

論文 (Original Article)

The Operationalization of the Kyoto Protocol with a Focus on Sinks : A Perspective for Japan

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Abstract

This report examines the outcome of the 6th meeting of the Committee of Parties (COP6) with respect to issues of Joint Implementation (JI) and the Clean Development Mechanism (CDM). This report also examines the International Panel on Climate Changes' recent *Special Report on Land Use, Land use Change and Forestry* and its *Third Assessment Report (TAR)* and other recent literature related to the carbon sinks potential and some of their policy implications for Japan are developed. Due to the Bush administration's decision that the U.S. will not continue to participate in the Kyoto Protocol (KP), this report now also includes a focus on recent relevant political events.

As developed in the report, the viability of biological carbon sinks, and particularly forests, has been well established in the literature. Sinks have the potential to have significant impacts on atmospheric carbon, especially in the relatively near term, e.g., over the next 50 years. With a diminished emphasis, at least in the U.S., on capping carbon emissions related to fossil fuel energy, sinks could become an even more critical component of any future climate policy.

In such an environment, what is a sensible sink strategy for Japan? The general conclusions of the TAR suggest that the global warming issue will continue to be important in the global community regardless of any single U.S. administration or, indeed, the fate of the KP. Despite recent negotiation difficulties, the long-term appropriateness of sink strategy for Japan seems clear. Forests are a major part of the Japanese landscape. Many Japanese forests are relatively young providing Japan with an opportunity for domestic sinks of carbon into the future. Additionally, the potential for forest carbon offsets outside of Japan is great and includes China, eastern Russia, Australia and parts of Southeast Asia. Variants of the JI and the CDM offer substantial potential for Japanese initiated forest carbon sequestration in these regions. Such activities are likely to be consistent with Japan's desire to maintain an economic and political presence in the various regions.

Key words: Kyoto Protocol, carbon sinks, Operationalization for Carbon Sinks

I. Background

A major purpose of this report initially was to examine the outcome of the 6th meeting of the Committee of Parties (COP6) with respect to its clarification of some of the more ambiguous elements of the Kyoto Protocol (KP). Consistent with this charge, this report includes a discussion of the findings of the Third Assessment Report (TAR) with respect to sinks and provides a brief review of some aspects and implications of the International Panel on Climate Change (IPCC) *Special Report on Land Use, Land Use Change and Forestry (LULUCF)*. It also reports on some recent research with respect to sinks, including estimates of the global potential for forest carbon sink capabilities by region. Additionally, it reviews some issues related to Joint Implementation (JI) and particularly the Clean Development Mechanism (CDM) in the light of recent events including a discussion of the

emerging role of emissions trading as it relates to carbon dioxide.

However, given the failure of COP6 in The Hague¹, and particularly its failure to provide clarification to Articles 3.3 and 3.4 of the Kyoto Protocol, this report could not examine its implications. The COP6 Part II meeting in Bonn, however, sought successfully to reach a political agreement aimed at setting the operational framework for the first commitment period on reducing emissions of Green House Gas (GHG) under the Kyoto Protocol. LULUCF was one of the important issues negotiated to eliminate the differences among Annex I countries and the Parties of Kyoto Protocol agreed on the operational rules of LULUC activities of Article 3.3 and 3.4 for the first commitment period.

Nevertheless, the withdrawal of the U.S. from the Kyoto Protocol after the meeting at The Hague raises questions as to the entire future of this process and as to

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1 It should be noted that the Bonn meeting in July 2001 was treated as a continuation of COP6.

the future of climate change negotiations generally. Hence, this report now includes a focus on recent relevant political events, new carbon sequestration research and other activities related to the potential of sinks in mitigating atmospheric carbon. Finally, as called for in the original contract, this report provides an assessment and quantitative evaluation of the opportunities to Japan to meet the emission reduction targets by sink activities and also to provide a strategic overview of important considerations for a country with Japan's particular circumstances, resources and needs. As the negotiations of COP6 Part II in Bonn placed priority on reaching a political agreement, the results do not clearly reflect the situation related to forest carbon sink capacities of each country. Thus this report must focus on the process and results of COP6 in The Hague in order to understand the differences of forest carbon sink capabilities among Annex I countries.

II. Background and Introduction

In 1997 the Japanese Government hosted the meetings that led to the creation of the Kyoto Protocol (KP). Although the Protocol was signed, it has yet to be ratified by most industrialized nations and many of the rules and details for the implementation of the Protocol are still under discussion. These ambiguities reflect the lack of clear definitions for many of the terms and concepts used in the Protocol. When the proposal for this report was developed in fall 2000, the COP6 was scheduled to meet in November in The Hague to resolve some of the definitions and ambiguities that were found in the Protocol.

There was some reason for optimism that these issues could be resolved in that many of the important issues involved biological sinks and COP6 had at its disposal the recently completed *Special Report on Land Use, Land Use Change and Forestry* (LULUCF). The Special Report had been commissioned from the Intergovernmental Panel on Climate Change (IPCC) by the COP to help clarify some of the implications of different definitions and interpretation of the ambiguities of the KP. An important charge given to the IPCC was to develop more fully the implications of some of the various alternative definitions.

