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001. cable	High-Level Climate Delegation to visit Seoul [partial] (1 page)	08/27/1998	b(7)(C), b(7)(F), b(6)

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2017-1095-F
bg248

RESTRICTION CODES

Presidential Records Act - [44 U.S.C. 2204(a)]

P1 National Security Classified Information [(a)(1) of the PRA]
P2 Relating to the appointment to Federal office [(a)(2) of the PRA]
P3 Release would violate a Federal statute [(a)(3) of the PRA]
P4 Release would disclose trade secrets or confidential commercial or financial information [(a)(4) of the PRA]
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Freedom of Information Act - [5 U.S.C. 552(b)]

b(1) National security classified information [(b)(1) of the FOIA]
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b(7) Release would disclose information compiled for law enforcement purposes [(b)(7) of the FOIA]
b(8) Release would disclose information concerning the regulation of financial institutions [(b)(8) of the FOIA]
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5. Transportation Sector

Energy consumption in the transportation sector has increased. The number of motor vehicles in Korea has increased by over one million per year since 1990 so that resulting energy consumption and air pollution have become serious problems. Facing huge energy consumption and CO2 emission increases, the Korean Government has carried out and promoted a number of policies to reduce greenhouse gases in the transportation sector.

5.1. Policy to Reduce Exhaust Gas Emissions from Motor Vehicles

5.1.1. Strengthening Exhaust Gas Emissions Standards

Exhaust gas emissions standards for motor vehicles were first introduced with the implementation decree of the Environment Conservation Law in June 1978, which was revised ten times since, including the amendment of the implementation regulation of the Air Quality Preservation Act in September 1996.

In accordance with the amendment of implementation regulations in March 1995 to limit exhaust gas emissions from 3-ton and heavier vehicles fueled by gasoline and to promote development of low-emission engines, emissions standards for city-buses involving NOx

and particle materials are strengthened in 1998. In 2000, the emissions standards for heavy duty vehicles are also strengthened to the equivalent level of developed countries. In the September 1996 amendment, emissions standards effective in 1998-2000 are strengthened to the level of developed countries for all vehicles: large-sized diesel vehicle emissions standards are strengthened from 25% to 40% beginning in 1998; jeeps and 8-passenger vans, which formerly were classified as small-sized cargo vehicles, are reclassified as passenger cars; and passenger vehicle emissions standards for NOx are strengthened from 0.62g/km to 0.40g/km.

5.1.2. Recall System Improvement

The recall system, practiced in only four countries (Korea, the USA, Canada, and Sweden), requires an inspection/test of in-use vehicles to determine if the emissions standards are being maintained during the emission warranty period. Korea introduced the recall system in 1992. In addition, the amendment of September 1996 requires recall inspections to be divided into preliminary and main segments so that fairness of the inspection system is guaranteed.

5.1.3. Strengthening Emission Warranty Period

In February 1991, when the Air Quality Preservation Act was introduced, the emission warranty periods were distinguished according to fuel and vehicle type, and the warrantees were extended in stages so that gas-fueled vehicles which came with 100,000-km warranties until 1995 had warrantees of 120,000 km from 1996.

In the September 1996 amendment, light-duty truck 40,000-km warranties in 1996 were extended to 60,000-km for 1998, and to either five years or 80,000-km from 2000, the same warranty periods as for passenger cars.

5.1.4. Promoting Motor Vehicle Fuel Quality

As a measure to reduce emissions from diesel vehicles, since July 1990, Korea began to produce and commercialize vehicles with passenger capacities of 15 or less operated by LNG or LPG instead of gasoline and diesel. There were 234,000 such vehicles, including sub-compact cars, as of December 1996.

Since 1991, Korea has strengthened support of research for CNG (Compressed Natural

Gas) bi-fuel systems and will start their distribution from 2000. To develop and distribute electrical hybrid cars, road testing will begin in 1999 and commercialization will be pursued thereafter.

5.1.5. Market Promotion of Buses Equipped with High-powered Engines

To prevent city-buses from emitting gases due to a lack of power, high-power buses, upgraded from 185 horsepower to 230 horsepower, were introduced from 1991. The entire bus fleet will be powered by 230 horsepower engines from 1999.

5.2. Policy Measures for Reducing Emissions from Vehicles in Operation

5.2.1. Strengthening Gas Emissions Standards

Gas emissions standards can be divided into regulated items and regulated standards by type of fuel or class of vehicle. Regulated items are CO and HC (Hydrocarbon) in gas and LPG-fueled vehicles, and exhaust pollution in diesel-fueled vehicles. Emissions standards for exhaust pollution have been strengthened from 40% to 30% levels for large diesel vehicles made after 1996, and to the levels of 25% and less for local buses from 1998.

5.2.2. Development of Diesel Particulate Traps

To remove pollution from exhaust emissions, diesel particulate traps have been developed using purification technology since 1992. In February 1996, the Ministry of Environment announced standards for test equipment and test methods, and designated test centers to conduct official assessments.

Wide dissemination of diesel particulate traps is encouraged by exemption from environment improvement surcharges and from road inspections.

5.2.3. Introduction of I/M Program

In December 1995, the Air Quality Preservation Act was revised to introduce periodic

emissions testing at designated test centers. Standards were tightened by the addition of the A/F test in Seoul from 1997 (nationwide from 1998). Testing is being changed from an unloaded test to a loaded test and a NOx test will be added soon.

5.3. Strengthening Fuel Quality Standards

Prior to 1992, manufacturing standards for motor vehicle fuel and additives regulated the concentration of lead and phosphorus. Since 1993, aromatic benzene and the amount of oxygen are also being regulated step-by-step.

Sulphur concentration in diesel fuel was regulated at 0.4% and below prior to 1992, 0.2% and below in 1993, 0.1% and below in 1996, and will be 0.05% and below from 1998.

5.4. Demand Management for Motor Vehicles

5.4.1. Energy-Savings and Pollution Mitigation through Vehicle Usage Limitation

The Government is to undertake energy saving policies in transport sector, which will result in GHG emissions reductions. In an effort to bring about voluntary cutback on the frequency of, in large part wastefull, motor vehicle usage the Government will not only maintain gasoline and diesel fuel prices at appropriate levels, but also reform the current tax system into a more environmently friendly one.

5.4.2. Expansion of Public Transportation Modes

The energy efficiency of public transportation is much higher than that of personal transportation. Thus, greater use of public transportation will reduce energy consumption and enhance the abatement of vehicle emissions.

1) Expansion of Subway lines

The No. 1 line of the first Seoul Subway network began operation in August 1974, No. 2 line followed in May 1984 and No. 3 and 4 lines in 1985. This network is 118 km long and connects the north, center and south of Seoul. In the second subway network, consisting of Number 5, 6, 7, 8 lines, No. 5 line, the north section of No. 7 line, and No. 8 line were completed in December 1996 for a total length of 100.4 km. The construction of Number 6

line, the south section of Number 7 line and the extension of Number 8 line will be completed in 1999 (total length 61.5 km).

City		Length(?)	Construction Period
Total		261.6	-
	sub-total	145.0	-
Seoul	<2nd network 2-1>	83.5	
	No. 5 line	52.0	1990~ 1996
	North section of No. 7 line	16.0	?
	No. 8 line	15.5	?
	<2nd network 2-2>	61.5	1994~ 1998
	No. 6 line	31.0	?
	South section of No. 7 line	26.0	?
	Amsa section of No. 8 line	4.5	?
Pusan	No. 2 line	39.1	1991~ 1998
Taegu	No. 1 line	28.3	1991~ 1997
	No. 2 line	24.6	1995~ 2000
Incheon	No. 1 line	24.6	1993~ 1999

<Table 5-53 > Current Status of Subway Construction

In Pusan, No. 1 line started service in June 1994 and the Number 2 and 3 lines are currently under construction. No. 1 line and No. 2 line of the Taegu subway system will be completed in 1998 and 2002, respectively. No. 1 line of the Incheon subway system will be complected in 1999. Additionally, the first lines in Gwangju and Taejun will be completed after 2003.

2) Construction of Light Rail Transit

The Light Rail Transit networks in metropolitan areas like Seoul and Pusan (89 km long and including six lines) will be completed by 2003. The network, to be extended to 221 km and include 13 lines, will be completed in phases during 2004-2011.

3) Encouragement of City Bus Use

The bus-only lane, which is in effect on roads which have more than three lanes one way, currently supports more than 150 buses/hour. This traffic is being lowered to more than 100 buses/hour. Bus arrival on-line information systems, transmitting traffic information to bus

stops, are being developed.

The Government plans to provide stable bus service by amending the "Vehicle Transportation Act." Also, it will support the construction of common garages for city buses.

4) Reduction of Demand for Personal Transportation

To reduce unnecessary use of motor vehicles, the Government is increasing the price of gasoline and diesel fuel. By raising taxes on vehicle use and implementing a traffic congestion charge, the Government will promote the use of public transportation.

The Government is reviewing a "Weekend Vehicle Operation System" and plans to encourage bicycle-riding, ride-sharing, etc.

6 Integration of Environmental and Economic Policies

1. Economic Development and the Environment

1.1. Environment-Friendly Economic Development

1.1.1. Establishment of Strategic Environmental Planning

The Master Plan for the Preservation of the Natural Environment (1994-2003) aims at striking a balance between protection of nature and development. In 1995, the "Green Vision 21" document presented Korea's ten-year environmental policy goals. The major goal of Green Vision 21 is to improve the quality of life by harmonizing preservation and development within the limits of the nation's environmental resources, with the benefits accruing to this generation and succeeding ones.

1.1.2. Change of Production and Consumption Patterns

Korean consumers with high incomes are likely to step up levels of consumption, buying more and bigger cars, and using more water and recreational services. However, they are also becoming increasingly aware of environmental implications as living standards rise. The Government is trying to stimulate this consciousness with programs like the Korean Eco-Labelling System and by levying charges on environmentally damaging products.

1.2. Economic Effects of Environmental Policies

1.2.1. Environmental Expenditures

Total public expenditure by government, including local government, grew 24% from 1992-1995, reaching 8,218 billion Won. These figures include expenditures for water supply and investment in nature protection. Total public expenditures in 1995 were about 1% of GDP, excluding expenditures for water supply and investment in conservation of nature.

Revenues from the emissions charge and the environmental quality improvement charge are credited to the Special Account for Environmental Improvement, which was established to make allocation of environmental resources more efficient.

Category		1992	1993	1994	1995
Total Expenditure		6,621	6,818	7,354	8,218
By Level of Government					
	Central	604	631	903	1,503
	Metropolitan Areas and Provinces	2,739	2,552	2,481	2,582
	Cities and Counties	3,278	3,634	3,964	4,133
By Environmental Medium					
	Water Quality	1,583	1,682	2,429	2,627
	Water Resources	3,286	3,286	3,207	3,605
	Waste	963	991	1,100	1,326
	Air Quality	22	20	19	124
	Nature and Soil	459	480	440	392
	Technology and Other	309	357	160	144

< Table 6-1 > Environment-related Expenditure in Public Sector(1992-1995)
(Unit: billion Won)

Note : 1995 prices were used.
Source: Ministry of Environment.

1.2.2. Competitiveness and Eco-industry

The Korean eco-industry began when environmental problems became apparent in the latter 1970s and developed parallel to overall industrial growth in the 1980s. More than 10,000 environmental firms are estimated to be active in Korea, and their number is growing at an annual rate of 7%. The eco-industry covers 17 fields including toxic substance remediation, waste recycling and anti-pollution equipment installation. The domestic market for environmental products was estimated at 4,000 billion Won in 1994 and is growing rapidly with increased investment in anti-pollution equipment due to strengthened environmental standards and steady economic growth.

2. Instruments for Policy Implementation

2.1. Regulations

The major instruments are environmental standards, emission limits and the designation of special zones.

Most of the country's waters have been assigned a quality class. Emission limits have been also specified for a number of substances (33 for water, 26 for air). Permits are required for atmospheric emissions and discharges into water. Separate limits have been set for specific installations such as sewage treatment stations and large stationary combustion sources.

In addition, various types of special zones, like water supply source areas and dust pollution control zones, exist. Depending on the type of zone, certain activities are prohibited, and both environmental standards and emission limits are made more stringent.

2.2. Economic Incentives

2.2.1. Environmental Charges

Korea's first use of economic instruments in environmental policy dates from 1983 when the emission charge system was put into effect. If permit holders are detected violating

specified conditions, the system imposes charges on emissions of certain pollutants in excess of set limits. Ten air pollutants, includingSOx, and 15 water pollutants, including BOD, COD and suspended solids, are subject to this charge.

Category	1991	1992	1993	1994	1995	1996
Amount Imposed (100 million Won)	222	104	128	161	157	119
No. of cases	3,815	3,099	3,808	4,267	3,544	3,190

< Table 6-2 > Imposed Amount of Emission Surcharges

Source : Environment White Book, 1997, Ministry of Environment.

The emission charge system was modified with an economic incentive policy in 1997, encouraging enterprises to reduce emissions to below the allowable level.

The environmental improvement charge to induce superior energy efficiency, introduced in 1991, is targeted at owners of commercial buildings whose floor area exceeds 160m^2 and diesel-powered vehicles.

	1993	1994	1995	1996
Amount Imposed (100 million Won)	399	893	1,256	1,784
No. of cases	225	4,109	4,544	5,527

< Table 6-3 > Amount of Environmental Charges Imposed

Source : Environment White Book, 1997, Ministry of Environment.

A waste disposal charge system was introduced in 1993 to deal with waste not covered by the deposit-refund system. The goal is to promote waste reduction and resource conservation. Producers and importers are charged for materials and products that are difficult to collect or recycle.

2.2.2. Deposit-refund System

A deposit-refund system for disposal of beverage containers was put into effect in 1992. The Government is planning to adjust the deposit rate to create more incentive for producer

treatment and recycling.

2.2.3. Financial Support

Central government financial support to local governments is primarily for water supply, waste water and solid waste treatment. The overall amount covers 30% to 70% of investment costs. Government support to industry consists of tax exemptions and long-term, low-interest loans to establish facilities to prevent, treat or recycle pollutants, or to develop related technologies.

2.2.4. Integration of Environmental Concerns in Financial Policy

Tax deductions are provided to certain companies involved in environmental conservation and also given for investment in anti-pollution facilities and for waste recycling. Taxes on gasoline, light oil, cars and electronics products are considered to have a beneficial environmental side-effect.

2.3. Other Instruments for Policy Integration

2.3.1. Land Use Planning and Environmental Impact Assessments

The 1977 Environment Conservation Act first introduced the requirement of environmental impact assessments for the development of urban projects, industrial sites and energy projects. The 1993 Environmental Impact Assessment Act increased the types and number of projects subject to the environmental impact assessment, and added public consultation procedures and provisions to ensure consultation results are incorporated in the project.

2.3.2. Public Information and Participation, Role of NGOs

The Ministry of Environment is engaged in raising citizens' environmental awareness through development of environmental courses in schools and publication of environmental statistics, including administrative ones like enforcement.

Environmental non-governmental organizations (NGOs) play an important role in educating and informing the public. About 200 NGOs carry out various campaigns on a local or national scale. The Government also provides limited financial support for environmental

NGOs.

2.3.3. Dispute Settlement

To permit prompt and fair compensation in the amount of actual damage to the health and property of citizens caused by pollution, the 1990 Environmental Dispute Settlement Act (revised in 1995) provides for settlement of conflicts.

2.3.4. Consumer Information and Market Structure

To direct consumer attention towards products that are less polluting or more energy efficient and to encourage manufacturers to adopt environment-friendly production and distribution processes, the Government has undertaken a number of initiatives. In 1992, for example, a voluntary eco-labelling program was initiated. A government-industry-consumer committee, the Korean Environmental Labelling Association, selects products to carry the eco-label.

In 1994, the Act for Promoting an Environment-Friendly Production System was adopted. It provides the establishment of a clean technology development support center.

In addition, the Environment-Friendly Plant Certification System was introduced to promote environment-friendly management. Plants listed under this system receive special benefits, such as exemption from acquiring a permit from environmental authorities prior to adding or modifying an installation, exemption from inspection, and access to low-interest loans.

2.3.5. Role of Private Enterprises

Korean industries are preparing to establish ISO 14000 environmental management systems, and some have their own internal environmental audit systems, and guidelines and criteria for environmental action. Their environmental targets are sometimes more stringent than government regulations.

7 Impact of Climate Change on the Korean Peninsula

1. Overview

Considering the potential pervasive effects of climate change, the Korean Government supports basic research related to risk assessment of climate change. The most comprehensive study was done by the Korean Institute of Science and Technology (KIST) and other research groups from 1993-1994. The study analyzed the impact of climate change on the ecosystem, agriculture, forestry, the ocean, hydrology, etc.

Detailed risk assessment studies have been carried out based on climate change scenario studies of the Korean Peninsula. The study analyzed the case of the doubling of carbon dioxide around the Korean Peninsula. The report will contribute to the evaluation of regional effects and the establishment of regional adaptation policies.

2. Anticipated Climate Changes

This study formulated five major general-circulation-model simulations of the Korean Peninsula. The results were analyzed to predict possible temperature changes due to a doubling of carbon dioxide.

It is predicted that temperatures will increase by 1.0-4.0C, with a probable range expected to be between 2.0 C and 2.5 C. As for regional and seasonal distributions, North Korea and the East Sea coast will have greater temperature changes than midwest coastal areas. Temperature change during winter will be greater than summer.

Three scenarios were also proposed to show the effects of rainfall on the Korean Peninsula, based on equations coupling results of synoptic rainfall distribution in general-circulation-model simulations with the distribution of regional rainfall on the Korean Peninsula. Scenarios assume an increase of 15% and 20% of annual rainfall as well as

negligible change in rainfall, respectively. The most likely scenario is a 15% increase.

Summer-time variability is expected to be greater than annual average variability. Rainfall changes during winter are also expected to be less than during summer.

3. Impact on Water Resources

Climate changes cause variations in soil moisture and water resources. The most important factor responsible is regional rainfall. The study analyzed past rainfall and river flow data based on Korean Peninsula temperature and rainfall change prediction scenarios reported by the Meteorological Research Institute.

The calculated regional outflow varies significantly depending on the scenario. With a 15% increase in rainfall, considered to be a representative scenario, the study estimates Han River flow would increase 28%, Nakdong river 23%, Geum River 23%, Youngsan River 24%, and Sumjin River 26%, resulting in an average increase in flow of up to 25%. The potential for heavy flood damage increases in the summer due to increased river flow.

It is expected that rainfall will increase with climate change. The general- circulation-model predictions, however, indicate great variability during summer rainfall, ranging from -25% to +30%. Such rainfall could cause catastrophic drought and floods.

Adaptation strategies for drastic drought would be needed along with modifications to the design of water resource facilities and a revision of the comprehensive long-term water resource plan.

4. Impact on Agriculture and Crop Growing

Under the condition that other environmental factors are constant, except temperature (rising higher than current levels), the study predicted changes in agricultural climate zones and for crop growth periods.

Such changes were studied using various agricultural climate sources and sample cases of

temperatures increasing 2C to 4 C, relative to the present. Results show the growing season would increase from its current 210-280 days to 220-320 days at 2C and to 230-340 days at 4 C. In the latter case, the southern coastal areas and the lower southern regions would become a subtropical climate zone experiencing almost no winter. The nation's central region would see a climate similar to current southern coastal areas. Thus, wheat and barley, which need winter fallow and now grow in the southern half,could be expected to be grown further north.

It is expected for rice cultivation that an average increase of 2C would result in the possibility of growing pseudo-late-season cultivar or late-season cultivar across the Korean Peninsula. Growth of mid-season cultivar could occur in the cold, high altitudes of the Taebaek mountain range. Problems due to low temperatures during growing seasons would be reduced considerably. As the time needed to vegetate reaches 190-200 days in the southern coastal regions, it would be possible to introduce a multiple cropping system.

Latent crop productivity should increase for the year due to the lengthening of summer by a maximum of 60 days. However, this only applies in a very limited fashion to dominant crops that would enjoy these new conditions. In the current ecosystem, pure "first level" productivity would decrease due to exaggerated high temperature conditions and the explosive demand for evapotranspiration that would follow. It would be difficult to maintain normal levels of production for perennial temperate zone fruit like apples, grapes, pears and peaches because of the significant turbulence expected to the natural ecosystem.

There are too many hidden dangers from global warming on crop productivity in a temperate climate zone like Korea to state simply a lengthening in the growing season will occur due to temperature rise. Accelerated global environmental change should rather be an accepted factor toward deterring or damaging agricultural ecosystem stability, and it would be preferable to formulate active response measures.

5. Impact on Vegetation

Three different climate scenarios, i.e., rises of ?, 2?, and 4? of annual average temperature due to a doubling of atmospheric carbon dioxide, were assumed, and changes in

the growth distribution patterns of vegetation were projected. Growth distribution of semi-temperate zone vegetation (eg., camellia tree) would increase with a 2? rise in annual average temperature and temperate zone and semi-boreal zone vegetation would decrease exponentially.

Changes to the forestry growth pattern in central temperate zones were analyzed with a scenario of a doubling of carbon dioxide after 80 years, accompanied by a 2 rise. Predictions are that decline of forests would start approximately 30 years after climate change began and severe damage would occur after 100 years.

Therefore, to maintain and improve development of forestry resources continuously and to maintain the ecosystem, it is imperative to formulate a plan to develop forestry planting and growth technology for each respective species.

6. Impact on Sea Level, Coastline and Coastal Structure

The Korean coastline consists of about 12,000km, including artificial coastline (13% of total). Coastal waters below 20m of altitude are extensively used. Coastal areas usually are characterized by high population and vigorous economy. Such areas are very sensitive to environmental impacts. A certain sea level rise would result in many problems, especially for the southern and western coastal areas, and destroy the ecosystem. Therefore, it is important to relocate basic structures and industries and to establish harmony between environment and industry.

