## K-2 Study on Policy & Legal Aspect of International Institution under the Kyoto Protocol for Climate Change Mitigation (Abstract of the Final Report)

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1. Introduction

The Kyoto Protocol, adopted in 1997, aims to limit greenhouse gas (GHG) emissions from Annex I countries (industrialized countries and countries whose economy is in transition to market economy, such as Russia and Central & East European Countries) in years between 2008-2012. At the same time, various institutions such as Kyoto mechanisms and compliance procedure were incorporated in the Protocol. Not only emission but certain sequestration activities by forest could be included in calculation of national emissions. Thus, an Annex I country that faces an emission reduction target has several different options under the Kyoto Protocol. First, it can achieve target by reducing emission of greenhouse gases. Second, it can increase forest to increase sequestration. Three, it can use Kyoto mechanism and purchase emission permit. The fourth option is to emit more than its target and face compliance. Last, and perhaps the least option is to walk away from the Kyoto Protocol.

Choices of options will be determined not only by the cost of option but also by other political & social factors. Choice of options, on the other hand, will influence future international negotiation for emissions beyond the year 2013, as well as for emissions from developing countries. It is thus important to study key Annex I countries on their decisions on, and responses to the Kyoto Protocol.

2. Research Objective

Objective of this research project is to find how Annex I countries respond to various aspects of the Kyoto Protocol. For this objective, this study analyzes international institutions that are incorporated in the Kyoto Protocol from policy-relevant aspects. International institutions that are referred to are, emission limitation targets, Kyoto mechanisms, methods to include sinks (sequestration & emissions by forests and land), and compliance procedure.

3. Brief description of method and outcome of research

Each sub-group deals with one or more international institutions that are set up in the Kyoto Protocol, and studies Annex I countries responses and how effective these institutions are from various aspects.

- Subgroup 1 looks into domestic factors concerning decision-making of Japan, the U.S. and the EU from political, economic, and legal aspect.
- Subgroup 2 focuses on emission reduction methods that are plausible in the three countries/regions mentioned above concerning land-use chance in agricultural sector.
- Subgroup 3 focuses on capacity of sequestration of $CO_2$ by forests in Annex I countries.

- Subgroup 4 develops models on emission trading and simulates trading of emission permits among Annex I countries.
- Subgroup 5 studies how clean development mechanism (CDM) could trigger technology transfer from developed to developing countries.

(1) Subgroup 1 looked into Japan, the U.S. and the EU on their domestic decision-making concerning international institutions that were set up under the Kyoto Protocol and decisions made at COP7 which was finalized as Marrakesh Accord. It also dealt with some major institutions such as emission trading and compliance procedure and studied their key features at international level.

1) Emission limitation and reduction target: Emission limitation commitment in the Kyoto Protocol was a result of hard negotiation, and it was agreed without agreeing to any specific burden-sharing rules. It was considered as a set of ambitious targets to achieve if it was to be achieved only by emission reductions, but it was actually watered down with other options such as use of Kyoto mechanisms and counting on sinks under Article 3.3 & 4. Even that was considered as economic disruption in the U.S., and the U.S. moved away from the Kyoto Protocol in 2001. The EU and Japan ratified the Kyoto Protocol in 2002 and has started to implement domestic laws necessary to achieve the target. Setting emission targets seems to be an approach that is difficult for the U.S. to agree to, but not so difficult for other Annex I countries.

2) International emission trading: Emission trading scheme under the Kyoto Protocol became one of major institutions under the Kyoto Protocol that attracted countries' attention during and after the negotiation. Most countries, if not all, show positive reaction towards setting up international emission trading rules. Even the U.S. is interested in the emission trading, and many American researchers consider the full trading type of commitment may able to bring back the U.S.. EU was not supportive of emission trading until COP3, but it changed its attitude thereafter. It has started to establish its own emission trading at the EU level. Japan is also considering the best way to harmonize domestic climate policy with international emission trading.

3) Counting sequestration under Article 3.3 & 4 was a controversial issue at COP3 and thereafter. Even though the concept of inclusion of sinks were agreed at COP3, the consequence of this agreement made tremendous difference in the level of emission target according to how the sequestration is actually counted. This thus became a controversial issue, and will remain a controversial issue in the next round of negotiation. The U.S. moved away from the Kyoto Protocol although it had a chance to gain much by Article 3.3 &4. The reason for not doing so was the U.S., or more precisely the Senate and the Bush administration, had no political intention to support Kyoto Protocol as a whole. The EU insisted little on this issue, as the situation differed among each member state. Japan was one of few countries that made effort to be able to count much on sinks.

