration

stabilization and temperature increase, with uncertainty factored in

- The probability that GHGs stabilized at 550ppm would cause a temperature increase of more than 2ºC is high, at 68~99%.
- In order to raise the probability to what IPCC terms "likely (66-90%)," that 2ºC will not be exceeded, indications are that GHG stabilization would have to be at 400ppm (with GHGs at 450ppm, the probability cannot be raised that high).
- Meinshausen shows the probabilities, for differing concentration stabilization targets, of the post-industrialization temperature rise being limited to below 2ºC. It is characterized by its use of probability distribution for 8 climate sensitivities.

7. Agenda for the Future

7.1 Further Study concerning Long-Term Targets

- In dealing with long-term targets, it is necessary to give them some level of flexibility, while keeping in mind uncertainty inherent to projections; and those targets require, even after being set, continuing re-evaluation, responding to further fulfillment of scientific knowledge.

- While it is important that Japan evaluate and establish long-term targets based on its own national strategy, on the other hand, close observation of the situation of various foreign countries is essential. For example, it is important to steadily collect, consider and examine the information on long-term objectives of limiting the temperature rise to 2°C, such as the discussions in EU, tracking their progress, and looking into their scientific and strategic backgrounds.

- Due to the call for political decisions and a strategy for Japan, the role of each country in the globally sought reduction of greenhouse gas (GHG) emissions is a topic for future study. In order to make progress in those evaluations from here on, it is important to also deepen one’s knowledge of the costs and benefits, and specific contents of necessary measures.

- When the impacts on ecosystems and agriculture are considered, it is important to take note of not only the degree of the rise in temperature but also the velocity of changes. For this reason, the study of rate of change is needed.

7.2 Risk Management of Climate Change

- Climate change may cause significant and irreversible impacts. Furthermore, global warming to some extent cannot be avoided due to the GHGs humankind has thus far emitted. Based on the recognition of these facts, we are asking ourselves the question of as to which levels the temperature rise should be limited, and to that end, which levels GHG concentrations must be controlled. However, since climate change cannot be examined in a laboratory setting, uncertainty in scientific findings cannot be avoided.

- In connection with this uncertainty, as long as the present socioeconomic activity is valued highly, our concerns about the negative impacts feared for the future would be more focused on the probability of the disaster not taking place. On the other hand, should we be concerned with the need to avoid the impact of what is already underway, we would be more interested in the probability of the occurrence of this phenomenon. According to the precautionary principle advocated in the United Nations Framework Convention on Climate Change, which stipulates that "lack of full scientific certainty should not be used as a reason for postponing precautionary measures" in consideration of irreversible impacts, the latter probability must be weighed more heavily.

- Moreover, it is necessary to keep in mind not only the adverse effects with relatively high probability of occurrence from climate change, but in considering uncertainties, also catastrophe events with a very low probability of occurrence.

- In consideration of these points, policymakers are required to assume the role of making decisions on matters filled with uncertainty. However, it is possible for science to provide suggestions in that decision-making process. From this point of view, the accumulation of knowledge and development of technological methodology are important issues as they support the decision-making process of policies for the "risk management of global warming." Those issues include such matters as "when and what steps have to be taken as adequate measures" and "how to balance mitigation and adaptation," based on progress in research on the impacts and the timing at which the thresholds is exceeded.

- The management of risks is an issue for the society at large and it is important for each person to share a scientific understanding, and to engage in intensifying serious discussions about the optimal method for goal setting and the ideal way of formulating measures in the future, based on common scientific knowledge. Therefore, public agencies must work at further efforts to provide citizens with information and to promote discussions concerned.

7.3 Clarification of "the Effects of Climate Change" in the Context of a Closely Integrated Global Economy

- Up until now, the concern for the effects of climate change has revolved around territories. For instance in Japan, research was centered on the effects to its own national land. However, agricultural and fishery products consumed in Japan, such as food and feed supply, for example, are imported from many areas of the world, and, thus, the effects of climate change in those countries or regions of origin also affect the people of Japan. From this point of view, it is necessary to not only examine "the effects on Japan's agriculture, forestry and fisheries industries," but also the influence on Japan's food supply.

- This issue is more than a matter of Japan's domestic concern. The UNFCCC's ultimate objective "to ensure food production is not threatened" does not only refer to the food production to fill the needs of people globally. In this closely integrated world, the needs of each country and their people will not be filled without trade. It is therefore critical to clarify the effects of climate change on food supply over areas of production and those of consumption as one integrated entity. Not limited to food production, in addition the effect must be examined from a similar stance for other fields such as securing water resources and the manufacture of industrial products.

- From this perspective, it is one of the challenges of the future that we attempt to clarify the effects of climate change in a way fit for the reality of a closely integrated global economy, while taking into consideration an international interdependence. In particular, it is necessary to examine the impacts that the climate change may bring upon international security and the countermeasures against such impacts, including the possibility of conflicts among people and among countries, arising from the threat to habitations and available water resources.

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Attachment

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