7. Impact on Marine Products

If seawater temperature off the Korean Peninsula rises, the most significant impact will be on cold-water fish. There are "water masses" in summer, cold during the winter season, along the deepest caves in the Yellow Sea which provide habitat for cold-water fish like codfish. In cases that the "cold-water masses" are extinguished before the summer season and that the cold-water masses are not formed because of the stream of the Kurilian Current

becoming more rapid, cold-water fish could become extinct in the Yellow Sea.

Since it is not certain if temperature rise in surface water directly causes temperature rise in the lowest-depth water, it is difficult to know whether bottom- or middle-depth cold-water fish are sustainable. Habitat of cold-water fish like salmon and herring would likely move northward. Moreover, middle-depth cold-water fish like the Alaska pollack and codfish would disappear from Korea's waters if no "cold-water masses" flowed from the north. Warm-water fish from the East China Sea would move to seas off the Korean Peninsula, providing habitat for mackerel, pike, sardine, etc.

8 Research and Observation

1. Research

1.1 Basic Research for National Communication

Korea is a signatory of the Climate Change Agreement of October 1993. Under Korea's commitment as a member country of the Agreement, Korea Energy Economics Institute (KEEI) has been designated to conduct basic research, investigating and presenting national statistics on greenhouse gas emissions like CQ.

1.1.1. Objectives

The research done by the Korea Energy Economics Institute had four objectives:

- report in detail national statistics on greenhouse gas emissions and absorption,
- analyze potential influences of global warming on Korea,
- research national policies for establishing a cost-effective plan to reduce greenhouse gases, and
- establish a plan to minimize the economic burden and contribute to national growth.

1.1.2. Scope

Research was conducted in social sciences and natural sciences for two years, 1994 and 1995.

First, on the basis of studies by IPCC and Korean specialists, this research investigated characteristics of greenhouse gases, and established the scale and scope of statistics. It classified greenhouse gases into two categories, main and other. The main category includes CO_2, methane, and NOx while the other category consists of CO, SOx, and CFCs. It analyzed the main sources of such gas emissions.

Second, it evaluated social and economic activities which influence greenhouse gas

emissions. In the first year, it evaluated the roles of energy, industry, transportation, agriculture, forestry, waste, land-use, and air and ocean in greenhouse gas emissions.

Third, it estimated the quantity of emissions and absorption of greenhouse gases in Korea. It used formal IPCC methodology to examine and measure emissions from various energy sources and economic activities, including agriculture and farming sectors.

Fourth, it evaluated the effects of climate change on the Korean Peninsula. It investigated the expected influence of doubling CO_2 density on natural and biological systems.

Fifth, it analyzed policy instruments like energy taxes, for possible reduction of greenhouse gas emissions.

Sixth, based upon the above evaluations and analyses, it recommended mid- and long-term policies for the reduction of greenhouse gas emissions.

1.2. Basic National Energy Plan

In 1996, Korea conducted research for the establishment of the ten-year National Energy Plan (1997-2006) on the basis of the Rationalization of Energy Utilization Act.

1.2.1. Objective

The objective of the research was to provide policy goals and strategies on energy supply and demand to ensure economic growth, minimization of environmental costs resulting from energy consumption, efficient energy use and improvement of energy-related technologies.

The National Energy Plan provides principles and directions for other energy-related plans regarding energy sources and sectors. Its research extends to all energy-related fields.

1.2.2. Scope and Scale

The research to establish the National Energy Plan included the analysis of trends and a forecast of international and domestic energy supply and demand in order to achieve a reliable energy supply. Through the evaluation procedure of previous policies, it also provided some policy issues related to energy conservation and improvement of energy efficiency, and development and promotion of efficient technology. Specifically, this research focused on setting up national policies in the context of minimizing environmental

costs from energy use in all sectors.

1.3. Action Plan for Climate Change Mitigation

To establish an action plan for climate change abatement including introduction of new strategies and fortification of existing policies, Korea is conducting a project from 1997 through 1999.

1.3.1. Objective

This project is to produce a cost-effective action plan for mid- and long-term energy, economic, and environmental policies, which is a national plan following the Climate Change Agreement.

1.3.2. Scope

In the first year of the project, the procedures include refinement and expansion of statistics for greenhouse gas emissions, development and preliminary operation of a model for analyzing reduction of greenhouse gases, establishment of a database to analyze greenhouse gas reduction, and case studies of developed countries' action plans.

1997	1998	1999
- Expanding Statistics of Greenhouse Gas Emissions - Development and Preliminary Operation of Model Analyzing Reduction of Greenhouse Gases - Establishment of Database For Analysis of Greenhouse Gas Reduction - Analysis of Action Plans of Developed Countries	- Forecast of Mid- and Long-Term Emissions of Greenhouse Gases - Analysis of Potential Reductions - Analysis of Preference of Potential Reductions - Analysis of International Cooperation - Analysis of Legal/Juridical Systems for Implementation of Action Plan - Analysis of Administration	- Re-Establishment of Reduction Goals and Analysis of Potential Reductions - Start-Up of Preferred Reductions - Establishment of Action Plans by Sector - Enforcement Regulations - International Cooperation

< Table 8-1 > Planned Research Projects for the Action Plan for Climate Change Mitigation

In the second year, 1998, this research will incorporate these aspects: forecast of mid- and long-term emissions from greenhouse gases, analysis of potential reductions analysis of

preference of potential reductions, analysis of joint implementation, analysis of legal/juridical systems and an administration system to implement the plan.

In the third year, 1999, the following five topics are included: re-establishment of reduction goals and analysis of potential reductions, derivation of preferred reductions, establishment of an action plan by sector, enforcement regulations, and international cooperation.

1.4. Plans for Development of Environmental Technology

In order to develop long-range and systematic environmental technology to carry out the government's environmental policy and to improve the national welfare, the Korean Government established a ten-year plan for the development of environmental technology in 1992. This plan laid out the strategies to progress from the current technology level to advanced technologies of developed countries. It includes investment of 974.7 billion Won (public investment - 792.7 billion Won, private investment - 182 billion Won) from 1992 through 2001.

Environmental technology will contribute to mitigation of climate change. In particular, "climate change forecasting technology" and "technological development to utilize CO_2" will be essential for mitigation of climate change.

The Korean Government arranged a one-year project (May 1996 to April 1997) to devise a long-range plan for environmental technological development to resolve domestic environmental problems, to respond to new international environmental regulations, and to contribute directly to solving world environmental problems in the next century.

The plan's primary objective was to meet the demand in the domestic environmental technology market necessary to improving new environmental technology and enforcing environmental standards, which could be realized by encouraging technological development by new businesses. In addition, this plan provided responses to international efforts to link environment and trade and proposed that the environmental technology industry be developed as an export industry in the 21st century.

It included a ten-year environmental technology development plan, along with the existing G-7 environmental engineering technology development project. The total amount of

investment for environmental engineering technology development in 1996 was 74.4 billion Won, which was equal to 0.019% of GNP. This figure represents an increase of 39.3% compared with the size of investment in the previous year.

Project	Total	Year					
		1992	1993	1994	1995	1996	1997-2001
Total	9,747	98	312	479	628	927	7,303
G-7 Project	4,315 (1,820)	66 (27)	189 (102)	301 (172)	382 (216)	553 (307)	2,824 (996)
Basic Technological Development	912	14	29	33	38	68	730
Supportive Technological Development	4,520	18	94	145	208	306	3,749

< Table 8-2 > Current and Planned Annual Investment for Environment Technology Development

Private Investment (in parentheses)
Source: Environmental White Paper, 1997, Ministry of Environment.

The ratio of public investment for environmental technology to total government R&D investment was 3.13%. Among OECD countries in 1992, this figure ranges from 0.7% to 3.6%. Compared to OECD members, it places Korea in the higher investment group. However, total investment is much lower than that of OECD countries.

The Korean Government plans to raise the ratio of environmental R&D to total government R&D investment up to 5% by 2001. The third stage of the G-7 project will be completed at that time. In 1997, the government established a Long-range Plan for Environmental Technology Development, which promotes consumer-oriented and advanced environmental technology development.

	Environmental Technology R&D Investment by Government(A) (billion won)	GNP(B) (billion won)	A/B (%)
1991	54	2,142,399	0.003
1992	109	2,387,046	0.005
1993	184	2,655,179	0.007
1994	494	3,037,726	0.016
1995	534	3,489,790	0.015
1996	744	3,734,819	0.019

< Table 8-3 > Annual Environment Technology R&D Investment per GNP

Source: Environmental White Paper, 1997, Ministry of Environment

1.5. G-7 Environmental Engineering Technology Development Projects

Since 1992, the Korean Government has used the advanced technology development project (G-7 project) to raise its technological development close to G-7-country standards.

This ten-year plan is divided into three stages. In the first stage (1992-1994), the project focused on obtaining and developing basic environmental technology. In the second stage (1995-1997), it focused on development of core technology and practical establishment of technology. In the third stage (1998-2001), the project focuses on utilization, commercialization, and exportation of the technologies. The results of the project is analyzed and evaluated every year.

From 1992 to 2001, public and private investment in this field will total 249.5 billion Won and 182 billion Won, respectively. Investment will yield three core technologies each in the areas of global environment, air quality, water quality, waste, and treatment.

From November 1992 to November 1996, the G-7 environmental engineering technology development projects attracted public and private investment of 66.7 billion and 82.4 billion Won, respectively, focusing on 23 core projects like desulphurization, denitrozation, clean-water, anti-pollution technology, etc.

	1st Stage (1992-1994)	2nd Stage (1995-1997)	3rd Stage (1998-2001)
Goal	Obtaining Basic Technology	Utilization and Establishment of Core Technology	Utilization, Commercialization and Establishment of General Environmental Management System
Technology Development	Pollution Mitigation Technology Development		Treatment Technology, Recycling Technology
Industry	Independent Development of Environmental Technology		Exportation of Environmental Technology

< Table 8-4 > Goals of G-7 Environmental Engineering Technology Development Projects

	Total	1992-1996	1997	1998-2001
Total	4,315	1,491	530	2,294
Government	2,495	667	237	1,591
Private	1,820	824	293	703

< Table 8-5 > Current and Planned Investment for G-7 Environmental Engineering Technology Development (100million Won)

The Korean Government will not only extend and strengthen the current G-7 projects, but it will also promote systematic and long-range environmental technology development projects to address current environmental problems.

1.6 Promotion of Basic and Fundamental Environmental Technology Development Projects

Since 1996, Korea has promoted the Basic and Fundamental Environmental Technology Development Project and the G-7 project to deal with recent growing demands for environmental technology.

This project requires public research and development and full-scale investigation, which private companies have some difficulties in conducting but which are necessary for the commercialization and utilization of environmental technology.

Year	1996	1997	1998	1999	2000	2001	Total
Investment	5	5	4.5	15	20	20	69.5

< Table 8-6 > Annual Investment Plan for Fundamental Environment Technology Development Projects (Unit: 100 Million Won)

1.7 Climate Change Forecasting Technology Research

The Korean Government has added a new research area, "monitoring global change and development of climate change forecasting technology," to the G-7 projects. From the second stage of the G-7 projects, this new research area has been modified to "climate change forecasting technology."

While this research continues, Korea is actively participating in GCTE (Global Change and Terrestrial Ecosystem), LUCC (Land Use and Cover Change), IGBP, which includes AMIP (Atmospheric Models Intercomparison Project), PMIP (Paleoclimate Modeling Intercomparison Project), and CMIP (Coupled Models Intercomparison Project), and START/TEACOM.

In the "Atmosphere/Ocean GCM Development" project, Korea is verifying atmosphere GCM through analysis and inspection of Asian monsoon and global water cycles, and developing new oceanic GCM including a surface mixed layer grid model for oceans. The oceanic GCM model successfully simulates climate change and the ENino phenomenon.

This project involves research on global and regional climate change due to greenhouse gas emissions. Through atmospheric GCM developments including investigating the stratosphere, the ozone effects from the multi-dispersion of sunlight and relationship between clouds and solar radiation can be estimated.

Korea also plans to study annual changes in the stratospheric cycle and analyze the ancient climate model project to describe climate patterns on the Korean Peninsula from 6,000 years ago.

The "Regional Climate Model" project reflects summer monsoons in East Asia and classifies 13 plant groups. This model separates East Asia into nine regions, analyzing Pan-

Asia monsoons, and enables analysts to model climate changes around the Korea Peninsula.

Also, data and information related to global warming is classified systematically and provided on the Internet as modeled data.

1.8. Greenhouse Gas Control Technology Research

After 1992, the Advanced Technology Development Project (a G-7 project) promoted chemical and biological technology to control amounts of CO_2, which accounts for 55% of global warming. This technology changes hydrogenized CO_2 through catalysts to methanol or combined hydrocarbons, and uses low-quality hydrocarbons to develop highly activated catalysts for useful combinations.

By introducing combined catalysts containing methanol, acid, and metal, this research raises the CO_2 transformation rate from 12.5% to 33%, and develops transformation of CO. Also being developed is production of liquid screening for CO_2 separation and production technology of screening for separating high temperature gas. A water-swollen hydrogel screen of high molecular complex, which is economical in energy consumption, is being developed as well.

1.9. Research Related to the Climate Change Convention

	Title	Year
Korea Energy Economics Institute	Policy measures for energy sector to combat global warming	1992
	Policy measures for energy sector regarding the Climate Change Convention	1993
	Mid- to long-term policies for reinforcing demand side management	1993
	Institutional measures for facilitating the expansion of new and renewable sources of energy	1994
	Study on UNFCCC National Communication	1994-95
	Development of a model for the evaluation of energy conservation policies	1995
	Basic National Energy Plan	1996
	Economic assessment of energy efficiency management system	1996
	Action plans for the Climate Change Convention	1997-99
	Facilitating the use of energy from waste	1997
	Economic analysis of energy/carbon tax with a dynamic general equilibrium model	1997

< Table 8-7 > List of Researches Related to the Climate Change Convention (cont'd)

	Title	Year
R&D Management Center for Energy and Resources	Development of solar thermoelectric cogeneration system	1995-97
	Development of the waste plasted pyrolysis process	1995-97
	Basic technology development for IGCC (Integrated Gasification Combined Cycle)	1995
	Development of photovoltaic-wind power hybrid system for the electrification of mono-electrified rural areas	1996
	Study on the high efficiency compound solar cell	1996
	Development of the fuel cell system	1996
	Separation and fixation of CO_2 by the formation of claxrates	1996-97
	Formation of clean fuel for the internal combustion engine from CO_2	1996-97
Korea Institute of Science and Technology (KIST)	A Study on Strategy And R&D Policy Measures to Address Global Warming	1991
	Studies on Potential Effects of Climate Change on Korea and Strategic Measures for Global Environment	1993-94
Korea Institute of Energy Research (KIER)	A Study on the Technological Strategy to Improve the Global Environment in the Energy Field	1996
Science and Technology Policy Institute (STEPI)	Future Comprehensive plan for Environment Research in Korea	1994

2. Observation

2.1. Climate Change Monitoring System

The Korean Government makes synoptic and other meteorological observations. These include not only surface weather observation, upper air observation, and marine meteorological observation but also aeronautical meteorology, satellite meteorology, radar observation, lightning, background air monitoring, earthquake monitoring, etc.

Since the climate monitoring network expansion project was initiated in 1993, the Korean Government has introduced and operated the following climate monitoring equipment: non-dispersive infrared analyser for atmospheric CO_2 concentration, gas chromatography for CH_4, N_2O, and CFCs and ozonesonde systems for vertical ozone distribution over Korea. In 1995, an atmospheric Particle Counter and UV-Biometer were imported.

In 1996, ion chromatography equipment for analyzing precipitation chemistry and an integrated air quality monitoring system for observing surface ozone and reactive gases (SO_2, NOx, CO, TSP) in the atmosphere were introduced.

	Surface	Upper Air	Satellite	Radar	Aeronautical	GAW (Global Atmospheric Watch)	Marine	Earth-quake	Lightning	AWS
Headquarters	1		1							
Regional	4		4							
Meteorological - Station	28	2	9	2	2	2				
Observatory	39		1	3	7	1				
Subtotal	72	2	15	5	9	3				
							3	12	10	400
Total								12	10	400

< Table 8-8 > Systematic Observation Network (Unit : number of units)

By 1995, the Korean Government provided climate monitoring systems which measure four greenhouse gases, CO_2, CFCs, CH_4, and N_2O, by introducing greenhouse gas

monitoring equipment.

Semi-automation of the CO_2 monitoring scheme on the basis of accumulated techniques saved costs and labor. Stratospheric ozone monitoring has been accomplished with Brewer ozone spectrophotometer by UV-Biometer.

A new GAW station was completed in 1996. Its role is to measure the background air pollution monitored under the WMO/GAW program. For this purpose, many advanced equipments such as an ion chromatography, ambient air monitoring systems, and several new laboratory instruments were introduced in 1997.

2.2. Mid- and Long-term Plan for Meteorological Technology Development

The long-term plan for meteorological technology development was established in 1994 to respond to international and domestic environmental problems. In 1997, the Korean Government also established mid-term action plans by sector. The planning period covers from 1997 to 2001.

This plan proposes modernization of meteorological equipment and structures, increases in investment and labor, international cooperation, activation of meteorological R&D, and improvement of a weather service system and weather information system.

The Korean Government will improve its meteorological information system by expanding the meteorological observation network and improve weather services by using dynamic forecasting technology.

Also, the Government will reinforce climate change monitoring and intensify research on analysis of climate change and development of forecasting technology.

2.3. Scenario Analysis of Climate Change

In 1994, the Korea Government arranged research regarding a scenario of climate change around the Korean Peninsula. The previous scenario conducted by international institutions

like IPCC could not be applied due to irregular precipitation, so new research was performed. The research examines the Korean climate and precipitation change due to increased CO_2 in the air. Analyzed data, obtained by running improved GCM from the main GCM_S used in advanced countries, were used.

The Korean Government will promote projects to expand and improve on this scenario, following biennially revised IPCC scenarios.

2.4. Participation in WMO

Korea actively participates in WCP, GCOS, GOOS, and GAW, established and operated by WMO (World Meteorological Organization), which explain the effects of global warming, El Nino, and acid rain and establish counterplans. Korea also participates in cooperative projects operated by WMO, like global energy and water cycle experimental (GEWEX), collection and analysis of data related to the interaction between atmosphere and ocean, and global monitoring for changes in temperature, sea level, sea ice, etc.

9 Enhancing Public Awareness

1. Public Relations and Education on Environmental Conservation

1.1. Public Relations (PR) on Environmental Conservation

Korea recognizes that some of the greatest contributions to environmental conservation can be made by the public. In the light of this, the Government's approach to public information campaigns on environmental conservation has been developed on two levels. The first level aims to raise public confidence in its environmental administration and to develop public awareness of environmental conservation. The second level aims to build a national competence in conservation in the 21st century by targeting the younger generations. The Government plans to achieve an efficient and systematic campaign by making full use of the mass media including TV, radio, newspapers, and the wide distribution of environmental information.

1.1.1. PR through Mass Media

The Government and its various agencies distribute reports on new environmental policies and the current environmental pollution situation to newspapers, broadcasting stations, and environmental journals. Environment-related non-governmental organizations are also included in the distribution process.

1.1.2. Public Contest on the Theme of Environmental Conservation

The Government has been holding an annual essay contest on environmental conservation since 1991. In addition, an environmental photo exhibition has been held since 1992, and has been expanded to four areas - encompassing TV campaigns, newspapers and magazines, photography and video. The winning pieces go on public exhibition to raise citizens' awareness about pollution.

	Total	1980-1981	1992	1993	1994	1995	1996
Total	43,961	17,361	4,557	5,676	5,452	5,015	5,900
Civil Servants	21,813	10,794	2,557	1,886	1,662	2,090	2,834
Professionals	22,138	6,567	2,000	3,790	3,790	2,925	3,066

< Table 9-1 > Outcome of Environmental Education (Unit : number of persons)

1.1.3. PR Materials

The Government distributes periodicals about environmental policy and related information to its affiliated institutions. The journal "Environment Information," which reports on domestic and international environmental programs, is distributed monthly, and the booklet "Establishment of a Green Environment Nation," which contains the "President's Environmental Declaration," and "Religious Leaders' Declaration of a Green Environment" were distributed to non-governmental organizations and educational institutions.

1.1.4. Appointment of Honorary Environment Monitors

Local governments have adopted an Honorary Environment Monitor System. From 1987, this system has monitored and reported on environmental pollution and has collected public opinions and promoted public awareness of environmental conservation.

The Government plans to strengthen its public information activities through all available means and measures and to introduce new campaign methods, especially those which directly reach and involve the public. The Government is also making efforts to encourage the public to voluntarily take action.

1.2. Education and Training on Environmental Conservation

The Government disseminates new technology and practical information to environment-related civil servants and technical staffs as a way of training environment experts. The general direction of training about the environment includes moral education, an understanding of environmental pollution, and the enhancement of the ability to cope with the changes of environmental policy.

1.3. Environmental Education in Schools and Local Societies

1.3.1. Environmental Education in Schools

The right to enjoy a clean environment was added to citizens' fundamental rights in the Constitution (1980). Thereafter, environmental laws have been legislated and related rules formulated.

Environmental education has been included in the curriculum of primary, middle and high schools since 1982 (the fourth notification of educational curriculum). In 1987, environmental education was included as one of the eight socially-important educational areas (the fifth notification of educational curriculum). With the sixth notification of educational curriculum (1992), environment courses like the Environment and Environmental Science were newly established in the middle school curriculum (1995) and the high school curriculum (1996), respectively. These changes resulted from society's growing awareness of environmental problems.