Compliance procedure: Two different types of compliance procedure were agreed in the Marrakesh accord, namely facilitative and compliance procedures. Especially for the latter, a punitive type of consequence was agreed for non-compliance of emission limitation targets. Such procedure is a unique one when compared with other existing multilateral environmental agreements (MEAs). It is expected to be an effective procedure, and we will need to wait for another several years until the effectiveness is observed. The U.S. considered consequence of non-compliance of emission target as significant, as emission trading may not work without it. The EU also considered it important but for environmental reasons. Japan did not support punitive consequence, saying such procedure may lead to difficulty in ratifying the Kyoto Protocol.

Although there are various factors that influence each country's decisions on the Kyoto

Protocol and its international institutions, one of the most fundamental factors is country's political system. The U.S.'s political system that is stemmed around check & balance relation between the White House and the Capitol Hill makes it more difficult than otherwise for the U.S. to ratify the Kyoto Protocol. Emission trading may be a key for the U.S. to accept the Kyoto Protocol. It would have been, however, more effective if the target itself was based on marginal cost rather than amount of emission reduction.

Position of the EU and its member states strongly reflected its domestic policy-making and policy integration within the EU. The Netherlands sought for leadership and advocated ambitious emission reduction target, but emission from the Netherlands has been increasing and it is now depending on Kyoto mechanism. Emission trading at EU level can be seen as one opportunity for the EU to get more integration. Japan's policy making used to be made exclusively within relevant governmental officials, and thus Japanese position was almost always reactive. In the last decade, however, Japanese non-government sub actors started to participate in Japanese policy making. Japan started to make more proactive reaction towards the issue.

(2) Subgroup 2 refined a model that evaluates agricultural policies that may also contribute as climate policy.

Relationship between global warming and terrestrial ecosystem such as cropland, forest and so on is very important for consideration of environmental problems. Though it is afraid that the terrestrial ecosystem exceeds a limit of the adaptation and deteriorates when rapid global warming progresses, it is thought that the whole of the terrestrial ecosystem may be a sink of carbon dioxide at present. In Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC), it was agreed that only the artificial activities which aimed at increase in carbon to the cropland can add up that one for the absorption to the amount of reduction.

The expansion activities of an artificial sink were recognized to attain a goal for numerical value of discharge reduction in each country in Kyoto Protocol. In the reopening meeting of COP6 that it is held in Bonn, Germany in July, 2001, it is also agreed that amount of absorption, which was carried out after 1990 as additional human activity by the farming area control and so on, can be added up to the amount of reduction. But, the interpretation of the protocol related to the absorption source, especially farming area, is not cleared. It is a subject still to examine internationally what kind of absorption source activities are recognized, how a change in the amount of carbon accumulation should be evaluated.

So far discharge repression and absorption expansion of the greenhouse gas from the cropland have been discussed in UNFCCC. In this research we estimate impact of the activities on greenhouse gas exchange in cropland soil with using a mathematical model, discuss what kind of difference on the impact among Japan, USA and EU, and what kind of strategy these countries and region shall take.

We use Rothamstead carbon cycle model[1)] and IPCC model[2)] as mathematical models. Activities which we investigate are show as follows.

| | Model | Activities |
|---|---|---|
| $CO_2$ | Rothamstead carbon cycle model | 1) Increase of crop residual<br>2) Increase of organic fertilizer input<br>3) Increase of no tillage area |
| $N_2O$ | IPCC model | 4) Increase of chemical fertilizer efficiency<br>5) Improvement of animal waste management system |

- Results

Figure 1 shows absorption amount in cropland soil when activity on carbon dioxide adsorption is carried out and Figure 2 shows absorption amount in cropland soil when activity on nitrous oxide adsorption is carried out. Table 2 shows change of nitrous oxide discharge by activity 2).

From Figure 1, most effective activities on carbon dioxide is the activity to increase input of crop residual to cropland. Increase of soil carbon amount by the activities depends on cropland area. From Table 2, nitrous oxide discharge by fertilizer input is smaller than carbon dioxide fixation. We investigate two activities for on nitrous oxide in from agriculture and livestock. In high efficiency of nitrogen fertilizer Japan has advantage than USA and EU. In improvement of animal waste management system, USA and EU have advantage.

Figure 3 shows the ratio of absorption amount in cropland soil when activity on carbon dioxide adsorption is carried out to target of carbon dioxide reduction. Figure 4 shows the ratio of absorption amount in cropland soil when activity on nitrous oxide adsorption is carried out to target of carbon dioxide reduction. The ratio of reduction by activities to target amount is not proportion to increase of soil carbon. When some activities are carried out to cropland soil, EU has advantage on carbon dioxide and USA has advantage on nitrous oxide.

The results show that greenhouse behavior depends on country, region, soil, climate and crop. Country which has large cropland area or a log of livestock has advantage in accounting amount of greenhouse gas reduction by activities. Then Japan does not need to put to account the activities in cropland as absorption countermeasure.