In higher education, an increasing number of colleges and universities have a Environment Department. In addition, international seminars on environmental education are frequently held and many books on environmental education are being published.

1.3.2. Environmental Education in Local Communities

The Government conducts statutory environmental education for civil servants and for environment managers in the private sector. In cooperation with the Interior Ministry and educational institutions, it supports environmental education institutions in the private sector. Local governments also conduct environmental education programs for honorary environment monitors and the public.

1.4. Support for Environmental Non-Governmental Organizations

Environment-related activities of non-governmental organizations include public information campaigns for environmental conservation, academic surveys and research, and seminars on environmental policies. The Government encourages public participation in decisions and implementation of environmental policies. Non-governmental organizations

are represented in the government's environment-related committees such as the central consultative body for environmental conservation. A "Policy Conference for Non-governmental Environmental Organizations " consisting of more than 20 non-governmental organizations was established to promote cooperation. The conference meets three or four times a year to discuss current environmental issues and policies. The Government also supports a variety of environmental events like "National Meetings for Green Action" on Water Day (March 22, 1996).

2. PR and Education on Energy Conservation

The Government plays a leading role in the national energy-conservation movement. It sets November as "Energy-Conservation Month" and every Friday as "Energy Conservation Day," and organizes environmental events like "Grand Meetings on Energy Conservation." The Government provides practical techniques and information on energy conservation with the help of mass media. Through TV advertisements, it emphasizes the necessity of saving energy, the relationship between energy, economy and environment (3Es), and provides practical tips.

The Government provides professional technical information to industry and holds "Energy Exhibitions" every year to promote efficient energy facilities. Additionally, it holds "Grand Meetings on Energy Conservation" every two years to inspire public awareness for saving energy.

2.1. Energy Conservation PR

2.1.1. PR through Mass Media

Regular programs in the mass media provide examples of efficient use of energy and induce improvement in energy efficiency and awareness of energy conservation. In 1996, there were 3,648 energy conservation campaigns in newspapers and magazines, 1,737 on TV, and 3,080 on radio.

2.1.2. Distribution of PR Materials and PR movies

The Government distributes energy conservation booklets, slogans, and placards to every government office, non-governmental organization and educational institution. The distribution of audio-visual materials containing examples of energy conservation policies is highly rated in raising public awareness.

2.1.3. Energy Conservation Campaign

The Government supports a public contest for excellent energy conservation examples and selected ones are widely publicized. It also gives lectures about saving energy and supports study tours to model energy conservation sites.

2.2. Energy Conservation Education

The Government implements a policy of early energy conservation education. Thirty-three schools have been designated as exemplary schools. It also has distributed educational materials to elementary and middle schools.

The number of colleges and universities having departments related to the environment is increasing. International seminars on environmental education are frequently held and professional books about environmental education are published regularly.

10 International Cooperation

1. Bilateral Cooperation

1.1. Energy Sector

Korea puts high priority on bilateral cooperation with several countries to promote energy related technology cooperation, as seen in Table 10-1.

Korea holds regular meetings with the United States, Japan, and Australia on a reciprocal basis concerning the promotion of the transfer of environmentally relevant technology. Energy technology cooperation projects with seven countries including Australia, Italy, and Russia are in progress.

Countries	Cooperation area	Current status
USA	- New and Renewable Sources of Energy - Energy Conservation	-Exchange of Agreement Notes, Faculties, and
Russia	- New and Renewable Sources of Energy - Energy Conservation	- Joint Research and Technological Cooperation, - Working Group on Technological Cooperation
Italy	- New and Renewable Sources of Energy	- Joint Workshops on New and Renewable Sources of Energy once a year
Canada	- Energy Conservation	- Exchange of Agreement Notes - Joint Seminar once a year
Australia	- Clean Energy	- Joint Seminar on Clean Energy - Joint Research
Japan	- New and Renewable Sources of Energy	- Information Exchange
China	- New and Renewable Sources of Energy	- Working Group on New and Renewable Sources of Energy - Joint Seminar once a year

< Table 10-1 > Bilateral Technology Cooperation in Energy Sector

1.2. Environmental Sector

Korea is encouraging international cooperation on exchanges of environmental information and data. The Korean-Japanese Environmental Committee, established in 1994, is conducting 31 projects including studies on the effects of industrial materials on humans and the protection of seasonal (migratory) birds. In 1987, the Ministry of the Environment of Korea and its U.S. counterpart exchanged a memorandum of understanding on environmental cooperation to conduct activities such as support of a clean water treatment team. A Korean-Chinese environmental cooperation agreement was reached in 1993 to promote 16 projects including monitoring of acid rain and joint research on the Yellow Sea environment. Korea has also signed environmental cooperation agreements with France and Canada to introduce advanced environmental technology and environment management techniques by exchanging environmental technology, data, and experts.

1.3. Meteorological Sector

After the Korean-Chinese Meteorological Cooperation Agreement in 1994, technological cooperation with China on telecommunications systems and Global Air Watch (GAW) began. The Korean-Japanese Science and Technology Cooperation Committee has yearly meetings, and the development of a weather forecast system on the Korean Peninsula is in progress in collaboration with Japan. Korea also is collaborating with Australia with the exchange of a memorandum of understanding on meteorological cooperation.

2. Multilateral Cooperation

Korea actively participates in a wide range of multilateral cooperation. It plays an active part in the activities of UNFCCC's greenhouse abatement program and also contributes funds, technology and manpower to UNEP.

2.1. UNFCCC

As a member of UNFCCC, Korea has participated in COP ? and COP ? , and subsidiary bodies, and is implementing a broad range of policies and measures to reduce greenhouse gases. In accordance with UNFCCC, the preparation of a cost-effective Korean Action Plan began in 1997.

In addition, the Asia Least Cost Greenhouse Gas Abatement (ALGAS) project is underway in collaboration with the Asian Development Bank. Twelve countries, including Korea, India, China, and Thailand, are also participating in the ALGAS project. The Korea Energy Economics Institute (KEEI) plays a key role in ALGAS research on greenhouse gas emission statistics, ways to achieve greenhouse gas abatement, and cost-effective emission abatement strategies.

Korea contributed US$5.6 million to the Global Environment Facility (GEF) in 1996-1997 to protect the global environment and will actively participate in the second GEF.

2.2. IPCC

Korea is participating in the activities of IPCC. The 9th IPCC general meeting in 1992 formed Working Group ? to evaluate socio-economic effects of and countermeasures for climate change. As a Co-chair of IPCC Working Group ? with Canada, Korea has made efforts to complete the Second Assessment and contributed to the assessment as a Lead Author. This committee is believed to be the first group to have economists and sociologists collaborate on climate change issues.

2.3. UNEP and UNDP

Korea has participated in several programs conducted by UNEP and plays an active role in the Global Environmental Monitoring System (GEMS) managed jointly by UNEP and WHO, and other cooperation programs managed by UNEP/ESCAP and PACE-E.

Korea is also participating in the Tumen River Development Project, which is one of the high priority projects in Northeast Asia cooperation.

2.4. OECD and IEA

After participation in the Environmental Policy Committee of OECD as an observer country in 1993, Korea conducted research and analysis on the applicability of environment-related laws and rules.

Korea joined the OECD in December 1996. The OECD Environmental Policy Evaluation Committee reviewed Korea's environmental policies and advised the future direction for improvement.

Korea, currently a non-voting member of the IEA, dispatches experts to IEA and participates in eight of 44 IEA programs. Korea is making efforts to join IEA as a full member country.

2.5. APEC

Korean energy experts are participating in six energy cooperation projects with APEC's Energy Working Group. Korea's cooperation with APEC includes standardization of energy efficiency, an environmental pollution monitoring system and drafting regulations on pollution emitting industries and hazardous wastes. In the second APEC Industrial Meeting, Korea proposed adoption of a minimum energy efficiency standard system among APEC member countries. This proposal gained the support from most of the member countries and was reflected in the Ministerial Declaration.

2.6. WHO

Korea contributed US$1.27 million to WHO's environmental projects. In a joint project with WHO, the Seoul International Environment Symposium was held in September 1992. Korea also provided financial assistance to the North-East Asia Conference on Environmental Cooperation (NEAC) and to workshops on assesment of environment polluting materials..

2.7. Convention to Combat Decertification (CCD)

Korea made recommendations to the CCD Secretariat for the efficient use of budgets at the Sixth CCD inter-governmental negotiation committee and contributed US$50,000 to support developing countries' participation. In the future, the Korean Government will make further financial contributions within its fiscal capability.

Korea, which has been very successful in afforestation, will offer its experience and technology through bilateral and multilateral cooperation. Cooperation with WEC/IEC, PECC/MEF is in progress.

2.8. ITTO

ITTO is currently establishing strategies for sustainable timber production in tropical countries, which will conserve carbon reservoirs in tropical forests. Korea supported ITTO with contribution of US$214,000 in 1995 and US$249,000 in 1996.

In addition to its contributions to ITTO, Korea also provided US$10,000 for a forest protection project in timber producing countries and gave additional financial support of US$100,000 to those countries in 1997.

2.9. World Commission on Forest and Sustainable Development (WCFSD)

Korea, a WFC member, has contributed US$30,000 to the organization and is actively participating in WFC activities.

2.10. World Meteorological Organization (WMO)

Korea dispatches meteorologists to the World Weather Watch Program, the World Climate Program, and other research projects of WMO. Korea will continue to participate in WMO's activities to find the causes of and to establish countermeasures for global warming,

destruction of the ozone layer, and acid rain.

2.11. Regional Environmental Cooperation

Korea maintains a close cooperative relationship with its Northeast Asian neighbors including Japan and China. It has entered environmental cooperation agreements with Japan and China to conduct joint projects with these countries. Korea hosted the second and fourth annual Northeast Asia Conference in September 1993 and September 1995. In the Northeast Asian Regional Environment Program (NEAREP), an inter-governmental negotiation meeting held by the Economic and Social Commission on Asia and the Pacific (ESCAP), cooperation projects among the Northeast Asian countries were established in the field of energy, air pollution, ecosystem management, and capacity building. The first Northwest Pacific Action meeting under UNEP was held in Seoul in September 1994. Northwest Pacific Action supports detailed ocean conservation programs.

11. Future Directions

In this National Communication, Korea has provided information on its natural environment and economic circumstances, energy consumption patterns, and inventories of greenhouse gas emissions/reservoirs. It has also forecast CO_2 emissions to 2010.

Information was given about current and future policies and measures to mitigate greenhouse gas emissions in all sectors including energy, agriculture, waste and transportation. Policies to enhance carbon dioxide gas emission uptake in the forestry sector were also discussed.

Korea reviewed its efforts concerning integrating environmental and economic policies, promoting climate change research and observation, and raising public awareness, all of which are being pursued by the Government to support the various above-mentioned policies and measures.

In recognizing the global nature of climate change, Korea is pursuing bilateral cooperation with the United States and Japan and other countries, and is also actively participating in international organizations such as UNFCCC, IEA, APEC and WMO.

To limit CO_2 emissions more effectively in the future, the Government will continue to emphasize policies that encourage voluntary participation of industry and the private sector, instead of existing policies that are regulation- and subsidy-oriented.

To this end, the Government will expand tax and financial support on the one hand, and will develop and implement measures to reduce CO_2 emissions through voluntary agreement between government and industry as in developed countries. The Government will, if necessary, take further action to enact laws promoting more effective mitigation.

The Government will also make greater efforts to enhance the awareness of industry and the general public regarding UNFCCC. The importance and impact of UNFCCC on Korea will be publicized through public forums, publication of pamphlets and guidebooks, and through the mass media.

To encourage rational energy use, education opportunities for industry and the general public will be expanded. Early education projects regarding energy use will be strengthened to enhance awareness among primary, middle and high school students, who are the future

leaders of the nation.

The Government will also encourage the industrial sector to develop plans that take into account CO_2 emission limitations in accordance with UNFCCC.

The Government will make efforts to obtain concrete outcomes from the newly introduced policies. It will also require energy suppliers to develop and carry out plans to enhance efficiency so that demand management investment can be expanded. At the same time, they will, accordingly, be encouraged to develop and implement means to minimize costs and losses incurred from those investments.

The activities of central and local governments will be coordinated so that regional energy plans can be established according to each region's unique circumstances. Support for regional energy projects will be continually expanded, and local governments will be encouraged to enhance awareness and capabilities regarding greenhouse gas issues.

Korea will take active efforts to refine and expand the scope of the next National Communication. First of all, consideration will be given to minimizing the uncertainty of the CO_2 emissions forecast and to including inventories and projections for emissions of greenhouse gases other than CO_2. In addition, mitigation policies for each greenhouse gas and by each industry will be presented, and an analysis of how each policy can contribute to abatement will also be included. Policies responding to climate change will be investigated as well.

Korea will make its best effort to mitigate and prevent climate change within its economic and social capabilities, and will strengthen bilateral and multilateral international cooperation so that these efforts can be pursued most effectively.

August 31, 2000

The Impact of Climate Change on Agriculture—

A Conceptual Study

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Abstract

We use a theoretical framework to analyze the impacts of climate change on agriculture. We show that the temperature effect, carbon fertilization effect, and daylight effect can offset one another and jointly influence farmers' adaptation strategy. Adjustment cost decreases the magnitude of adaptation. The shape and latitude of a region are important in determining the welfare impact of climate change. Our model implies that the developing countries as a whole would have more chance than the developed countries as a whole to lose from global warming. We also assess the logic behind the Ricardian approach of Mendelsohn et al. and find that their optimistic results are not surprising because they overestimate the benefit and underestimate the cost of global warming.

Keywords: climate change, adaptation, carbon fertilization, adjustment cost.

JEL Classification numbers:

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1. Introduction

Concerns about the increase in greenhouse gases (GHG) in the atmosphere have led to a growing body of literature on the impact of climate change on agriculture. Most of the studies are empirical and provide quantitative estimates on the impact of global warming on various regions. This study is theoretical and aims to provide a qualitative understanding of the possible directions and magnitude resulting from the interaction of the various factors associated with the climate change phenomenon. This framework can also provide a better vantage point to assess various quantitative analyses.

There is a large body of literature on impact assessment that is useful in developing methodologies to assess the impact of increasing GHG. Zilberman et al. (1991) review the various methods used to analyze the impact of banning the use of agricultural chemicals. The initial stage is the assessment of the impact of changes in pest control strategy on yield and cost per acre of various crops and various locations. These methods develop aggregate impacts under different assumptions about changes in land use and other practices, in response to the changes in pesticide availability. The partial budgeting approach, which has been used in the past by government regulatory bodies, does consider adaptation and changes in land-use patterns.

Results generally tend to suggest that farmers will lose substantially from pesticide regulations. Other approaches recognize that the system may adjust to pesticide regulations through changes in land-use patterns, switching from one technology to another, as well as changes in prices associated with reduction in supply. It was also found that farmers, and in some cases agriculture, may actually gain from changes.

Studies that allow flexible responses show that the main effect of pesticide bans are borne by consumers through higher prices of food and that impacts vary among farmers.

Similar findings emerge from comparing alternative methodologies to assess the impact of water use regulations, for example, water supply reductions. Studies that don't allow changes in crops or adoption of conservation technologies result in a much higher estimate than costs of supply reduction studies that allow land use changes and adaptation (see a comparison in the RAND study). The literature on water supply reduction also recognizes that the cost of the change is much lower if, in addition to land use adjustment, there is institutional adaptation, for example, introduction of water markets instead of queuing.

The importance of adaptation is also apparent when comparing the outcomes of various studies on the impact of climate change. Earlier agronomic studies were similar to the partial budgeting approach their methodology and a low degree of adaptation suggested significant costs for farmers from climate change in the United States. The agroeconomic studies by Adams et al. that allow adaptation in land use suggested a lower impact.

Mendelsohn et al. introduce the innovative Ricardian approach. Unlike the agroeconomic studies, this approach estimates economically how agricultural rents (or land prices) are related to geographic and physical factors at various locations and factors that will be modified by increasing GHG (temperature and rainfall). Through simulations, the rents or land prices resulting from changes associated with increased GHG will be derived for each location, and then aggregate rents before and after the change will be compared. The advantage of this approach is that it empirically quantifies the results of

actual adaptation to changes by comparing rents across locations, assuming that similar adaptations are likely to occur within locations as climate conditions change. Second, this approach is easier to implement and requires less detailed modeling of agroeconomic processes such as changes in land use and practices across locations.

There are no exceptionally significant differences in the underlying model behind the Ricardian approach but, rather, more flexible agroeconomic approaches that allow for adaptation in terms of land use and technology. While the agroeconomic models explicitly model the economic mechanisms that result in changes in farmers' income and the economic well-being of other groups, the Ricardian model estimates a reduced form equation of rent that supposedly was the result of profit maximization and adaptation. The differences in outcomes between the models may reflect the result that the Ricardian model is based on estimated rent equations and simulates how they will be modified by changes in GHG, while the agroeconomic model computes rents and other surpluses resulting from the changes in climatic conditions using a more general equilibrium analysis.

In this paper, our conceptual analysis is more structural and considers how various factors associated with rising GHG in the atmosphere affect productivity and profitability of various crops. The model explicitly considers adaptation and resource allocation and general equilibrium outcomes. These outcomes will also result in estimates of changes in rent (or profit per acre) across locations.

This paper looks at how different assumptions about the impact of increased GHG will qualitatively affect U. S. agriculture. In particular, it considers three effects: (1) increase in temperature, (2) fertilization (increased productivity because of higher levels

of carbon dioxide in the atmosphere, and (3) daylight. We consider a situation where there are two crop systems, one more northern than the other. An increase in GHG will change the relative profitability of the two crops and may lead to changes in land-use patterns.

We recognize that there are differences in productivity among crops that reflect lateral differences, and that switching from one crop system to another and, in particular, establishing the agricultural production in locations that have not been settled before, will entail a significant fixed setup cost that has to be taken into account in our analysis. The model itself is an extension of the von Thunen model that analyzes resource allocation over space. In traditional applications of these models, the horizontal axis originates in the city center. Here the horizontal axis measures southward distance from the most northern point (border with Canada in the case of the United States or the Northern polar in other cases). We consider land use choices among the two crop systems across locations before and after climate change. We show that climate change may increase or reduce farmer's well-being, and the impact depends on the relative magnitude of the temperature effect, lateral movement effect, the fixed cost associated with crop change and settlement, and finally, the shape and latitude of the region. Our analysis suggests that the findings Mendelsohn et al. are not surprising, given the assumptions, and that the impact of climate change on agriculture in terms of cost are more significant if the settlement effect is taken into consideration.

Section 2 presents the model, with which we study farmers' adaptation to climate change. Section 3 discusses the welfare implication. In Section 4 we apply our framework to assessing Ricardian approach and conclusions follow in Section 5.

2. Model

In this section, we first present the setup of the model and show how land is allocated for a given climate. Then we discuss how warming changes crop profit curves. Finally we explore how farmers adapt to the change.

2.1. The setup of the model

For simplicity and the convenience of explanation, we assume the region under study is in the Northern Hemisphere, and north of latitude 23.5°. There are only two crop systems in this region. One of these crops is more appropriate for a colder climate, and the other for a warmer climate. For example, these crops could be wheat and rice, or alternatively, apples and oranges. We call the northern crop (wheat or apples) the cold crop, and the southern one (rice or oranges) the hot crop. Let i indicate c and h, which represent the cold and the hot crop, respectively.

Let α be the location indicator measuring from north to south, and ρ represent carbon dioxide concentration. Let F represent temperature, which is a function of location and carbon dioxide concentration, $F(\alpha, \rho)$. Temperature increases from north to south and increases with carbon dioxide concentration, so $F_\alpha > 0$ and $F_\rho > 0$. Let D represent the density of daylight, which increases from north to south in the area north of latitude 23.5°; that is, $D = D(\alpha)$ with $D_\alpha > 0$.

Let Q_i be the annual yields per acre at location α for crop i. The production function is: $Q_i = Q_i(Z_i(\alpha), F, \rho, D)$, where $Z_i(\alpha)$ represents all the annual inputs used for the production of crop i at location α, including capital, labor, and technology. More

carbon fertilization and daylight can significantly increase crop yields, so $Q_\rho > 0$ and $Q_D > 0$. According to the basic agricultural principle, productivity is a hill-shaped function of temperature. Thus, at the northern bound of a crop zone, yields increase when it gets warmer, i.e., $Q_F > 0$, and at the southern bound, yields decrease when it is warmer, i.e., $Q_F < 0$.

The variable cost for crop *i* at location α is $C_i\left(Z_i(\alpha)\right)$. The land at location α is cultivated only if the settlement cost is no more than the total future profits. Let *S* be the annual depreciation of the total settlement cost at location α, such that the accumulation of *S* over the land's economic life is equal to the total settlement cost. We assume $S(\alpha)$ is the same across locations, i.e., $S_\alpha = 0$.

Let P_i be the market price for crop *i*, which is taken as given by competitive farmers, but not affected by each individual farmer's actions. The profit of crop *i* at location α is:

$$\pi_i(\alpha) = P_i Q_i\left(Z_i(\alpha), F(\alpha,\rho), \rho, D(\alpha)\right) - C_i\left(Z_i(\alpha)\right) - S(\alpha).$$

Then the total profit of crop *i* in this whole region is:

$$\pi_i = \int_{\alpha_1}^{\alpha_2} \pi_i(\alpha) = \int_{\alpha_1}^{\alpha_2} \left(P_i Q_i Z_i(\alpha), F(\alpha,\rho), \rho, D(\alpha)\right) - C_i\left(Z_i(\alpha)\right) - S(\alpha) g(\alpha) d\alpha,$$

where α_1 and α_2 are the two bounds of the area where crop *i* is produced, and $g(\alpha)$ is the acreage function describing the shape of the region.[1]

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[1] If *g* is an increasing function of α, then the region has more land in the south than in the north.

We assume there is no externality. Since each farmer attempts to maximize profits, then all farmers in the region maximize the total profits of the two crops:

$$\max \int_{a}^{\alpha^*} \left(P_c Q_c\left(Z_c(\alpha), F(\alpha,\rho), \rho, D(\alpha)\right) - C_c\left(Z_c(\alpha)\right) - S(\alpha)\right) g(\alpha)\, d\alpha$$
$$+ \int_{\alpha^*}^{b} \left(P_h Q_h\left(Z_h(\alpha), F(\alpha,\rho), \rho, D(\alpha)\right) - C_h\left(Z_h(\alpha)\right) - S(\alpha)\right) g(\alpha)\, d\alpha,$$

where a is the northern bound of the cold crop zone; b is the southern bound of the hot crop zone; and α^* represents the cutoff location that separates the two crops. The farmers living near the cutoff location would want to switch to different crops in response to climate change. We call them marginal farmers.

2.2 The allocation of land use

For a given climate, farmers need to decide whether to farm and what crop to grow. We study how the cutoff and bound locations are determined, which indicates farmers' allocation of land use.

Proposition 1. *The cutoff location α^* is determined by the condition that the profits of the two crops at location α^* are equal; that is, $P_c Q_c(\alpha^*) - C_c(\alpha^*) = P_h Q_h(\alpha^*) - C_h(\alpha^*)$. The bound locations a and b are determined by the conditions that the profits at locations a and b are zero; that is, $P_c Q_c(a) = C_c(a) + S(a)$ and $P_h Q_h(b) = C_h(b) + S(b)$ for a and b respectively.*

These are the first order conditions of the objective function with respect to α^*, a and b.

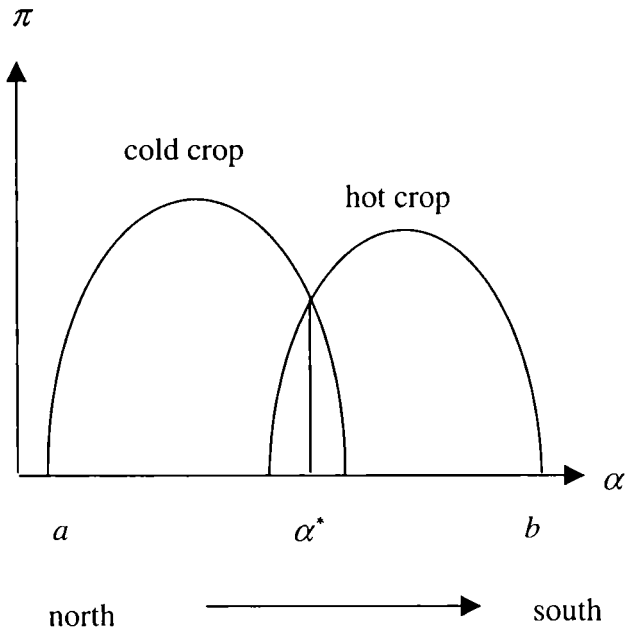

Figure 1. The allocation of land use.

Figure 1 shows the allocation of land use. The profit π is a quadratic function of location α given crop prices. Profits are zero at locations a and b. Beyond these bounds, production is not profitable, so there should be no farming. Within the area where the two curves overlap, production is profitable for both crops, but is higher for one than for the other. Therefore, in order to maximize profits, farmers would produce the cold crop in the area between a and α^*, and the hot crop in the area between α^* and b.

1.3 The impacts of warming on profits

Crop yields are affected by several important factors related to climate change, including temperature, daylight, and carbon fertilization. Although some other factors, such as rainfall and pest, are also important, we assume their effects are constant in order to keep the model transparent enough to give us insights. The readers who are interested in other effects can easily apply our model to their analysis.

As the temperature increases, profit curves would shift northwards as shown in Figure 2. The temperatures at $a2$ and $b2$ after warming are the same as those at $a1$ and $b1$ before warming. We refer to the shift of the profit curves as crop migration.

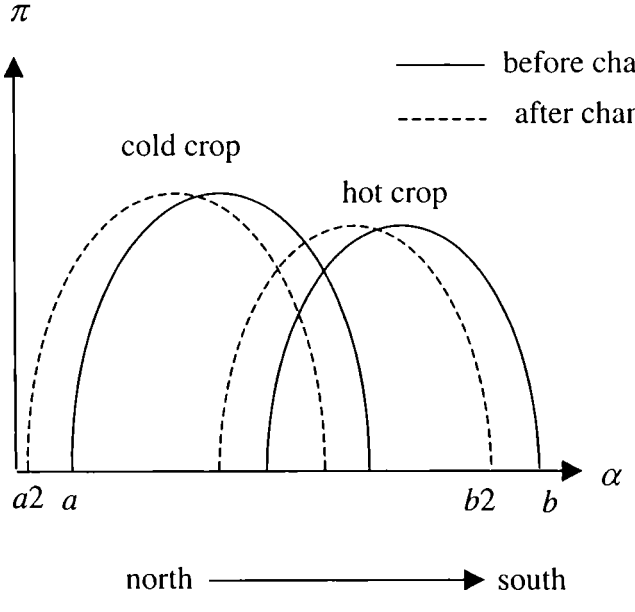

Figure 2. Temperature effect

However, the shifted curves would not be like the one shown in Figure 2 because of the daylight effect. Figure 3 illustrates that the daylight effect makes the shifted curves shift down. There is less daylight in the north than in the south, and in general, crop

yields are positively related to daylight. Therefore, as profit curves shift northwards, yields would be lower than before, given the same temperature.

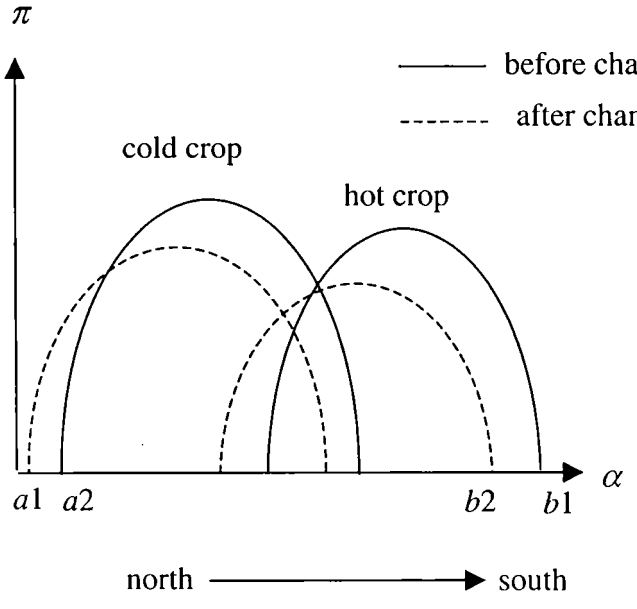

Figure 3. Daylight effect

Another important factor to consider is carbon fertilization. Carbon dioxide not only is the most important greenhouse gas, but also has a significant fertilization effect on crops. Therefore when global warming occurs as a result of the accumulation of greenhouse gases, the profit curves would shift up. This effect is shown in Figure 4.

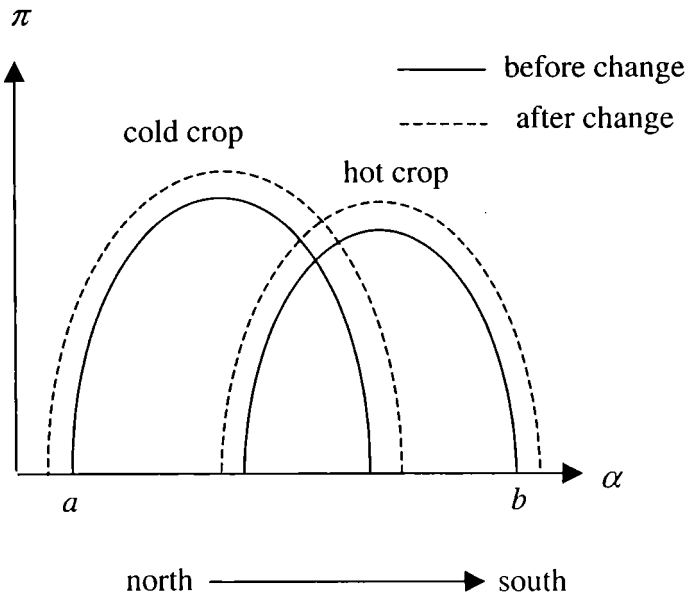

Figure 4. Carbon fertilization effect

2.4 Farmers' adaptation - adjusting land use

Due to the temperature, daylight, and carbon fertilization effects, profit curves would change after global warming occurs. Then some land becomes more appropriate for other crops, some undeveloped land becomes profitable for agriculture, and some currently used land becomes unprofitable. In response to these changes, farmers would want to adjust land use. What farmers can do is to switch crops, cultivate new land, and abandon unprofitable land. Farmers' adaptation behavior can be indicated by the shift of the cutoff and bound locations. Intuitively the cutoff location should move northwards if the hot crop benefits more than the cold crop from warming, since the marginal farmers would want to switch from the hot crop to the cold crop. The bound location a should move northwards if the cold crop at a benefits from warming, and the bound location b should move northwards if the hot crop at b loses from warming.

We study this problem using comparative statics. The exogenous parameter ρ represents carbon dioxide concentration, which indicates the level of global warming. When ρ increases, crop profits change, which in turn affects the land allocation. Therefore α^*, a, and b are endogenously determined. The signs of $\frac{d\alpha^*}{d\rho}, \frac{da}{d\rho}, \frac{db}{d\rho}$ indicate the direction these locations would move.

2.4.1 *The cutoff location*

After totally differentiating the first order conditions with respect to α^*, Z_c and Z_h, we obtain the following equation (Appendix A provides the proof):

$$\underbrace{\left[P_c\left(\frac{\partial \overset{-}{Q}_c}{\partial F}\frac{\partial \overset{+}{F}}{\partial \alpha^*}+\frac{\partial \overset{+}{Q}_c}{\partial D}\frac{\partial \overset{+}{D}}{\partial \alpha^*}\right)\right.}_{(1)}\underbrace{\left.-P_h\left(\frac{\partial \overset{+}{Q}_h}{\partial F}\frac{\partial \overset{+}{F}}{\partial \alpha^*}+\frac{\partial \overset{+}{Q}_h}{\partial D}\frac{\partial \overset{+}{D}}{\partial \alpha^*}\right)\right]}_{(2)}d\alpha^*$$
$$=-\underbrace{\left[P_c\left(\frac{\partial \overset{-}{Q}_c}{\partial F}\frac{\partial \overset{+}{F}}{\partial \rho}+\frac{\partial \overset{+}{Q}_c}{\partial \rho}\right)\right.}_{(3)}\underbrace{\left.-P_h\left(\frac{\partial \overset{+}{Q}_h}{\partial F}\frac{\partial \overset{+}{F}}{\partial \rho}+\frac{\partial \overset{+}{Q}_h}{\partial \rho}\right)\right]}_{(4)}d\rho.$$

The signs of all the partial derivatives are pre-determined by construction.[2] Terms (1) and (2) are the marginal revenue for the cold and hot crop, respectively, due to the shift of the cutoff location. Both of them are determined by two parts: the effect of temperature $\frac{\partial Q_i}{\partial F}\frac{\partial F}{\partial \alpha^*}$ and the effect of daylight $\frac{\partial Q_i}{\partial D}\frac{\partial D}{\partial \alpha^*}$. The two effects go in the same direction for the hot crop because the cutoff location is the northern bound of the hot

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[2] The sign of $\frac{\partial D}{\partial \alpha^*}$ is unambiguous for the area south from the latitude of 23.5°. In that case, the analysis is similar to the one we present here.

crop, where the increases in temperature and daylight both increase yields. For the cold crop, however, the two effects are opposite. The cutoff location is the southern bound of the cold crop, where the increase in temperature would lower yields, although daylight still has a positive effect.

Terms (3) and (4) are the marginal revenue for the cold crop and the hot crop due to the increase of carbon concentration. Both terms are determined by temperature effect $\frac{\partial Q_i}{\partial F}\frac{\partial F}{\partial \rho}$ and carbon fertilization effect $\frac{\partial Q_i}{\partial \rho}$. The carbon fertilization effect is always positive, but the temperature effect is positive for the hot crop and negative for the cold crop at the cutoff location.

The sign of $\frac{d\alpha^*}{d\rho}$ depends on the sign of terms (1) and (3). If the temperature effect is smaller than either the carbon fertilization effect or the daylight effect, then the sign of $\frac{d\alpha^*}{d\rho}$ also depends on the relative magnitudes of terms (1) and (2), or the relative magnitudes of terms (3) and (4).

Proposition 2. *After climate change the cutoff location can move in either direction, depending on the relative magnitudes of the temperature effect, daylight effect, and carbon fertilization effect.*

If the temperature effect dominates both the carbon fertilization effect and the daylight effect, terms (1) and (3) are both negative, which implies $\frac{d\alpha^*}{d\rho} < 0$, i.e., the

cutoff location moves northwards. In this case, the net impact of warming at the cutoff location is negative for the cold crop, but positive for the hot crop. That is, the cold crop loses and the hot crop gains from climate change. Figure 5 illustrates this situation. For the area between $a1^*$ and $a2^*$, it is more profitable to produce the cold crop before climate change, but more profitable to produce the hot crop after climate change. So the farmers living in this area would be willing to switch from the cold crop to the hot crop in response to these changes. This scenario is what people generally assume as a consequence of global warming when they ignore the carbon fertilization effect, daylight effect, and adjustment cost.

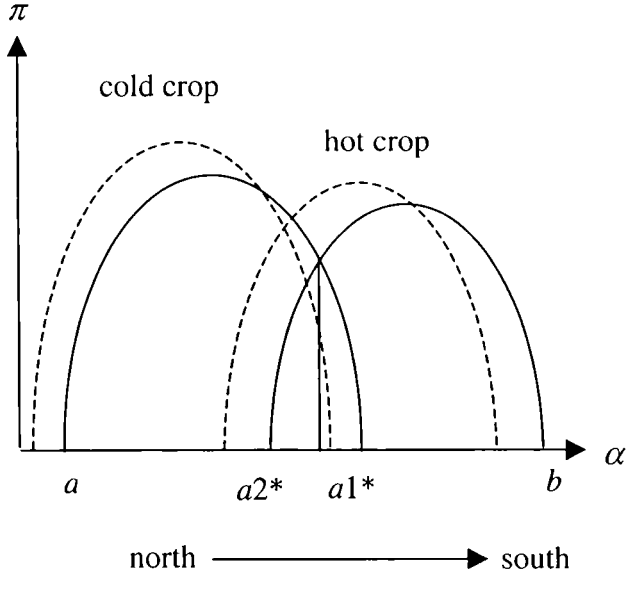

Figure 5. The northward shift of the cutoff location

It is also possible that the temperature effect is smaller than either the carbon fertilization effect or the daylight effect. In that case, the cutoff location can move in either direction depending on the relative benefit each crop could gain from climate

change. For example, if the carbon fertilization effect is greater than the temperature effect $\left(\left|\frac{\partial Q_c}{\partial \rho}\right| > \left|\frac{\partial Q_c}{\partial F}\frac{\partial F}{\partial \rho}\right|\right)$, and the cold crop gains more from carbon accumulation than the hot crop does (term (3) is bigger than term (4)), then given the temperature effect is greater than the daylight effect (term (1) is negative), we have $\frac{d\alpha^*}{d\rho} > 0$. That implies the cutoff location would move southwards, as illustrated in Figure 6.

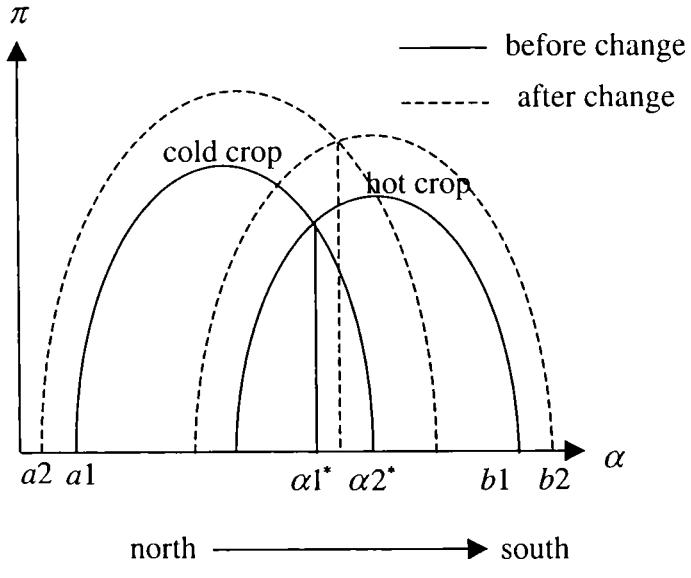

Figure 6. The southward shift of the cutoff location

However, no matter which direction the cutoff location moves, it could not move all the way to $\alpha 2^*$ because there are adjustment costs.

Proposition 3. *The adjustment benefit equals the adjustment cost at the new cutoff location.*

The adjustment benefit of switching from the cold crop to the hot crop at location α is:

$$Benefit(\alpha) = \underbrace{\left(P_h Q_h\left(Z_h(\alpha), F(\alpha,\rho), \rho, D(\alpha)\right) - C_h\left(Z_h(\alpha)\right)\right)}_{(A)}$$
$$- \underbrace{\left(P_c Q_c\left(Z_c(\alpha), F(\alpha,\rho), \rho, D(\alpha)\right) - C_c\left(Z_c(\alpha)\right)\right)}_{(B)}.$$

After climate changes, if farmers grow the hot crop, the profit is term (A); if farmers grow the cold crop, the profit is term (B). The net benefit of switching from the cold crop to the hot crop is the difference between the two profits. Figure 7 shows that the adjustment benefit at α is smaller when α is farther from the original cutoff location $\alpha 1^*$, which is also depicted in Figure 8, where the adjustment benefit at α is a decreasing function of the distance between α and $\alpha 1^*$. For example, in Figures 7 and 8, the adjustment benefit is BC at $\alpha 1^*$, EF at m, and 0 at $\alpha 2^*$.

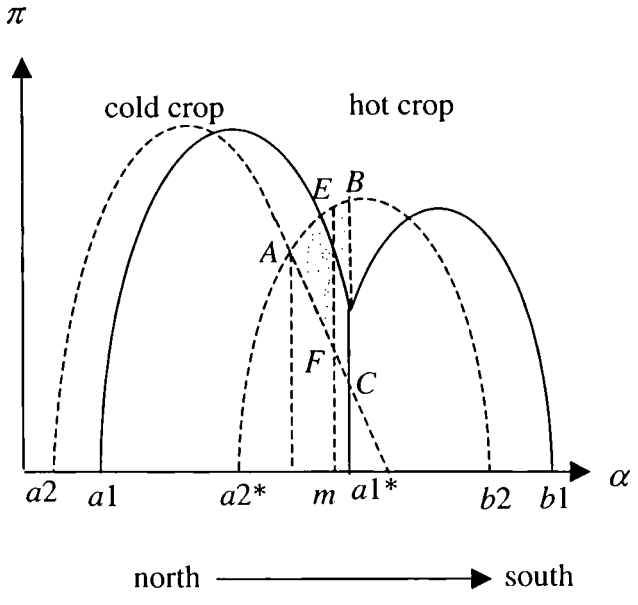

Figure 7. Adjustment benefit and cost

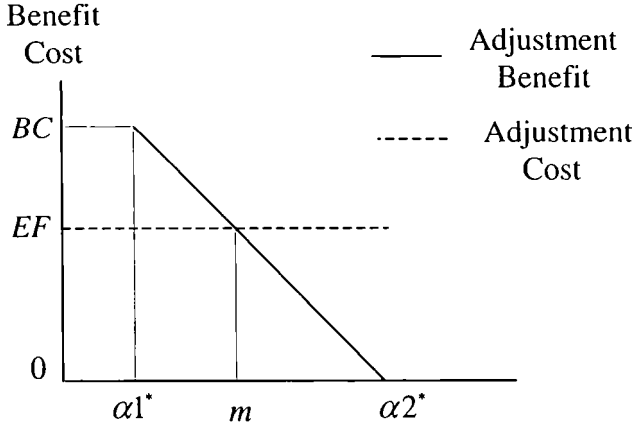

Figure 8. Adjustment benefit and cost

If there is no adjustment cost, the cutoff location would move from $\alpha 1^*$ to $\alpha 2^*$, i.e., the farmers living in the area between $\alpha 1^*$ and $\alpha 2^*$ would all switch from the cold

crop to the hot crop. In that case, the total gain from switching crops is the area *ABC*. When there is an adjustment cost, however, the cutoff location could not move that far. The final result would be determined by the comparison of the adjustment benefit and the adjustment cost. The higher the adjustment cost, the less farther the cutoff location could move. If the adjustment cost is *EF* over locations, then the new cutoff location would be *m*. If the adjustment cost is higher than or equal to *BC*, then farmers would not switch crops at all because they would not gain anything from the adjustment.

2.4.2 The bound locations

Proposition 4. *After climate change the northern bound of the cold crop would move northwards. The southern bound of the hot crop can move in either direction depending on the relative magnitudes of the temperature, daylight, and carbon fertilization effects.* (Appendix B provides the proof.)

Global warming has a positive impact on the cold crop at location *a*, which would drive the profit at *a* above zero. Then the equilibrium condition for the bound location is violated. As a result, *a* must move northwards to satisfy the new equilibrium condition. The intuition is that global warming makes some undeveloped land in the north profitable, so farmers would want to cultivate more primitive lands. This is illustrated in Figure 9, where the area between $a1$ and $a2$ would be the new land developed for the cold crop.