(3) Subgroup 3 examines and compares the approach of the governments of Japan, Canada and the European Union (EU) with respect to carbon sinks for meeting their respective Kyoto Protocol (KP) carbon reduction targets. The study examines forest resources of each country to stimulate the government policies to utilize the forest sector to achieve KP carbon reduction targets. The measures to be adopted on KP in the forest sector are carbon sequestration by promoting afforestation/ reforestation and deforestation (ARD) and forest management under Articles 3.3 and 3.4 of the KP. It was clear that only several countries among Umbrella group expect the significant role of sinks in meeting the Kyoto targets could be much larger than their carbon reduction targets in spite of all EU countries can not expect forests as carbon sinks measures so much.

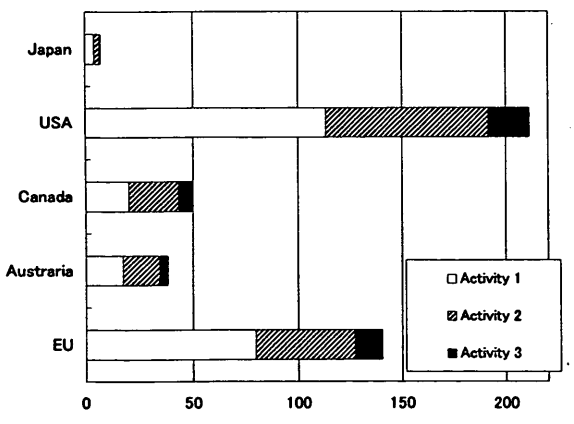


Figure 1 Carbon dioxide adsorption when activities are carried out ($10^3$tC)

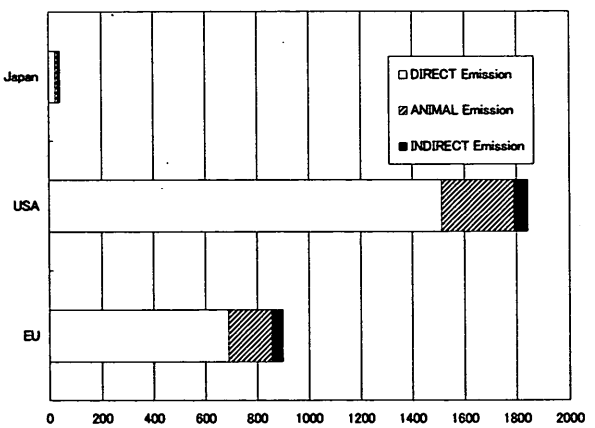


Figure 2 Nitrous oxide adsorption when activities are carried out ($10^6$tC)

Table 1 Nitrous oxide discharge with caying out activity 2

| Nitrous oxide discharge | | |
|---|---|---|
| | $N_2O$-t | Mt $CO_2$ Eq |
| Japan | 558 | 0.17 |
| USA | 17,924 | 5.56 |
| Canada | 4,513 | 1.40 |
| Australia | 3,564 | 1.10 |
| EU | 10,629 | 3.3 |

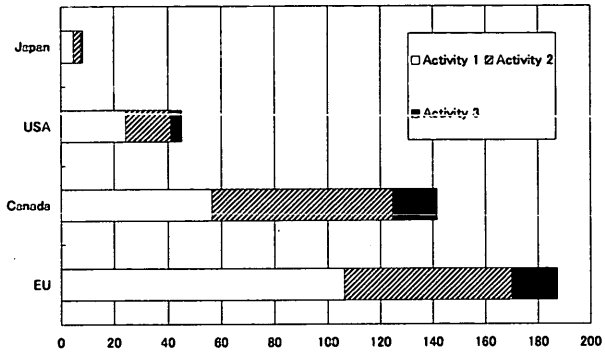


Figure 3 Ratio of carbon dioxide absorption to target reduction(%)

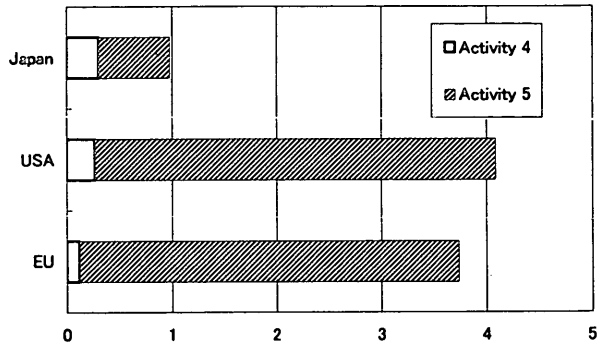


Figure 4 Ratio of nitrous oxide absorption to target reduction(%)

Positive countries to utilize sinks measures insist that afforestation/reforestation and forest management are implemented reasonably and well established techniques. On the other hand, negative countries to adopt sinks measures to clear emission reduction express that an original goal for a GHG reduction target becomes a bone cutout through forest management as sinks.