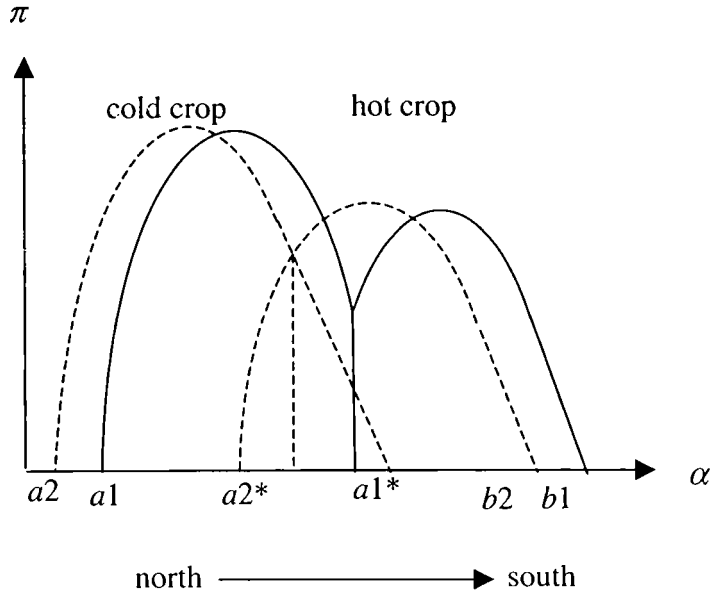

Figure 9. The shifts of the bound locations

The impact of warming on crops at location b is complicated. Location b is the southern bound of the hot crop, where the carbon fertilization effect increases the profit, but the temperature effect decreases the profit, while the daylight effect tends to drive b southwards. As a result, the direction in which b moves depends on which effect is bigger.

The following equation about $\frac{db}{d\rho}$ is derived from totally differentiating the equilibrium condition for b:

$$\left(\frac{\partial \bar{Q}_h}{\partial F}\frac{\partial \overset{+}{F}}{\partial b}+\frac{\partial \overset{+}{Q}_h}{\partial D}\frac{\partial \overset{+}{D}}{\partial b}\right)db=\left(\frac{\partial \bar{Q}_h}{\partial F}\frac{\partial \overset{+}{F}}{\partial \rho}+\frac{\partial \overset{+}{Q}_h}{\partial \rho}\right)dp.$$

If the temperature effect is greater than the other two effects, i.e.,

$\left|\frac{\partial Q_h}{\partial F}\frac{\partial F}{\partial b}\right| > \left|\frac{\partial Q_h}{\partial D}\frac{\partial D}{\partial b}\right|$, and $\left|\frac{\partial Q_h}{\partial F}\frac{\partial F}{\partial \rho}\right| > \left|\frac{\partial Q_h}{\partial \rho}\right|$, then $\frac{db}{d\rho} < 0$. This is shown in Figure 9,

where $b1$ and $b2$ are the bound locations before and after climate change. Yields are higher at location $b1$ than at $b2$ due to the daylight effect, and are higher after warming than before warming at $b1$ due to the carbon fertilization effect. Nevertheless, the temperature effect makes the location $b1$ too hot for farming after climate change, which offsets both the daylight and carbon fertilization effects. Therefore farmers living between $b1$ and $b2$ would need to consider abandoning this piece of land.

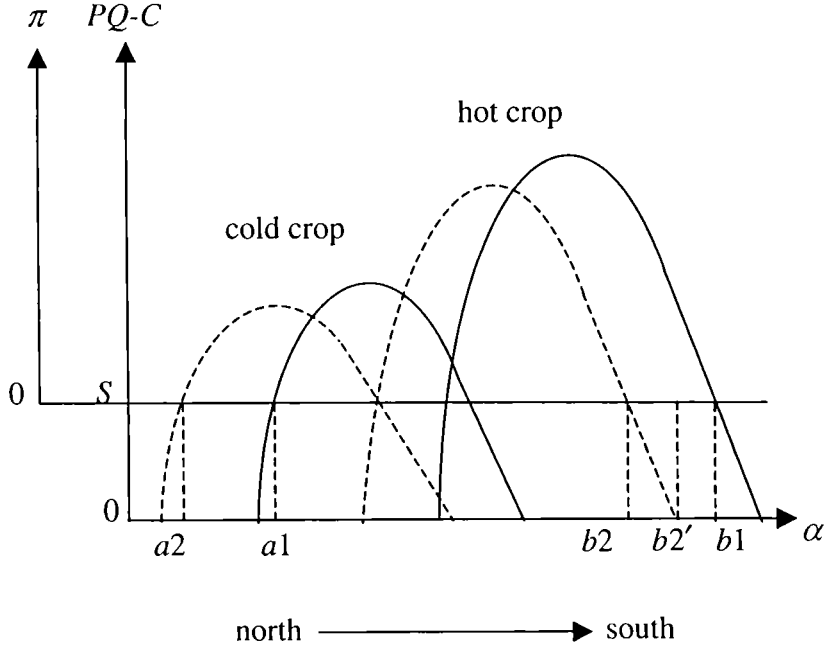

Figure 10. The role of the sunk cost

However, farmers would not abandon the whole piece of land between $b1$ and $b2$. After climate change, farmers would have no way to pay off the settlement cost for this area, whether or not it is abandoned, so they would treat the settlement cost as sunk cost when they make decisions about production. In Figure 10, the new bound location should be $b2$ according to the equilibrium condition. However, in the area between $b2$ and $b2'$, the $PQ-C$ is lower than S, but greater than 0. That is, although the annual revenue cannot cover the depreciation of the settlement cost, it can fully cover the variable cost. In that case, it is better to keep the area between $b2$ and $b2'$ than to abandon it. Thus, the new bound location would be $b2'$ instead of $b2$.

3. The implications on welfare

This section explores how the latitude and shape of a region affect the welfare impact of global warming.

3.1 The latitude

Figures 11 and 12 illustrate the importance of the latitude a region located. In Figure 11, if the region is big enough to contain both bound locations $a2$ and $b1$, it would gain from warming. However, if the borders are as shown, this region would lose from warming because climate change calls for northward migration of both crops, but this region does not have land in the north to take advantage of developing new land. Figure 12 shows the opposite situation. If the region is big enough to contain both bound locations $a2$ and $b1$, it would lose from warming. However, if the borders are as shown, this region would be able to avoid loss because it does not have that much land in the south to abandon.

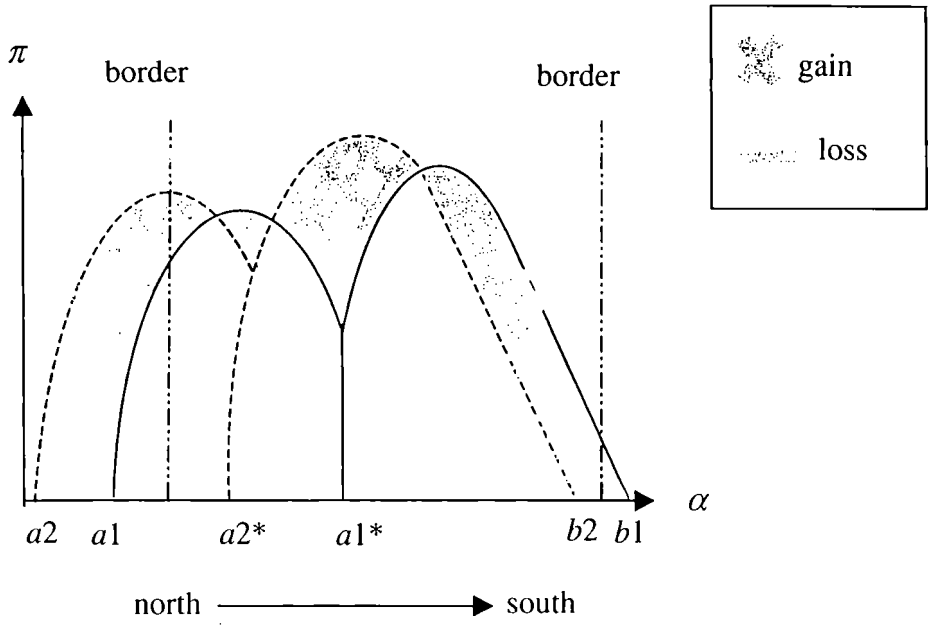

Figure 11

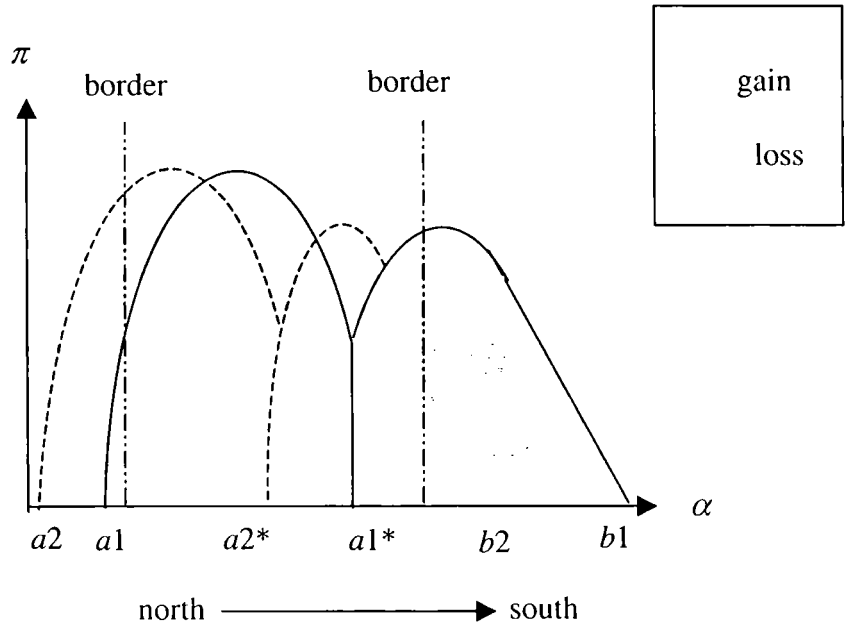

Figure 12

The direct implication is that, in general, the regions located in high latitudes could possibly gain from global warming because there is land in the cold areas for crop

migration; the regions in low latitudes could lose some of the currently profitable land would have to abandoned. It is conceivable that developing countries as a whole would be more likely to lose from warming than developed countries because most developing countries (e.g., Africa, South America and south Asia) are located in low latitudes, while most developed countries (e.g., Europe, Japan and North America) are located in mid to high latitudes.

3.2 The shape

Figures 13 and 14 illustrate the importance of the shape $g(\alpha)$ of a region. In Figure 13, $g(\alpha)$ is a decreasing function of α; that is, the region has more land in the north than in the south. If the cutoff and bound locations all move northwards for the reasons we discuss above, then the region would have more profitable land after climate change, because the new developed land is larger than the abandoned land. Figure 14 shows the opposite situation.

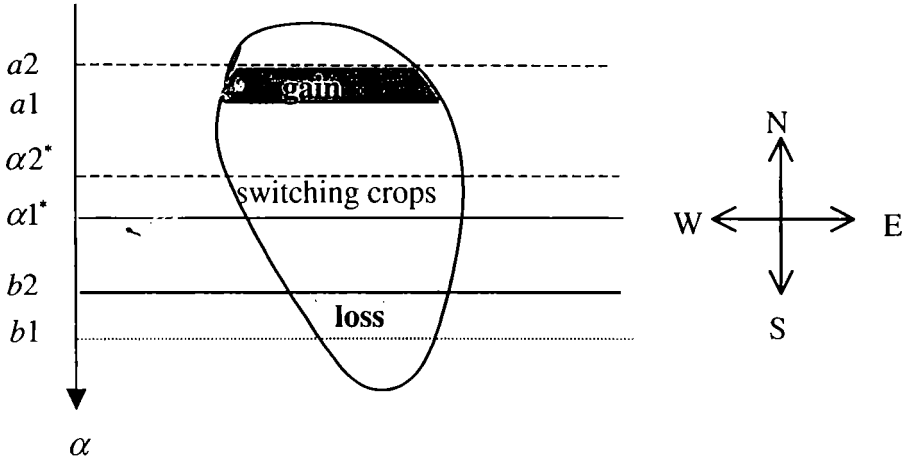

Figure 13.

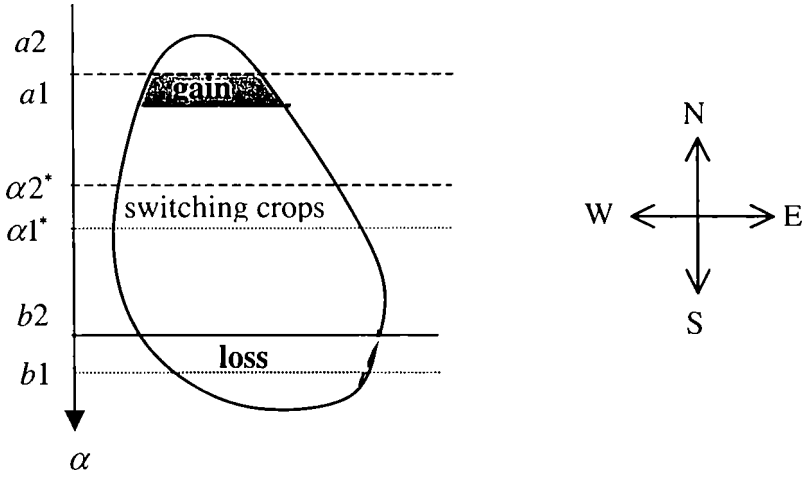

Figure 14.

Again, this implies that the developing countries as a whole are more likely to lose from warming because developing countries have less land in high latitudes than in low latitudes (for example, the North America and South America).

4. The assessment of Ricardian approach

This section assesses the Ricardian approach proposed in the paper by Mendelsohnet al. (henceforth, MNS) (1994). Mendelsohn and Nordhaus claim that the MNS paper: "was one of the first empirical studies to demonstrate that warming could be beneficial." Based on our model, we argue that the optimistic result obtained in the MNS paper ignores the daylight effect, and the settlement and adjustment costs, and it relies on the specific shape and location of the U.S. Thus, their conclusion is likely to be biased and does not have general implications.

The MNS paper studies the impacts of climate change on agriculture by using the economic data on land value. Mendolsohn et al. first examine the influence of climate on the value of farmland. Then by measuring farm revenue, they estimate the direct impacts of climate change on crop yields, and the indirect impacts of adaptation. In order to assess MNS within our framework, we need to interpret their approach using our language. Since MNS is an empirical study, which uses a completely different method, we can only interpret the *logic* behind their approach, instead of the estimation method *per se*.

First, Mendelsohn et al. understate the cost of adaptation since they do not consider the adjustment cost at all. This problem has been criticized, and Mendelsohn and Nordhaus agree that the adjustment cost is important in estimating impacts. Our model implies that understating the adjustment cost would give an overestimate of the benefit of adaptation, which, in turn, underestimates the damage global warming would impose on agriculture.

Second, although Mendelsohn et al. consider crop switching, they do not take into account the daylight effect. As our model shows, after farmers switch crops in response to climate change, the yields, given the same temperature, would be lower than before because there is less daylight in the north. Therefore, MNS overestimate the yields for the switched crops.

Third, MNS do not consider the fertilization effect. It is true that including this positive effect can support the conclusion that agriculture could gain from climate change. However, excluding this effect precludes MNS to take into account another possible scenario after warming: the other direction of crop switching. Since MNS ignore the carbon fertilization, the only direction they consider is crop switching is from the cold crop to the hot crop. As we show, when the fertilization effect outweighs the temperature effect, it is possible that marginal farmers switch from the hot to the cold crops.

Finally, MNS overestimate the amount of new developed land in the north. When MNS adjust land rent across locations in response to climate change, they implicitly assume all the profit curves shift in a parallel pattern northwards, as shown in Figure 15.

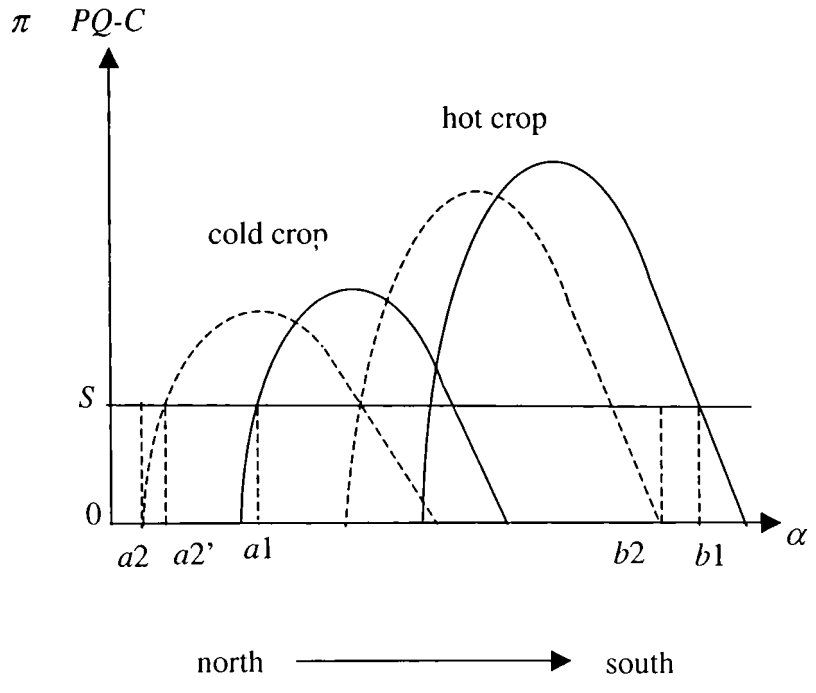

Figure 15.

MNS take $a1$ and $b1$ as original bound locations because the two bounds are pre-determined by history, and MNS use the empirical data. MNS do not take into account the settlement cost, so they use $a2$ and $b2$ as the new bounds, which satisfy the condition that $PQ-C=0$. As we have discussed, the new bound locations should be $a2'$ and $b2$ if both settlement cost and sunk cost are taken into account. Therefore, MNS overestimate the gains of the profitable land by the amount of $a2'-a2$. The U.S. is rectangle-shaped, with almost as much land in the north as in the south. Thus when MNS overestimate the profitable land by $a2'-a2$, they overstate a significant gain of the total amount of profitable land, as shown in Figure 16.

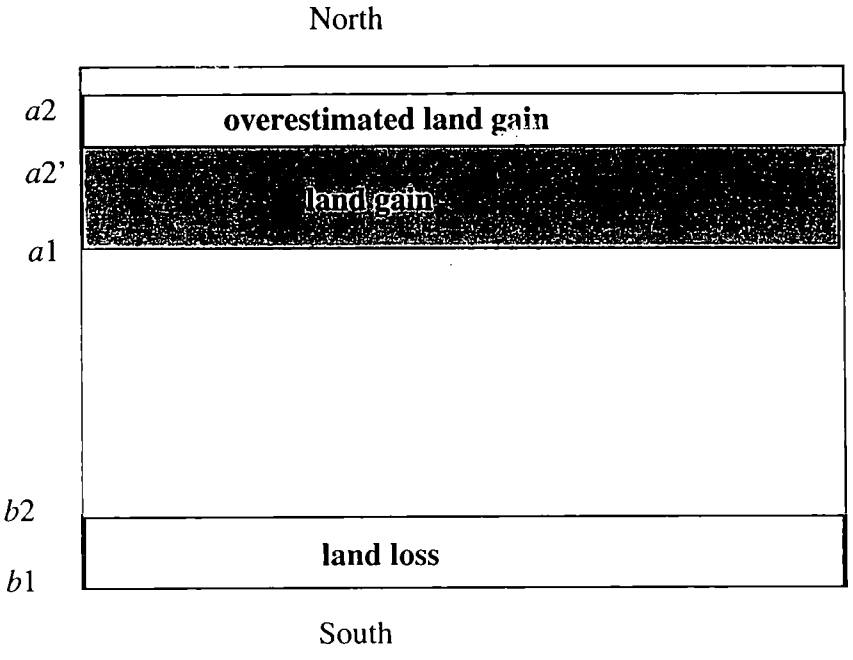

Figure 16.

Since MNS overstate the gains and understate the cost, it is not surprising that they can obtain an optimistic conclusion.

5. Conclusion

We use a theoretical framework to analyze the impacts of climate change on agriculture. We show that the temperature effect, carbon fertilization effect and daylight effect can offset one another, and jointly influence farmers' adaptation choice. Adjustment cost can significantly decrease the magnitude of adaptation.

When we assess the logic behind the Ricardian approach, we conclude that MNS's results are likely to be biased because they do not take into account the settlement and

adjustment cost, and they ignore the daylight and carbon fertilization effect. Another source of bias that can arise in the Ricardian estimates is their assumption of unchanged price. Climate change is a global issue, so if one region is affected by climate change, it is possible that other regions would also be affected. In the Ricardian model, MNS implicitly assume that if the production of grain decreases the rest of the world will produce enough extra grain. However, as the international studies show: the global average reduction in grain would be almost the same as in the U.S. Therefore, the assumption of unchanged price is not realistic, and we expect it would cause some bias in the estimates of the impact on agriculture.

Although we realize that it is not appropriate to assume the relative price is unchanged. The main purpose of this paper is the show how different factors and adjustment cost influence adaptation choice. Adding market effect would make it hard to explain these effects because market effect can dominates every effect, then makes the model much more complicated. Another reason is that most empirical papers in this field assume constant relative price, so keeping the same assumption can allow us to compare our conceptual study with the empirical studies. We will study the market effect in our further research, where we show that the assumption of unchanged price can make big difference in the adaptation choice in terms of the magnitude or even the direction of adjusting land use.

Other important features we do not include in this paper are the potential changes in both demand and supply of the crops. World population is growing, so it can be projected that the demand for food will be increasing in next several decades. This demand change would have big effect on the market price, and then would affect

agricultural adaptation choice. However, if biotechnology develops fast enough to increase the supply, then it might be able to offset the increasing demand. In that case, both the demand change and supply change would have little impact on agricultural adaptations.

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September 7, 2000

The Impact of Climate Change on Agriculture— A Conceptual Study

Xuemei Liu,* David Sunding, and David Zilberman

Appendices

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Appendix A

The original optimization problem is:

$$\max \int_{a}^{\alpha^*} \left(P_c Q_c\left(Z_c(\alpha), F(\alpha,\rho), \rho, D(\alpha)\right) - C_c\left(Z_c(\alpha)\right) - S(\alpha)\right) g(\alpha)\, d\alpha$$
$$+ \int_{\alpha^*}^{b} \left(P_h Q_h\left(Z_h(\alpha), F(\alpha,\rho), \rho, D(\alpha)\right) - C_h\left(Z_h(\alpha)\right) - S(\alpha)\right) g(\alpha)\, d\alpha.$$

The first order condition with respect to α^* is:

$$P_c Q_c\left(Z_c(\alpha^*), F(\alpha^*,\rho), \rho, D(\alpha^*)\right) - C_c\left(Z_c(\alpha^*)\right)$$
$$= P_h Q_h\left(Z_h(\alpha), F(\alpha^*,\rho), \rho, D(\alpha^*)\right) - C_h\left(Z_h(\alpha^*)\right).$$

Totally differentiating yields:

$$Q_c dP_c + P_c\left[\frac{\partial Q_c}{\partial Z_c}\frac{\partial Z_c}{\partial \alpha^*} d\alpha^* + \frac{\partial Q_c}{\partial F}\left(\frac{\partial F}{\partial \alpha^*} d\alpha^* + \frac{\partial F}{\partial \rho} d\rho\right) + \frac{\partial Q_c}{\partial \rho} d\rho + \frac{\partial Q_c}{\partial D}\frac{\partial D}{\partial \alpha^*} d\alpha^*\right]$$
$$- \frac{\partial Q_c}{\partial Z_c}\frac{\partial Z_c}{\partial \alpha^*} d\alpha^*$$
$$= Q_h dP_h + P_h\left[\frac{\partial Q_h}{\partial Z_h}\frac{\partial Z_h}{\partial \alpha^*} d\alpha^* + \frac{\partial Q_h}{\partial F}\left(\frac{\partial F}{\partial \alpha^*} d\alpha^* + \frac{\partial F}{\partial \rho} d\rho\right) + \frac{\partial Q_h}{\partial \rho} d\rho + \frac{\partial Q_h}{\partial D}\frac{\partial D}{\partial \alpha^*} d\alpha^*\right]$$
$$- \frac{\partial Q_h}{\partial Z_h}\frac{\partial Z_h}{\partial \alpha^*} d\alpha^*,$$

where $\frac{\partial C}{\partial \alpha^*} = 0$ by construction. Collecting terms gives

$$\left\{\left[P_c\left(\frac{\partial Q_c}{\partial F}\frac{\partial F}{\partial \alpha^*}+\frac{\partial Q_c}{\partial D}\frac{\partial D}{\partial \alpha^*}\right)-P_h\left(\frac{\partial Q_h}{\partial F}\frac{\partial F}{\partial \alpha^*}+\frac{\partial Q_h}{\partial D}\frac{\partial D}{\partial \alpha^*}\right)\right]\right.$$
$$\left.+\underbrace{\left[P_c\left(\frac{\partial Q_c}{\partial Z_c}-\frac{\partial C_c}{\partial Z_c}\right)\frac{\partial Z_c}{\partial \alpha^*}}_{(1)}-\underbrace{P_h\left(\frac{\partial Q_h}{\partial Z_h}-\frac{\partial C_h}{\partial Z_h}\right)\frac{\partial Z_c}{\partial \alpha^*}}_{(2)}\right]\right\}d\alpha^*$$
$$=\left[P_h\left(\frac{\partial Q_h}{\partial F}\frac{\partial F}{\partial \rho}+\frac{\partial Q_h}{\partial \rho}\right)-P_c\left(\frac{\partial Q_c}{\partial F}\frac{\partial F}{\partial \rho}+\frac{\partial Q_c}{\partial \rho}\right)\right]d\rho-Q_c dP_c+Q_h dP_h.$$

In the above equation, terms (1) and (2) are equal to zero at the equilibrium since in order to maximize profits, farmers would choose input in the way that marginal revenue product equals input price, i.e., $P_i\frac{\partial Q_i}{\partial Z_i}-\frac{\partial C_i}{\partial Z_i}$. Since competitive farmers take market prices as given, dP_i is also zero.

$\frac{\partial Q_h}{\partial F}>0$, since $\alpha*$ is the northern bound of the hot crop, the increase in temperature will increase productivity.

$\frac{\partial Q_c}{\partial F}<0$ since α^* is the southern bound of the cold crop, the increase in temperature will decrease productivity.

$\frac{\partial F}{\partial \alpha^*}>0$. Temperature increases with α.

$\frac{\partial Q_i}{\partial D}>0$. Yield increases with the density of daylight.

$\frac{\partial D}{\partial \alpha^*}>0$. There is more daylight in the south than in the north.

$\frac{\partial F}{\partial \rho}>0$. Temperature increases with carbon dioxide concentration.

$\frac{\partial Q_i}{\partial \rho}>0$. Yield increases with carbon concentration.

Therefore, we can label the signs for all the terms as:

$$\underbrace{\left[P_c\left(\frac{\partial \bar{Q}_c}{\partial F}\frac{\partial \dot{F}}{\partial \alpha^*}+\frac{\partial \dot{Q}_c}{\partial D}\frac{\partial \dot{D}}{\partial \alpha^*}\right)-P_h\left(\frac{\partial \dot{Q}_h}{\partial F}\frac{\partial \dot{F}}{\partial \alpha^*}+\frac{\partial \dot{Q}_h}{\partial D}\frac{\partial \dot{D}}{\partial \alpha^*}\right)\right]}_{A} d\alpha^*$$

$$= \underbrace{\left[P_h\left(\frac{\partial \dot{Q}_h}{\partial F}\frac{\partial \dot{F}}{\partial \rho}+\frac{\partial \dot{Q}_h}{\partial \rho}\right)-P_c\left(\frac{\partial \bar{Q}_c}{\partial F}\frac{\partial \dot{F}}{\partial \rho}+\frac{\partial \dot{Q}_c}{\partial \rho}\right)\right]}_{B} d\rho.$$

Appendix B

- Bound location a.

The equilibrium condition for a is:

$$P_c Q_c\left(Z_c(a), F(a,\rho), \rho, D(a)\right) = C_c\left(Z_c(a)\right) + S(a).$$

Totally differentiating this equation gives:

$$Q_c dP_c + P_c\left(\frac{\partial Q_c}{\partial Z_c}\frac{\partial Z_c}{\partial a}da + \frac{\partial Q_c}{\partial F}\left(\frac{\partial F}{\partial a}d\alpha + \frac{\partial F}{\partial \rho}d\rho\right) + \frac{\partial Q_c}{\partial \rho}d\rho + \frac{\partial Q_c}{\partial D}\frac{\partial D}{\partial a}d\alpha\right)$$
$$= \frac{\partial C_c}{\partial Z_c}\frac{\partial Z_c}{\partial a}da + \frac{dS}{d\alpha}da$$

where $\frac{dS}{d\alpha} = 0$ by construction.

Collecting terms yields:

$$\left(\frac{\partial Q_c}{\partial F}\frac{\partial F}{\partial a} + \frac{\partial Q_c}{\partial D}\frac{\partial D}{\partial a}\right)da + \underbrace{\left(P_c\frac{\partial Q_c}{\partial Z_c} - \frac{\partial C_c}{\partial Z_c}\right)}_{(1)}\frac{\partial Z_c}{\partial a}da = -\left(\frac{\partial Q_c}{\partial F}\frac{\partial F}{\partial \rho} + \frac{\partial Q_c}{\partial \rho}\right)d\rho - Q_c d\rho$$

where term (1) and $d\rho$ are zero because marginal revenue product equals input price at the equilibrium.

Then we obtain:

$$\left(\frac{\partial^{+}Q_c}{\partial F}\frac{\partial^{+}F}{\partial a} + \frac{\partial^{+}Q_c}{\partial D}\frac{\partial^{+}D}{\partial a}\right)da = -\left(\frac{\partial^{+}Q_c}{\partial F}\frac{\partial^{+}F}{\partial \rho} + \frac{\partial^{+}Q_c}{\partial \rho}\right)d\rho$$

which implies $\frac{da}{d\rho} < 0$.

- Bound location b

The equilibrium condition for b is:

$$P_h Q_h\left(Z_h(b), F(b,\rho), \rho, D(b)\right) = C_h\left(Z_h(b)\right) + S(b).$$

By following the same procedure as for location a, we obtain:

$$P_h\left(\frac{\partial Q_h}{\partial F}\left(\frac{\partial F}{\partial b}db + \frac{\partial F}{\partial \rho}d\rho\right) + \frac{\partial Q_h}{\partial D}d\rho + \frac{\partial Q_h}{\partial D}\frac{\partial D}{\partial b}db\right) = \frac{dS}{db}db$$

where $\frac{dS}{db} = 0$, reorganizing terms yields:

$$\left(\frac{\partial \bar{Q}_h}{\partial F}\frac{\partial \overset{+}{F}}{\partial b} + \frac{\partial \overset{+}{Q}_h}{\partial D}\frac{\partial \overset{+}{D}}{\partial b}\right)db = -\left(\frac{\partial \bar{Q}_h}{\partial F}\frac{\partial \overset{+}{F}}{\partial \rho} + \frac{\partial \overset{+}{Q}_h}{\partial \rho}\right)d\rho$$

where the signs are labeled by construction.

Schedule for Climate Change Delegation

Thursday, September 3

1430	EST Counselor Anderson and Science Officer Masters depart Chancery to meet delegation at Kimpo Airport.
1550	Delegation Arrives via Asiana Air 322 Met by Anderson and Masters
1600-1630	Delegation clears customs
1630-1730	Delegation departs airport to Westin Chosun
1730-RON	Delegation free time

Friday, September 4

0650-0720	Economic Minister Counselor Fairfax .EST Counselor Anderson, and Science Officer Masters travel from residences to Westin Chosun
0720-0730	Embassy officers meet Delegation at Westin Chosun
0730-0900	Breakfast meeting hosted by Korea Energy Economics Institute(KEEI) at 9TH Gate Restaurant, Westin Chosun
0905-0920	Delegation departs Westin Chosun for Chancery
0930-1000	Delegation meets with Ambassador Stephen Bosworth
1005-1010	Delegation departs Chancery travels to MOFAT
1015-1100	Delegation meets with State Minister for Trade Han Duck-Soo, MOFAT Room 1801
1100-1110	Delegation departs MOFAT travels to Blue House
1115-1145	Delegation meets with Dr. Oh Jong-Nam, Blue House Presidential Secretary for Economic Affairs
1145-1200	Delegation departs Blue House travels to Koreana Hotel

1200-1330	No host lunch. Koreana Hotel
1335-1410	Delegation travels to Government Complex at Kwachon
1415-1445	Delegation meets with Deputy Minister for Environmental Policy Yang Bang-Chul, Ministry of Environment, Room 605, Building 5, Government Complex, Kwachon
1450-1455	Delegation walks to Building 3, Government Complex, Kwachon
1500-1550	Delegation meets with Deputy Minister for Energy Policy Chung Jang-Sup, Ministry of Commerce, Industry, and Energy , room 606, Building 3, Government Complex, Kwachon
1550-1630	Delegation departs Kwachon, travels to Westin Chosun
1630-RON	Delegation free time
1700-1800	AA/S Kimble and Susan Gordon depart Westin Chosun for Kimpo Airport
1840	AA/S Kimble and Susan Gordon depart Seoul via KAL 705

Saturday, September 5

TBD	Remainder of Delegation departs Seoul for Washington, DC

Energy and Environment Division,
Korea Energy Economics Institute

1998 Project Summary

The Division is conducting a variety of projects to meet the policy needs for responding to the international and domestic concern on the harmonization of economic development and conservation of gloval environment. The following are major projects which are being conducted currently.

■ Action Plan for the Reponse to the Framework Convention on Climate Change (1997 - 1999, Principal Investigator: Dr. Sungwhee Shin)

The objective of this project is to devise a nation-wide action plan for the economic development harmonized with environment conservation focusing on mitigating GHG emissions in Korea. The micro-data such as the investment cost, technical efficiency, lifetime of technological options will be gathered to construct a database. Together with the database, an assessment model will be developed to formulate a strategy to attain a structural change into the energy efficient, competitive, and environmentally friendly economy.

■ Study on the Integrated Model of Energy · Economy · Environment (1998, Principal Investigator: Dr. Jin-Gyu OH)

This study aims to develop the integrated 3E macro economic model for the analysis of government policies to harmonize economic development and environment conservation. This country model is primarily based on the top-down multi-sectoral general equilibrium framework. Policies for simulations would include tax policies and regulation policies and their effects on emissions of pollutants such as carbon dioxide and economic variables.

■ Economic Effects of Carbon Tax with a General Equilibrium Illustration for Korea (1998, Principal Investigator: Yoon-Young Kang)

The feasibility and efficiency arguments of a national carbon tax are analysed. A national carbon tax is analysed as a policy instrument to reach such an internationally agreed national CO_2 emission reduction objective. This study evaluates the impacts of controlling CO_2 emissions using a multi-sectoral, dynamic, computable general equilibrium model for Korea. The economic effects discussed include impacts on main macroeconomic variables (in particular, economic growth), sectoral allocation of production, and effects on the market for energy.

■ Effects of Possible Mechanisms to Reduce GHG on Domestic Economy

(1998, Principal Investigator: Dr. Gyeong L. Cho)

The objectives of the study are to estimate the potential costs of possible mechanisms, such as, joint implementation and emission trade, and to investigate and compare the economic implications of potential commitments to reduce greenhouse gas emissions. Further, the study provides the domestic policy responses to climate changes and to policies and measures of other countries. In order to do that, we constructs multi-countries and multi-sectoral dynamic general equilibrium model suitable for analysing policy issues where the interactions between sectors and countries are significant.

■ A Study on CO_2 Emissions Trading System:

A Cost-Effective Mitigation for Korea Electricity Industry

(1998, Principal Investigator: Dr. Kihoon Lee)

This study is aimed to provide some practical information, know-hows, guidelines to Korean economy and especially Korean electricity industry on how to use CO_2 emissions trading system in mitigating CO_2 emissions cost effectively. The study will focus on analyses of CO_2 tradable permit market structure, possible participating strategies in global CO_2 emissions trading system, and benefits/costs of participations. The study will consist of (1) recent development of Climate Change Convention (2) market potential for CO_2 tradable permits (3) mitigation potential for Korean economy and Korean electricity industry (4) feasibility for domestic CO_2 permit trading system.

■ UN Climate Convention and Joint Implementation

(1998, Principal Investigator: Dr. Yonghun Jung)

On December 1997, the Kyoto Protocol was adopted at the third Conference of the Parties. Despite lack of details on various issues including JI, Emissions Trading, Clean Development Mechanism, and etc., the adoption of the protocol will no doubt have significant influence over many countries in the world in various aspects such as economic, social and political ones. Joint Implementation seems one of the most effective measures to enhance the flexibility in meeting the presumed target levels of GHG emissions reduction for Annex I countries.gH However it does not have to be confined to those countries. Korea as a country with high-level energy efficient technologies may have some opportunities for JI. Thus this study intends to identify those opportunities as well as means to participate in future JI projects either independently or jointly.

■ The Economic Impact of International Climate Chane Policy on Korea

(1998. 7. - 1999. 6, Joint Research with ABARE)

The purpose of this study is to contribute to international climate change policy development by providing an assessment of the economic impacts on developing countries such as Korea of policies to reduce carbon dioxide emissions from fossil fuel combustion in Annex I countries. It will use the global computable general equilibrium model, MEGABARE, developed by ABARE for the assessment.

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DEPT FOR EAP/K - TDELARE/STHORNTON/ESAGURTON

BEIJING FOR CEA CHAIR DR. JANET YELLEN

WHITE HOUSE PASS TO CEA

WHITE HOUSE PASS TO OSTP

E.O. 12958: N/A
TAGS: ORTA, SENV, ECON, KS
SUBJECT: PROPOSED SEOUL SCHEDULE FOR CEA CHAIR AND GLOBAL CLIMATE CHANGE DELEGATION

REF: (A)SEOUL 03608, (B)SECSTATE 112282, (C) SEOUL 03626

1. EMBASSY HAS INCORPORATED INFORMAL FEEDBACK FROM CEA AND EAP/K AND PROPOSES THE FOLLOWING SCHEDULE FOR DR. JANET L. YELLEN AND THE DELEGATION. PLEASE NOTE THAT THE AMBASSADOR PLANS TO PARTICIPATE IN THE 30 JUNE COUNTRY TEAM MEETING. IN ADDITION, THE AMBASSADOR INVITES DR. YELLEN TO A BREAKFAST AT THE RESIDENCE ON THURSDAY, JULY 2 AT 7:30 AM. REGRET TO INFORM THAT DR. HOESUNG LEE HAD TO LEAVE FOR THE IPCC MEETING IN BONN.

2. THE REVISED SCHEDULE FOR DR. YELLEN IS AS FOLLOWS:

TUESDAY, JUNE 30

12:30 PM: ARRIVE KIMPO AIRPORT BY CA 123 FROM BEIJING
(MET BY EST COUNSELOR MEER)

2:00 PM: MODIFIED COUNTRY TEAM BRIEFING AT EMBASSY
(SANDWICHES AND DRINKS SUPPLIED FOR VISITORS)

4:00 PM: DEPART EMBASSY FOR MINISTRY OF FOREIGN AFFAIRS AND TRADE

4:30 PM: STATE MINISTER FOR TRADE DR. HAN DUK-SOO (CONFIRMED)

5:30 PM: MR. HAN JUNG-KIL, ASSISTANT MINISTER FOR ECONOMIC POLICY COORDINATION AND CHAIRMAN OF THE PRIME MINISTER'S TASK FORCE FOR CLIMATE CHANGE (CONFIRMED)

6:15 PM: LEAVE FOR HYATT HOTEL

6:30 PM: ARRIVE AT HYATT HOTEL

WEDNESDAY, JULY 1

9:30 AM: MR. SEO SA-HYEON, DEPUTY MINISTER FOR ENERGY POLICY, MINISTRY OF COMMERCE, INDUSTRY, AND ENERGY (TO BE CONFIRMED)

10:30 AM: MR. CHOI JAE WOOK, MINISTER FOR ENVIRONMENTAL AFFAIRS (CONFIRMED)

11:30 AM: DEPART FOR KOREAN ENERGY ECONOMIC INSTITUTE (KEEI)

12 NOON: LUNCH WITH KEEI PRESIDENT DR. SHIN JEONG-SIK AND STANDING ADVISOR DR. LEE HOE-SUNG (CONFIRMED)

1:30 PM: DISCUSSIONS AT KEEI (CONFIRMED)

2:30 PM: DEPART KEEI FOR HOTEL

3:00 PM: ARRIVE HOTEL (NO FURTHER APPOINTMENTS)

THURSDAY, JULY 2

7:15 AM: DEPART HYATT HOTEL FOR AMBASSADOR'S RESIDENCE

7:30 AM: BREAKFAST WITH AMBASSADOR

9:00 AM - 9:45 AM: FREE TIME

9:45 AM: DEPART FOR DOWNTOWN OFFICES OF THE MINISTRY OF FINANCE AND ECONOMY

10:00 AM: COURTESY CALL ON MR. LEE KYU-SUNG, MINISTER OF FINANCE AND ECONOMY (CONFIRMED)

10:45 AM: FREE TIME

12:45 AM: DEPART FOR KIMPO AIRPORT FOR UA 818 LEAVING AT 2:20 PM

BOSWORTH
BT
#3682
NNNN

Yang

fwd position TBD

contact pts @ working level bt countries

dom reduction should be primary, flex mechs supplemental

flex mechs should be impl cost-effectively

Fadi Faye

DOE ACTIVITIES

IN

SOUTH KOREA

August 26, 1998

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OVERVIEW

Divider Title: _____

United States
Energy Information Administration

November 1997

South Korea

The Republic of Korea (South Korea) has a growing economy which depends on imports for 95 percent of its energy needs. The military threat from North Korea, across the Demilitarized Zone, is a constant concern. The United States is a major ally and trading partner.

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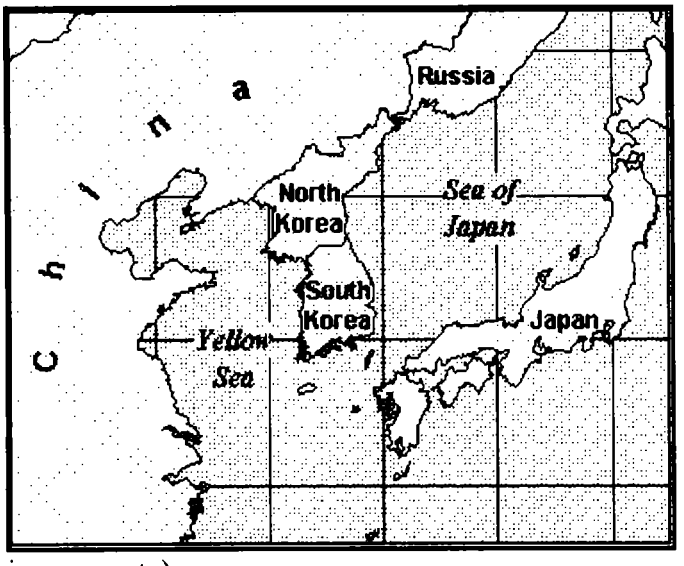

BACKGROUND

Under the leadership of Kim Young Sam (whose term of office expires in February 1998 and is ineligible to run for re-election), South Korea is implementing financial reforms and liberalizing its economy under the banner of "segyehwa" (globalization and internationalization). In September 1997, Kim Young Sam resigned the presidency of South Korea's ruling New Korea Party. Kim has been succeeded by Lee Hoi Chang, the party's candidate in the December 18, 1997 presidential election. Running against Lee are Kim Dai Jung of the leading opposition party (National Congress for New Politics) and Rhee In Je (a former governor who quit the ruling party to form his own party).