According to the world forest resource assessment compiled by FAO, forested are of total EU is 1/9 of Russian forest area, 1/3 comparing to US forested area and only a half of Canadian forest area. Such unbalanced forest area by countries means some countries have big advantages by KP Article 3.3 and 3.4 and other countries get only a relatively small portion of share. If such kind of unfairness measures would be introduced into an international negotiation like a KP, it was difficult their negotiations reach an agreement point.

Also timber-exporting countries want to harvest much timber than timber importing countries. Then there is another difference between timber exporting countries and timber importing countries. It is desirable that we should bring the plan which assures fairness among countries to discuss new rules for the second commitment period of KP.

(4) Sub group 4 deals with international emission trading. The research was organized into two distinctive studies.

1) Agent-based simulation and the results

Toward the achievement of numerical target in the first commitment period implementation of emission reduction measures becomes urgent matter. So far, the agent-based simulation has been applied mainly to the analysis of economic phenomenon as a complex system, but agent-based approach is also potentially a very effective tool for designing the international regime such as the Kyoto Protocol. We considered the agent-based simulations, web-based gaming simulations, and game theoretical analysis for the international greenhouse gas (GHG) emissions trading.

This research develops an agent-based simulation framework and created 12 Nation agents; 6 are Annex I countries who are assigned reduction targets in the level of emissions in 1990, and 6 are Non Annex I countries who are not assigned targets for reduction as in the CERT model[3]. We consider dynamic market development through the first commitment period 2008-2012. In each trading year, the COP agent sends Request for Bid (RFB) messages to all nations that have an asking price. Upon receiving the RFB message, a Nation agent examines the asking price and his Marginal Abatement Cost (MAC) to decide the amount of the domestic reduction. Then he sends back a Bid message to the COP agent which says how much he wants to buy or to sell at the asked price. After repeating this RFB-BID process, the COP model will find the equilibrium price where the demand and the supply balance. Thus, the equilibrium price for each year is determined when the MAC functions and the assigned reductions of all of the participants are given. For the multiple trading periods, we considered a partition of the assigned reduction as a strategy of agents.

Gaming simulations with human players in an environment similar to the agents' environment are expected to help us in constructing plausible behavior models and extracting the essential dynamics. We implemented a remote accessing in the framework which enables human players to collaborate with software agents, and constructed a Web application for a gaming simulation modeling international emissions trading.

We performed preliminary gaming experiments on June, 2002. We assigned 5 Annex I countries without USA to 5 pairs of players. At first, we tried the Walras trading. Then, we executed the Double Auction (DA). Reference costs to compare the relative performance of the game results are obtained by the simulation with software agents at Walrasian equilibrium price.

Through these experiments, all nations achieved the assigned reduction target, though FSU at DA (5 years) only over-achieved the target and left much of their credit up to 375 MtC unsold, and FSU and EET who act as sellers showed good performance due to high prices.

2) Concluding Remarks

We considered a dynamical simulation for the international GHG emissions trading with our agent-based simulation framework. Furthermore, we developed a Web application for the gaming simulation of the emissions trading which works along with the agent system through network to study realistic human behavior. We are expecting that such an agent-based approach which utilizes gaming simulation together with the computational simulation and analysis helps us to construct improved heterogeneous behavior models and to propose more stable and low-cost trading process for the Kyoto Protocol.

3) Gaming simulation

We conducted experiments on greenhouse gases emissions trading using human subjects. Our attention is liability of emissions permits. There are two types of liability in emissions trading among countries: liability of trading among countries and liability to the Kyoto Protocol. Regardless the status of reduction in a seller country, she must provide

emissions permits following the contract, which is called "seller's liability" system. On the other hand, a buyer country might not be able to receive all emissions permits based upon the contract depending on the status of seller countries, which is called "buyer's liability" system. No detailed analysis has been conducted on buyer's liability system so far. In our experiment, we designed two types of buyer's liability system depending on the order of liability. The "country-first" liability system is that trading liability among countries has its priority and "Kyoto-first" liability system is that the promise in the Kyoto Protocol has its priority. In seller's liability sessions, we found two cases: the success case and the bubble case. In buyer's liability sessions, we found new cases called the intentional bankruptcy case under Kyoto-first, and the anti-bubble case under country-first and Kyoto-first.

(5) Sub group 5 studied how the CDM could trigger technology transfer from developed to developing countries. First, problems related to technology transfer in general are discussed. Then, by studying Japanese policy-making process concerning ODA and other assistances, this study developed a Japan model to stimulate CDM.

This model is based on the Dutch model that utilized CDM's underlying possibility. In case of Japan where consensus is highly respected, a CDM committee should be established where relevant ministries gather. It should coordinate with International Cooperation Bank and other funding should come from industries that are interested in purchasing emission permits. On the other hand, information on CDM should be well acknowledged in developing countries.

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