Although South Korea is considered one of the world's big emerging markets, its economic growth has slowed from nearly 9 percent in 1995 to a projected 5.5 percent in 1997. The restructuring of large companies and financial institutions has led to labor actions, declarations of bankruptcy by some of the largest conglomerates in the economy, and government aid for ailing financial institutions. The country's currency value and stock market have also been affected by a financial crisis wreaking havoc on economies throughout southeast Asia. Priorities include restoring the country's economic health and global competitiveness, while continuing to reform the corporate and bureaucratic structure. On a positive note, the country's trade balance has improved over the past 6 months, and the current account deficit is now projected to be only about half the size of the 1996 deficit.

South Korea became the 29th member of the Organization for Economic Cooperation and Development (OECD) in December 1996, and is also a member of the World Trade Organization (WTO) and APEC (Asia Pacific Economic Cooperation). In its financial liberalization plan submitted to the OECD, South Korea promises to fully open its stock market to foreign investors by 2000 (the current limit of 23 percent foreign is expected to be raised to 26 percent in late 1997). Foreign investment in local conglomerates

(known as "chaebols") and long-term corporate bonds of small companies is also planned. The United States and Japan already are major investors in South Korea.

The United States is South Korea's most important trading partner, providing 22 percent of South Korea's imports and purchasing 17 percent of its exports in 1996 (more than any other country). However, this relationship has become strained over barriers to U.S. automobile exports. In October 1997, U.S. Trade Representative Charlene Barshefsky formally designated South Korea as a "priority" foreign country subject to review. This opens up the possibility of future sanctions under U.S. trade law.

South Korea exists under nearly constant tensions with North Korea, particularly in the Demilitarized Zone along the 38th parallel -- the most heavily armed border in the world. Technically, the two countries have been at war since the 1950s, as South Korea never signed the 1953 armistice ending hostilities (neither did the United States). Under a 1954 Mutual Defense Treaty, the United States maintains about 37,000 troops in South Korea to assist its defense against external aggression. An attempt to hold four-way talks among North Korea, South Korea, China, and the United States floundered in September 1997 on North Korea's insistence that the agenda include a discussion of the withdrawal of U.S. troops from South Korea.

South Korea's relations with North Korea are highly limited by ongoing tensions, and consist primarily of security-related initiatives. For example, South Korea agreed to provide two light-water nuclear reactors to North Korea as part of an October 1994 U.S.-North Korea bilateral agreement in which North Korea agreed to freeze and eventually dismantle its graphite technology nuclear program (which could have a dual use in a nuclear weapons program). Employees of South Korea's state power company are now working in North Korea on the first phase of the construction project. South Korea has also donated food supplies in response to international appeals to help North Korea cope with a major famine threatening its population. South Korea lifted its ban on direct trade and investment in North Korea in 1994, and as of September 1997 had authorized 26 companies to do business or invest in North Korea. In October 1997, South Korea signed an aviation agreement that will allow commercial flights over North Korea beginning in February 1998.

OIL

Oil supplies the largest share of South Korea's total energy requirements (about two-thirds of primary energy consumption in 1995), and demand has been rising rapidly with industrial expansion and rising incomes. The growth in gasoline demand has been particularly strong (20 percent annually since 1984) due to increased car ownership. Car ownership rose from 2.1 million cars in 1990 to more than 6 million, and is expected to hit 11 million by 2000.

With no domestic reserves, South Korea must import all of its crude oil. As a security measure, the country plans to diversify its sources of supply in order to reduce its dependence on the Middle East (from 78 percent currently to 65 percent within 10 years). One example is LG-Caltex Corp.'s announcement in December 1996 of a long-term contract to import 30,000 barrels per day of Alaskan North Slope oil from BP. South Korea is also building a strategic petroleum reserve in anticipation of joining the International Energy Agency (IEA). Strategic stocks are currently equivalent to a 60-day supply (the IEA requires a 90-day supply).

An important aspect of the country's long-term strategy is to increase oil imports from overseas projects in which South Korean firms are participating (to a targeted 10 percent of imports by 2010). At the end of 1996, South Korean companies were participating in 37 oil fields in 16 countries. In March 1997, crude oil production capacity at these fields was estimated at 43,500 barrels per day. State-run Korea Petroleum Development Corp. (PEDCO) is currently participating in 19 oil exploration projects in 13 countries, including 5 fields (in Yemen, Egypt, Argentina, Peru, and the North Sea) which together produce 18,000

barrels per day. Major refiners and trading houses are also actively involved in development of overseas petroleum reserves.

Five major refining companies produce petroleum products primarily for use within South Korea. However, exports of petroleum products have increased in 1997 as the companies have completed refinery expansions. In the first 7 months of 1997, exports exceeded 500,000 barrels per day, including large volumes to China and Taiwan. This surge is largely attributable to a rapid expansion of the country's refining capacity, which has doubled since January 1996 (to an estimated 2.4 million barrels per day). In July 1997, Ssangyong Oil Refining Company (35-percent owned by Saudi Aramco) signed the country's first term contract to sell gasoline to an oil-producing country (an agreement to export 1.8 million barrels to Saudi Aramco over a 6-month period).

In January 1997, South Korea began implementing the deregulation of petroleum product prices and liberalization of import and export markets. Government price ceilings on petroleum products were lifted (refiners were required to give the government advance notice of price increases for the first 6 months), and non-refiners (up to 50 percent foreign ownership) were permitted to import and export crude oil and petroleum products without the need for a government license. Beginning January 1, 1999, any company will be able to enter any level of the oil business by simply registering with the government.

In September 1997, South Korea dedicated a 593-mile oil product pipeline and a large oil products storage terminal (1.97 million barrels capacity) in Songnam. The pipeline serves the terminal as well as cities throughout the southern part of the country. The first phase, serving cities in the Seoul area, has been open since 1992.

NATURAL GAS

South Korea relies on imported liquefied natural gas (LNG) to meet its growing demand for natural gas, which currently supplies about 7.5 percent of its total energy needs. This share is projected to increase to 10 percent of consumption in 2010. According to the International Energy Agency, the power sector accounted for about half of total natural gas consumption in 1994, followed by the residential sector (at 32 percent) and the industrial and commercial sectors (at about 9 percent each).

Korea Gas Corp. estimates LNG demand will more than double by 2001 (to 20.7 million metric tons compared with 9.5 million metric tons in 1996), and continue increasing (to 25 million metric tons in 2006 and 29.3 million metric tons in 2010). To meet these higher demand levels, South Korea is increasing the capacity at its existing terminals (Pyongtaek and Inchon) and planning a third LNG receiving terminal at a location not yet determined. It is also investing in storage facilities and entering into additional long-term supply agreements.

South Korea currently gets most of its LNG from Indonesia (55 percent) and Malaysia (34 percent), with smaller volumes from Brunei and Australia. As with oil, South Korea is trying to diversify its LNG supply sources as a security measure. Long term agreements have recently been signed with Oman and Qatar, which are expected to supply 40 percent of South Korea's LNG in 2001 (as the Indonesian and Malaysian shares fall to 32 percent and 12 percent, respectively). The Oman project is noteworthy in that it is the first in which South Korea has taken an equity position (with the purchase of a 12 percent stake by Korea LNG, a new company formed by five South Korean companies -- including Korea Gas). Formal signing of a long-term agreement with Brunei is expected by the end of 1997. Future supplies are also planned from new LNG projects in Yemen and Canada's British Colombia. Longer term options include the possibility of a pipeline to ship natural gas from Russia (Irkutsk in East Siberia), via China.

During 1997, Korea Gas Corp. conducted its fourth round of bidding for seven LNG carriers needed to transport LNG from Oman and Indonesia for up to 25 years. The company is also investing in

infrastructure to deliver the gas to domestic markets. It plans to complete a national transmission loop with extensions to remote cities by 1999. Distribution and sale of natural gas is handled by 10 private companies, each of which has exclusive rights to operate within a defined area.

COAL

Coal supplies about 18 percent of South Korea's total energy requirements. Most of these requirements are met by imports, since the only indigenous coal resources consist of a low-quality anthracite used in home heating and small boilers. Bituminous coal supplies (steam coal for power plants and industrial boilers and metallurgical coal for steelmaking) are imported mainly from Australia. State power company KEPCO has invested in several Australian coal mines, and plans to increase coal imports from China, Indonesia, and possibly the western United States. The company is particularly interested in new sources of low-sulfur coal needed to meet new government emissions guidelines for 1999.

ELECTRIC POWER

South Korea uses a combination of thermal, nuclear, and hydroelectric capacity to meet its demand for electric power. Thermal capacity (coal, oil, and LNG) generates nearly 62 percent of the total, nuclear nearly 36 percent, and hydro less than 3 percent. Currently, nuclear power is generated by 12 units at four plants (Kori, Ulchin, Wolsong, and Yonggwang), with total net generating capacity of nearly 10 gigawatts (including 650 megawatts from a new unit of the Wolsong plant dedicated in September 1997). In addition, industrial companies (steel plants, refineries, chemical makers, etc.) have installed about 3 gigawatts of self-generation capacity which is not connected to KEPCO's grid.

South Korea's Ministry of Trade, Industry, and Energy projects the country will need to more than double its electric generating capacity (to 67.51 gigawatts) by 2010 to meet anticipated electricity demand increases of 11-12 percent annually. To reduce the country's large energy trade deficit, the plan calls for reducing the relative share of LNG generation while increasing the relative importance of the country's nuclear, coal, and hydroelectric power. The country plans to complete four more nuclear plants totaling 3.2 gigawatts by 2000, and another 2 nuclear plants totaling 1.9 gigawatts by 2003 (two more nuclear plants are in the planning stage).

Plans include a gradually increasing role for independent power producers (IPPs), which ultimately could provide 6 gigawatts or more of power. In 1996, South Korea awarded two 450-megawatt LNG-fired plants and two 500-megawatt coal-fired plants to South Korean companies on a build, own, and operate (BOO) basis. The second round, currently underway, is seeking bidders for two 450-megawatt LNG-fired plants. Foreign ownership of IPPs may not exceed 50 percent and a foreign firm may not represent the majority interest in the project.

The potential market share for U.S. fossil-fired and nuclear generation technology and flue gas desulfurization technology is estimated to exceed $1 billion over the next 14 years.

In October 1997, South Korea's Securities and Exchange Commission approved a request by the Korea Development Bank to purchase a 6.92 percent stake in KEPCO, which would reduce the government's share to 68.63 percent. Subsequently, KEPCO announced plans to buy back shares equivalent to 0.87 percent equity over a 3-month period to support the bearish domestic stock market. Currently, individual investors are allowed to hold up to 1 percent each, but the Ministry of Finance and Economy has announced plans to increase the individual share limit to 3 percent.

ENVIRONMENT

As South Korea's economy has developed, environmental concerns have become increasingly important. The Ministry of Environment, established in 1990, presented a long-term master plan ("Vision") in 1995. The long-term plan emphasizes a sound national environment and codification of environmental standards

to be met by 2005.

In addition to an over-arching basic law, South Korea has enacted specific legislation covering air, water, waste, noise, and other forms of pollution. Regulation and enforcement is delegated to various ministries and regional bodies.

Energy-related environmental initiatives include measures affecting gasoline consumption and electric power production. Unleaded gasoline was introduced in 1987 and phased out by 1993, and gasoline specifications on aromatics, benzene compounds, and oxygen content are being tightened. Long-term plans for the electric power sector include the adoption of flue gas desulfurization, high-efficiency dust collection technologies, and clean coal technology. The electric power plan also includes a demand side management program designed to reduce peak demand and the associated need for additional power plants.

South Korea's economy has significant room for conserving energy. For example, a February 1997 report by the Bank of Korea indicated Korean manufacturing companies use significantly more energy than Japanese companies for each $1 million worth of goods produced (110 tons of oil equivalent versus only 60 tons in Japan, based on data for 1990). Basic material companies (including steel, petrochemicals, and cement makers) used nearly twice as much energy per $1 million worth of output (240 tons of oil equivalent versus 130 tons in Japan), according to the Bank.

COUNTRY OVERVIEW

President: Kim Young-Sam (since February 1993; next election December 18, 1997)
Independence: August 15, 1948
Population (7/97E): 45.9 million
Location/Size: Eastern Asia/98,480 square kilometers (38,000 square miles), about the size of Indiana
Major Cities: Seoul (capital), Pusan, Taegu, Inchon, Kwangju
Language: Korean (English widely taught in high schools)
Ethnic Groups: Korean, with small Chinese minority
Religions: Christianity, 48.6%; Buddhism, 47.4%; Confucianism, 3%; Other, 1%
Defense (8/96): Army, 548,000; Navy, 60,000; Air Force, 52,000 (*plus 35,910 U.S. troops*)

ECONOMIC OVERVIEW

Currency: Won (W)
Exchange Rate (10/31/97): US$1 = W965
Gross Domestic Product (GDP, Market Exchange Rate, 1996): $485 billion
Real GDP Growth Rate (1996): 7.1%
Inflation Rate (consumer prices) (1996): 4.9%
Unemployment Rate (9/97): 2.2%
External Debt (1996): $104.7 billion
Total Reserves, Non-Gold (9/97): $30.4 billion
Current Account Balance (1996): -$21.8 billion
Trade Balance (1996): -$15.5 billion (-$3.9 billion with U.S.)
Exports (1996): $128.4 billion ($22.7 billion to U.S.)
Imports (1996): $143.8 billion ($26.6 billion from U.S.)
Major Exports: Manufactures, textiles, ships, automobiles, steel, computers, footwear
Major Imports: Crude oil, food, machinery and transportation equipment, chemicals and chemical products, base metals and articles.
Top Trading Partners: United States, Japan, China, Germany

ENERGY OVERVIEW

Trade, Industry, and Energy Minister: Yim Chang-yol
Oil Consumption (1996E): 2.16 million barrels per day (b/d)
Crude Oil Refining Capacity (1/1/97): 2.2 million b/d
Natural Gas Consumption (1996E): 457 billion cubic feet (bcf)
Recoverable Coal Reserves (12/31/93): 202 million short tons
Coal Production (1996E): 5.5 million short tons
Coal Consumption (1996E): 57.6 million short tons
Coal Imports (1996E): 52.7 million short tons
Electric Generation Capacity (1/1/96): 32.2 gigawatts
Electricity Generation (1996E): 194.2 billion kilowatthours (Kwh)

ENVIRONMENT OVERVIEW

Minister of Environment: Yun Yo-Chun
Total Energy Consumption (1995E): 6.28 quadrillion Btu
Energy Consumption per Capita (1995E): 140.1 million Btu (versus 345.9 million Btu for the United States)
Energy-Related Carbon Emissions (1995E): 101.45 million metric tons (1.7% of world carbon emissions)
Carbon Emissions Per Capita (1995E): 2.3 metric tons (vs. 5.4 metric tons in the United States)
Major Environmental Issues: Air pollution in large cities; water pollution from the discharge of sewage and industrial effluents; drift net fishing.

ENERGY INDUSTRY

State Energy Companies: Korea Petroleum Development Co.; Daehan Oil Pipeline Corporation (DOPCO); Korea Electric Power Company (KEPCO); Korea Gas Corp.
Major Oil Companies (Private): SK Corp. (formerly Yukong); LG-Caltex (formerly Honam);. Ssangyong Oil ; Hanwha Oil, Hyundai Oil
Major Refineries (1/1/97 Capacity): Ulsan (759,500 b/d); Onsan (500,000 b/d); Yocheon (361,000 b/d); Daesan (310,000 b/d); Inchon (261,000 b/d)
Major Ports: Pusan, Inchon, Kunsan, Mokpo, Ulsan
Liquefied Natural Gas (LNG) Regasification Terminals: Pyongtaek, Inchon

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For more information from EIA on South Korea, please see:
EIA - Country Information on South Korea

Links to other sites:
1997 CIA World Factbook - South Korea
U.S. International Trade Administration, Country Commercial Guide - South Korea
U.S. Department of Energy's Office of Fossil Energy's International section - South Korea

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BILATERALS

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U.S.-KOREA BILATERAL ENERGY COOPERATION ACTIVITIES

The Department of Energy (DOE) currently has four implementing arrangements dealing with science and technology cooperation with the Ministry of Science and Technology (MOST) of Republic of Korea (ROK). (In addition, we have informal nuclear cooperation. The nuclear group will be meeting in Korea at the same time you are there see p. 3). DOE's four arrangements come under the U.S.-ROK S&T Agreement. These arrangements as well as those from other U.S.G. agencies are reviewed every two years under the Joint Committee Meeting on Science and Technology Cooperation. The last meeting took place in January of 1998 in Seoul. A status of DOE's activities for each of these arrangements is as follows:

Implementing Arrangement No. 2 between DOE and the Ministry of Science and Technology (MOST) for Cooperative Laboratory Relationship between the Federal Energy Technology Center and the Korea Institute of Energy Research (KIER) and the Korea Institute of Science and Technology (KIST) in the area of Fossil Energy Technology.

In October 1997, a joint workshop on energy and environment was organized by KIER and co-sponsored by DOE and the Department of Commerce. This workshop, which took place in Taeduk, Korea, included a two-day technical conference followed by several industrial site visits. On the Korean side, the workshop was sponsored by KIER with support from the Ministry of Trade, Industry and Energy (MOTIE) and MOST, with heavy participation by the Korea Electric Power Corporation (KEPCO). The U.S. delegation was composed of representatives from DOE as well as 16 private companies. While in the past these type of workshops (as called for under the Arrangement) focused primarily on coal, last year the focus was expanded to include air pollution control, advanced power generation, and waste management.

Implementing Arrangement between DOE and MOST for Cooperation in the area of Fusion Energy Research and Related Fields.

On June 14, 1996, DOE and MOST signed an Implementing Arrangement for cooperation in Fusion Energy Research and Related Fields. The signing of this Arrangement provided the auspices for the Korean Basic Science Institute (KBSI)-Princeton Plasma Physics Laboratory (PPPL) to enter into a contractual arrangement in support of the Korea Superconducting Tokamak Advanced Research (KSTAR) Project. To date, the Koreans have paid PPPL $4,000,037. In addition, under a phase 2 activity, Korea has agreed to pay PPPL an additional $1,400.000. KSTAR is a collaborative venture among Korean national laboratories, Korean universities, and Korean industry. Its mission is to: develop and construct a steady-state capable, superconducting Tokamak (the KSTAR) Project; develop advanced, flexible Tokamak operating scenarios to address global and localized confinement physics issues; and establish a Korean physics and technology base for superconducting steady-state fusion reactors to support future fusion energy development. Under this KBSI-PPPL arrangement, PPPL is the coordinating laboratory of the U.S. team effort. Other U.S. participants include the Massachusetts Institute of Technology,

Technology, General Atomics, Oak Ridge National Laboratory, Lawrence Livermore National Laboratory, and Northrop-Grumman Corp. The U.S. role is to assist the KBSI and its team members in designing and building the KSTAR experiment, to provide opportunities for Korean team members to obtain the necessary technical knowledge and expertise in designing fusion devices, and to assist the KBSI in setting up the requisite engineering and management programs to monitor and control the Project. To date, significant activity supportive of KSTAR has been initiated and is now working well with considerable interaction between the U.S.-Korean teams through KBSI and PPPL.

On September 4, 1997, the first meeting of the Program Coordinators of the U.S.-Korea Implementing Arrangement was held in Germantown, Maryland, to explore the possibility of a broader U.S.-Korea Bilateral Fusion Program. Following an informative and productive exchange of views, it was agreed that each side would develop a proposed first year's program of work that focuses on joint planning activities to explore areas of likely mutual interest. They further agreed to reach agreement on a single list by the Fall of 1997, and complete the preparations for the first year's program of work during a U.S. delegation visit to Korean in January 1998, but because of logistical problems the DOE was unable to go. It now appears that they two sides will meet in the Fall of this year.

Implementing Arrangement between DOE and MOST for Cooperation in the area of Solar Energy Technology Research.

Over the past two years collaborative activities were carried out in three major areas through DOE's National Renewable Energy Laboratory (NREL). The first of these activities was the preparation by NREL of a document on effective technology transfer mechanisms in the United States as possible models for Korea. A report was prepared for KIER in May 1996, listing 11 technology transfer mechanisms used by the federal laboratories in the U.S., of which four were considered the most effective and applicable to Korea. These were: licensing of a technology developed in a national laboratory; cooperative research and development agreements (CRADAs); spin-off companies; and joint ventures between a laboratory and industry.

The second activity was the exchange of technical and administrative personnel between MOST institutes (such as KIER) and NREL. Four such exchanges occurred in the 1995-97 period. The longest exchange was with an official from Ministry of Trade, Industry, and Energy. This individual spent two years (1995-96) at NREL learning about the administrative, organizational and technical structures of NREL and DOE and their interaction with utilities and the private industry. A representative from KIER visited NREL twice in 1995/96 to work with NREL staff on the Korean solar radiation data (see below).

During the third activity, NREL provided training in solar radiation resource assessment for KIER during a visit to KIER in 1994 and subsequent visits to NREL by a KIER

scientist during 1994,95, and 96. Most recently, a representative from NREL spent two weeks (October 29-November 11, 1997) at KIER and provided its staff with expertise on how to improve the quality of solar radiation measurements from the 16-station solar monitoring network set up by KIER throughout the Republic of Korea.

On August 24-31, 1997, NREL organized a photovoltaic-diesel hybrid workshop at the ISES Solar World Congress with KIER, which was held in Taejon, Korea.

Implementing Arrangement between DOE and MOST for cooperation in the area of Energy Conservation and Environmental Technology.

No activities have taken place under this Arrangement.

In the nuclear arena, there is a Joint Standing Committee on Nuclear Energy Cooperation (JSCNEC) with MOST. This bilateral activity began in 1976, and is led by the Department of State, with participation by DOE, NRC, and ACDA. This Committee has contributed to a concerted overall U.S.G. effort to maximize U.S. benefits from bilateral nuclear cooperation, nuclear energy trade, including sales of nuclear power plants and uranium enrichment services. There is no formal nuclear agreement associated with this Committee, under which a number of cooperative activities take place. However, DOE does have one Arrangement and one Memorandum of Understanding that deal with nuclear cooperation (listed below). These activities are also reviewed every year along with the other DOE nuclear cooperative efforts, under the U.S.-ROK Joint Standing Committee on Nuclear Energy Cooperation (JSCNEC). The next meeting of the Committee will be taking place June 22-23 and 26 in Seoul, June 24-25 the group will be in Taejon.

Arrangement between DOE and MOST Concerning Research and Development in Nuclear Material Control, Accountancy, Verification, Physical Protection, and Advance Containment and Surveillance Technologies for International Safeguards Application

Memorandum of Understanding between DOE and MOST for a Cooperative Laboratory Relationship for Research and Development for Civil Uses of Atomic Energy

Ongoing DOE/Lab activities include:

a) Design and development of an Advanced Liquid Metal Reactor (ALMR) (with NE) (only a dialogue)
b) Technology development for low level waste treatment, decontamination, decommissioning and environmental restoration (with EM)
c) Cooperation in plate type research reactor fuel technology (with Argonne National Laboratory (ANL))
d) cooperation in radioisotope production, including development of low enriched uranium targets (with NE)

e) Collaboration on R&D related to disposal of low and intermediate level waste
f) Return of spent research reactor fuel to the U.S. (with EM)
g) Collaboration on irradiation testing R&D at the Advanced Test Reactor (ATR) (with Idaho National Engineering and Environmental Laboratory (INEEL))
h) Collaboration with DOE on nuclear energy R&D under NE's Nuclear Energy Security Program (with ANL, Brookhaven National Laboratory (BNL), INEEL, Lawrence Livermore National Laboratory (LLNL), Oak Ridge National Laboratory (ORNL), and Sandia National Laboratory (SNL))
i) Physical protection of nuclear materials (with NN)
j) Cooperation in the development & implementation of a safeguards system for DUPIC (direct use of spent Pressurized Water Reactor (PWR) fuel in Candu reactors) (with NN)
k) Collaboration on the development of human resources for nuclear safety (with NN)

New Activities:

a) Technical cooperation on High Level Waste (HLW) disposal technology development and performance assessment (with SNL)
b) Collaboration on research reactor decommissioning (with INEEL)
c) Research collaboration on safety and reliability techniques for teal-time computer of reactor protection systems (with LLNL)

Potential Activities:

In February 1998, NE forward to MOST some 104 proposal for collaboration with the National Laboratories. So far the Korean Atomic Energy Research Institute (KAERI) has identified seven proposals of particular interest. We suspect that the Koreans will identify interest in several more at the JSCNEC meeting. The seven proposals identified include:

a) Fission neutron evaluation (with BNL)
b) Severe accident test and evaluation technology (with ANL)
c) Advanced monitoring, diagnostics and control (with ANL)
d) Development and demonstration of a supervisory PWR feedwater control system (with ORNL)
e) Robotics and remote systems (with ORNL)
f) Analysis of Korean robotic needs and application study (SNL)
g) Reactor pressure vessel irradiation studies (with ORNL)

Representatives from the participating laboratories will accompany the delegation to Taejon to give technical presentations on the projects the Koreans have identified.

We do not anticipate that any contracts for collaboration will be signed during JSCNEC, but the technical briefings and subsequent discussions should make possible the preparation by the labs of the necessary contracts.

Prepared by: Peter Paul Jodoin, PO-82, 6-5906
Date: June 17, 1998

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	NSAE-00	NSF-01	OCS-03	OIC-02	PA-00	PM-00	PRS-00
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TAGS: SENV, KS
SUBJECT: HIGH-LEVEL CLIMATE DELEGATION VISIT TO SEOUL, SEPTEMBER 3-5, 1998

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SEOUL 01 OF 02 4964

CONTROL OFFICER:
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1. OVERALL CONTROL OFFICER FOR THE VISIT OF HIGH-LEVEL CLIMATE DELEGATION WILL BE (b)(6), (b)(7)c, (b)(7)f SHE CAN BE REACHED 24-HOURS A DAY THROUGH THE EMBASSY SWITCHBOARD (822-397-4144), BY FAX DURING BUSINESS HOURS AT 822-722-1429 (IDD), 822-725-4431 (TIE LINE).

MEETING SCHEDULE:
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2. FOLLOWING IS A TENTATIVE SCHEDULE WE HAVE ARRANGED TO DATE:

THURSDAY, SEPTEMBER 3:

1550 ARRIVE KIMPO VIA ASIANA AIR #332.
MET BY (b)(6), (b)(7)c, (b)(7)f

FRIDAY, SEPTEMBER 4:

0730-0900 BREAKFAST MEETING HOSTED BY KOREA ENERGY ECONOMICS INSTITUTE (KEEI) AT THE 9TH GATE RESTAURANT, WESTIN CHOSUN HOTEL.

ATTENDEES FROM KEEI:
DR. SHIN JUNG-SHIK, PRESIDENT
DR. LEE HOE-SUNG, STANDING ADVISOR
DR. CHUNG YONG-HUN, SENIOR RESEARCH FELLOW

0930-1000 MEETING WITH AMBASSADOR STEPHEN W. BOSWORTH AT THE CHANCERY.

1015-1100 MEETING WITH STATE MINISTER FOR TRADE HAN DUCK-SOO FOR TRADE, MINISTRY OF FOREIGN AFFAIRS & TRADE (MOFAT) ROOM 1801.

1115-1145 MEETING WITH BLUE HOUSE SENIOR SECRETARY TO THE PRESIDENT FOR ECONOMIC AFFAIRS KANG BONG-KYUN (TENTATIVE)

1200-1330 POSSIBLE LUNCHEON HOSTED BY MOFAT (TIME, PLACE AND THE NAME OF THE HOST NOT YET DETERMINED)

1415-1450 MEETING WITH DEPUTY MINISTER YANG BANG-CHUL FOR ENVIRONMENTAL POLICY, MINISTRY OF ENVIRONMENT (MOE) AT ROOM 605, BUILDING 5, GOVERNMENT COMPLEX KWACHON.

1500-1550 MEETING WITH DEPUTY MINISTER SEO SA-HYEON FOR ENERGY POLICY, MINISTRY OF COMMERCE, INDUSTRY, AND ENERGY (MOCIE) AT ROOM 606, BUILDING 3, GOVERNMENT COMPLEX KWACHON.

1550 DEPART KWACHON FOR HOTEL.

SATURDAY, SEPTEMBER 5:
DEPART SEOUL FOR TOKYO

PRESS EVENT:
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3. POST SUGGESTS A SMALL ROUND TABLE DISCUSSION WITH A SELECTED GROUP OF REPORTERS AT THE USIS OFFICE ENROUTE TO HOTEL FROM KIMPO AIRPORT UPON ARRIVAL. WE BELIEVE THIS WOULD BE AN EFFECTIVE MEANS TO CAPTURE PUBLIC ATTENTION AND TO STRESS THE IMPORTANCE OF THE CLIMATE CHANGE ISSUE AND THE EXTREMELY HIGH IMPORTANCE THE US GOVERNMENT PLACES KOREA ON THIS ISSUE.

HOTEL RESERVATIONS:
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4. SEVEN STANDARD HOTEL ROOMS WITHIN USG PER DIEM (USD121) HAVE BEEN RESERVED AT THE WESTIN CHOSUN HOTEL FROM SEPTEMBER 3 THROUGH 5, 1998 (2 NIGHTS). CONFIRMATION NUMBERS ARE AS FOLLOWS:

MELINDA KIMBLE	108121
TODD STERN	108122

JOE ALDY	108123
SUSAN GORDON	108124
MARK MAZUR	108125
WILLIAM NITZE	108126
RAY SQUITIERI	108129

THE WESTIN CHOSUN HOTEL IS LOCATED AT 87, SOKONG-DONG, CHOONG-KU; TEL: 822-771-0500; FAX: 822-752-1443.

SECURITY THREAT ASSESSMENT:
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5. THE POLITICAL SITUATION IN KOREA IS STABLE, AND AT PRESENT, THERE IS NO LOCALLY KNOWN TERRORIST THREAT TARGETING US CITIZENS VISITING THE REPUBLIC OF KOREA (ROK). HOWEVER, AMERICANS IN SEOUL ARE SUBJECT TO WORLD-WIDE THREAT FROM INTERNATIONAL TERRORISTS AS OTHER MAJOR CITIES AND IS FURTHER SUBJECTED TO UNPREDICTABLE ACTIONS BY NORTH KOREA, WHICH IS A KNOWN SUPPORTER OF TERRORISM. DEMONSTRATIONS FREQUENTLY OCCUR IN SEOUL WHICH CAN INCLUDE ANTI-US TONE AND DEMANDS FOR US TROOP REMOVAL, IT IS ADVISED TO AVOID LARGE GATHERINGS OR CROWDS. ALTHOUGH DEMONSTRATIONS ARE MOSTLY CONFINED TO CAMPUSES, THEY MAY ALSO OCCUR AT ANY ROK GOVERNMENT LOCATION AND US GOVERNMENT/MILITARY FACILITIES. INTELLIGENCE COLLECTION EFFORTS ARE SOPHISTICATED, PROFESSIONAL AND UNDETECTABLE. ONE MUST ASSUME THAT ALL ROOMS, TELEPHONES, CELLULAR PHONES, AND FAX MACHINES CAN BE MONITORED, ONE SHOULD NOT DISCUSS SENSITIVE OR CLASSIFIED INFORMATION IN UNCONTROLLED AREAS. STREET CRIME CONSISTS OF MOSTLY ROBBERIES AND PICK-POCKETS/PURSE SLASHINGS IN CROWDED AREAS (I.E., BUSES AND SUBWAYS). THESE INCIDENTS ARE NORMALLY NON-VIOLENT IN NATURE. INCIDENTS OF SEXUAL HARASSMENT AND MOLESTATION OF FOREIGN WOMEN HAVE OCCURRED. POLICE ARE CONSIDERED CAPABLE AND WELL-TRAINED. SEOUL METROPOLITAN AUTHORITIES STAFF ENGLISH SPEAKING PERSONNEL 24 HOURS DAILY TO HANDLE LOCAL EMERGENCIES, NUMBERS ARE AS FOLLOWS: 112 POLICE EMERGENCY, 119 FIRE AND AMBULANCE.

CHRISTENSON

Risk of An Inadvertently Stringent Emissions Target for Korea

Premise: The risk of an inadvertently stringent target is an important economic rationale why Korea may not accept an emissions target. Such risk, however, may be substantially mitigated by indexing the target to the future values of economic variables. Although choice of a particular form of indexing could be deferred, a specific illustration of it might work and how it could address the risk may alleviate Korean concerns.

Risk to be characterized in terms of:

- Out-of-sample error in forecasting Korean carbon emissions for 1989 to 1993.
- Standard deviation of out-of-sample forecast errors.
- Likelihood that inadvertent stringency exceeds the break-even emissions target.

Methods to generate risk estimates:

- Data: 43 years of data, 118 countries,
- Variables: carbon emissions, GDP, population, investment, world oil prices
- Model: unit of observation is nonoverlapping 5 year average of emissions,
  - fixed effects regression,
  - GDP effects that vary with 10 levels of development.

Base Case:

- no contemporaneous variables, no lagged emissions.

Other models:

- contemporaneous GDP, population, oil prices
- lagged emissions
- both contemporaneous variables and lagged emissions.

SOUTH KOREA AT A GLANCE

South Korea is the world's 11th largest economy, having grown by 8% annually over the last 15 years. Real GDP growth slowed sharply in the 4th quarter of 1997, however, as Korea found itself caught in the Asian financial crisis. Domestic demand fell sharply, driving down output in most manufacturing sectors. Output has fallen further in 1998, with domestic automakers' sales down 5.5% in the first quarter of 1998. At the same time, unemployment was rising quickly, prices were rising, and real wages falling. World trade is expected to slow from 9.7% annual growth in 1997 to 7.2% in 1998 and 1999; this will weaken external demand for Korean products. On balance, over the next 5 years, Korean gdp growth is expected to grow only about 3.2% annually, half the 7.2% annual rate of the 5 previous years.

	1997	1998	1999
GDP ($ bn)	448.3	303.8	393.4
GDP per head ($)	9,760	6,650	8,420
GDP ($ bn at PPP)	608.8	611.4	644.1
GDP per head ($ at PPP)	13,250	13,200	13,780
Private consumption ($ bn)	239.6	153.5	200.4
Private consumption per head ($)	5,210	3,310	4,290
Export of goods & services-%change	23.6	2.3	8
Import of goods & services-%change	3.8	-5	10

Economic Indicators

	1993	1994	1995	1996	1997
GDP at market prices (W bn)	267.1	306	352	390	421
Real GDP growth (%)	5.8	8.6	8.7	7.3	5.5
Consumer price inflation (av; %)	4.8	6.2	4.5	4.9	4.5
Population	44.1	44.5	44.9	45.5	45.9
Exports fob ($ bn)	81	93.7	123.2	128.3	138.6
Imports fob ($ bn)	79.1	96.8	127.9	143.6	142.5
Current-account balance ($ bn)	1	-3.9	-8.3	-23.1	-8.6
Reserves excluding gold ($ bn)	20.2	25.6	32.7	34	21.1
Total external debt (a) ($ bn)	63.9	81.5	108.5	137.7	170.5
Debt-service ratio, paid (%)	9.4	6.9	7.3	8.8	11
Exchange rate (av; W:$)	802.7	803.5	771.3	804.5	950

June 12, 1998 W1,394:$1

Economist research service

Quality of Life

With Korea's rapid growth over the last 25 years, its quality-of-life indicators have improved as well. By most measures, Koreans now live better than their counterparts elsewhere in Asia and Australia.

	S. Korea	Asia and Australia
Health		
Infant mortality rate (per 1,000 live births)	9.8	26.6
Food and nutrition		
Food (% of household spending)	26.4	27.2
Consumption of calories (per day)	3268	2775
Protein (grams/day)	85.4	75.7
Meat consumption (kg/year)	39.5	49.5
Milk consumption (litres/year)	20.9	66.6
Coffee & tea consumption (kg/year)	1.5	2.0
Consumer goods		
Cars in use (per 1,000 population)	126.8	123.1
Phones in use (per 1,000 population)	414.7	229.8
Television sets in use (per 1,000 population	323.0	269.4
Retail sales (per 1,000 population)		
Refrigerators	n/a	13.7
Washing machines	35.5	24.4
Dishwashers	0.5	3.8
Videorecorders	27.8	28.1
Housing		
Stock of dwellings (per 1,000 population)	195.3	246.7

Sources: UN Statistical Office; World Bank; FAO; Euromonito national statistics.

Exports in the crisis

With the onset of the regional economic crisis, 1997 Korean export growth slowed to only 5% in dollar terms, although export volume rose at the pre-crisis pace of 16% annually. Korean exporters apparently responded to threats to their market share, especially by the Japanese, by cutting prices, which fell by 7% in 1997.

Exports of selected commodities
Millions

	1996	1997	% change
Apparel & accessories	4,221	4,192	-0.7
Passenger cars	9,089	9,264	1.9
Footwear	1,235	982	-20.5
Textiles & fabrics	8,703	8,864	1.8
Transistors, chips, etc	17,305	19,663	13.6
Iron & steel	4,549	5,041	10.8
Office machines	5,673	6,405	12.9
Telecommunications equipment	4,404	4,572	3.8
Refined petroleum products	3,678	5,099	38.6
Chemical elements & compounds	2,967	3,761	26.8
Television receivers	2,206	1,558	-29.4
Sound equipment, VCRs, etc	1,747	1,293	-26
Radios	530	377	-29
Ships etc	7,127	6,520	-8.5
Household electrical goods	1,909	1,900	-0.5
Textile yarn	1,469	1,753	19.3
Musical instruments & parts	1,451	1,196	-17.6
Rubber tires & tubes	1,549	1,437	-7.2
Electric-power machinery	1,621	1,728	6.6
Power-generating equipment	693	791	14.2
Total incl others	129,715	136,164	5

Source: Bank of Korea, Monthly Statistical Bulletin.

Korea: Export sector

Principal exports 1997(b)	millions
Transistors, semiconductors, etc	19,663
Textiles, fabrics & yarn	10,617
Passenger cars	9,264
Ships & floating structures	6,520
Refined petroleum products	5,099
Total incl others	136,164

Main destinations of exports 1997	% of total
US	15.9
Japan	10.8
China (c)	10.3
Hong Kong	8.6
Singapore	4.3

Main destination of imports 1997	% of total
US	20.7
Japan	19.2
China (c)	6.7
Saudi Arabia	4.9
Australia	4.1

Korea Interagency WG

many ministries involved/concerned
→ task force
import 98% energy, $276/yr
energy cons for env, $, energy security
will sign KP & UN mtg
econ burdens to join Annex I
need interim stage for deving countries - 3rd period not a setback but a forward-looking decision
want close consultation w/ US
should have confidence in measures to address GHG
- too much uncertainty now

CEE

trading → compliance
ancillary benefits

Han Duk-Soo

Concerns

1) GHG emis & energy use & econ growth

Needs

1) accurate statistics - need more preparation
2) growth closely related to GHG emis
   → sustainable growth

want trial period

1990 - 2010 for Annex I → want 20y - horizon as well
→ 2018

in meantime energy prices + energy cons.

Jin-Gyn Oh (KEEI)

1. Over the last eight years since 1991, I have witnessed U.S. leadership in shaping climate negotiation, wether conservative or progressive outcome.
I hope U.S. show same leadership in building basis for global participation. I think support for capacity building in many developing countries, not suprizingly including Korea, is key to that effect. U.S. Country Studies program over the last four years is good successful example. I hope there is a need to maintain half-built capacity in developing world and another phase of that sort would be necessary in showing U.S. efforts and meaningful capacity building.

2. I think climate concern has two different tasks in developing and developed countries. I think how to incorporate climate concern in economic development policies is major challenges in developing world, whereas in developed countries, how to incorporate climate concern in lifestyle and consumption pattern should be key issue.
If climate policy counteract economic development, it will not work.
So, For the developing world, priority should be placed on "No regret policy".
On the ground of historical responsibility, Annex I countries should no push Non Annex I countries beyond no regret potential.

3. I see the world established Common goal.
and the world established common but differentiated responsibility.
What is needed now is shared partnership in research community. It will help to firstly build capacity, secondly identify no regret potential, finally formulate path for sustainable development.

SCENESETTER FOR KOREA: CLIMATE CHANGE

BACKGROUND

The U.S. and the Republic of Korea have a five decade strategic partnership shaped by the Cold War and the Sino-North Korean alliance that overshadowed the growth, prosperity and democratic evolution that made ROK one of the most prosperous economies in Asia. Korea prizes its close relations with the U.S., but given our long-term security relationship, many Korean officials find it difficult to comprehend the U.S. 21st century global agenda -- especially in areas like Climate Change. Moreover, the recent financial crisis has added to Korea's evident sense of "diplomatic insecurity" and a degree of resentment about being pushed to take steps that are not in Korea's economic interest. Importantly, too, Korea's decision to join the OECD is not universally popular at home as some believe Korea was aspiring to a level of global responsibility that it is unprepared to assume. Our goal should be to reassure Korea that we recognize such decisions vis-a-vis Kyoto require careful analysis of the economic implications. The good news is that many Korean economic officials have Ph.d.'s from U.S. universities, so you can have a technical conversation with them. But they may want to move slowly and cautiously.

In Korea's case you want to offer reassurance and welcome the chance to begin a dialogue on the potential of the flexibility mechanisms.

- Clearly we understand the priority you are placing on the current economic situation. Given U.S. leadership in the Asian financial crisis, there can be no question about the priority we also place on economic and political stability in the region and Korea, in particular.
- From our perspective, however, we can take this difficult period as an opportunity to build U.S. Korean cooperation in many areas that will contribute to future stability and prosperity in the region. We certainly believe Climate Change is among the areas where long-term U.S. Korean cooperation will be important.
- Given Korea's emphasis on attracting FDI, I would like to explore with you the possibility of including incentives for energy efficient and other environmentally friendly technologies in your economic programs. Moreover, I would like to discuss the role of energy efficient technology in your broader technology strategy, including opportunities for "leapfrogging" through development and export of energy efficient products.
- We hope to have a descriptive discussion of the economic implications of addressing Climate Change. We realize the necessary global action must be taken within a framework that protects economic growth while we seek longer term environmental benefits.
- We would like to discuss the role of energy efficient technology in your broader technology strategy, including opportunities for leapfrogging through development and export of energy efficient products.
- We know you have given much thought to Korea's economic growth and energy requirements in the next century and would welcome a discussion of how you see long term trends.
- My role in the Administration is to advise on both short and long term economic implications of policy actions. I would welcome the opportunity to share with you our approach to this issue.
- We see this as the beginning of an extended dialogue. We do not believe decisions can be made quickly, but we hope to lay a foundation for building a global partnership for action on Climate Change. OECD countries have capacity, technology, and research infrastructure to contribute much to the solution of the problem.