With this document in hand it was believed that the COP was likely to make some progress to clarifying the Protocol. However, even with the definitions of the

Kyoto Protocol somewhat clarified and resolved, ambiguities and uncertainties persist. Given the clarified definitions and programs, questions exist for the various countries as with which mix of programs and approaches are optimal for that particular country. Furthermore, decisions remained to be made as to the role that agricultural and forestry management would be allowed to play as a carbon sink. Thus, despite a degree of clarification, vagueness and uncertainty have continued and collective decisions by the parties are required for a workable Protocol.

As is well known, the Hague meeting was unable to resolve many of the serious issues and an agreement was not reached. At The Hague, some countries did not get as large a cap as might be justified by Article 3.4 and their respective activities. On the other hand, other countries realized a large cap through Article 3.4 activities.²

Perhaps the most contentious issue over sinks at The Hague was found in the question of the degree to which carbon sequestered as the result of forest and agricultural management could be used against country targets. The possibility of biological sink management had been raised in Article 3.4, but never fully accepted nor had the various details been adequately addressed. Generally, Japan was allied with the U.S., Canada, Australia and some other countries. Japan, together with the U.S. and Canada, presented a proposal for the phase-in of forest management under Article 3.4 of the KP (additional activities), stressing that it provided incentives to implement additional sequestration activities (*Earth Negotiations Bulletin* 2000). The three countries also supported a decision on Article 3.3 (afforestation, reforestation, deforestation) and 3.4 as a package.

In general, the European Union (EU) resisted the idea of carbon sinks from managed forests. The U.S. position, spelled out in a memo dated August 5, 2000, maintained that U.S. managed forests accumulated about 300 million tones of carbon annually, or about 50 percent of targeted reduction called for in the KP. The U.S. asked for some credit for this. In the final negotiations the U.S. asked for about 50 million tones of carbon credit toward meeting its KP targets. This number was not accepted by the Europeans.³

A subsequent meeting, focusing on sinks was held in Ottawa in December 2000, attempted to complete an agreement before the end of the Clinton administration,

2 Japan is one of these countries, because land use, land use change and forestry activities are fundamental to satisfy its target of emission reduction of GHG under the Kyoto Protocol.

3 One could argue that much carbon sequestered through forest growth, even when managed, would be sequestered independent of the KP and so ought not to be eligible for carbon credits. However, the Europeans are receiving carbon credit for the conversion of British energy production to natural gas from coal and for the renovation of the eastern German industrial base to more a modern, more efficient less emitting technology, both of which actions would have occurred independently of the KP. Additionally, Russia would receive credit for "hot air" which does not involve Kyoto relevant reductions.

but it was not successful.

A decision was made at The Hague not to terminate COP6, but rather to continue the discussions in Bonn, and a meeting was held in July 2001. In the intervening period the U.S. withdrew as an active participation from the KP and thus was not involved in the subsequent Bonn negotiations.

Negotiations in Bonn in July 2001, COP6 Part II, achieved a considerable measure of success. In spite of the differences between European countries and Canada, Japan, Australia and other countries, a LULUCF operational frame was come to agreement principally to bring Kyoto Protocol to life in Bonn. This was owing to European compromise, which was pushed by US withdrawn from Kyoto Protocol. Although core operational rules were agreed at COP6 Part II, there are still many ambiguities in LULUCF and it is too early to evaluate fully the effects of sinks for each country.

Although sinks are often given as the reason that the negotiations failed at The Hague, many had believed the problems were much broader. Victor (2001) especially points to the problems and differences in attitudes between Europe and America on trading and the difficulties in starting up a workable process. At The Hague, there were a number of serious substantive obstacles that contributed to the meeting's failure. Anderson (2001) identifies four key issue areas involving obstacles: transfers of technology to the developing world, sinks, mechanisms, including the trading of emission permits, and compliance. The Kyoto text makes no provisions for compliance enforcement. Anderson argues that although the differences on sinks were important, other issues were far from resolved and would, in themselves, have precluded any agreement at The Hague.

Additionally, the timing of the meeting turned out to be extremely poor. First, the U.S. was represented by a delegation from the outgoing Clinton Administration and it was not clear whether the successor would be the Democrat, Vice President Al Gore, or the Republican, George W. Bush. Thus, there was uncertainty as to the nature and depth of the commitment that would be associated with any American agreement. Second, the approach of the U.S. and some other countries, which would rely heavily on carbon sinks and trading, was opposed by many, especially in Europe, as being not sufficiently onerous. Under an arrangement whereby the U.S. could meet a large portion of its targeted emissions reduction commitments from biological sinks and the prospects for Europe were limited,⁴ one might

argue that the competitive position of the U.S. vis-a-vis the EU would be enhanced. In this situation adjustments required by the U.S. energy sector would be lessened while those of the EU energy sector would be relatively large. In fact, the Canadian environmental minister said, "Europe adopted a position they knew would force the United States to pull out" (Stavins 2001).

Additionally, some elements in the extreme environmentalist community appeared to believe that the process of addressing climate change should be painful to the economy. Thus, even if forest and biological sequestration are the most efficient, least-cost approach, the consequences in terms of changing country comparative advantages in industrial production might give some to oppose such an approach.

Finally, many countries in Europe had just experienced protests associated with rising energy prices. Under such circumstances we can surmise that it would have been politically difficult for the Europeans to accept a carbon strategy that would stress energy conservation and result in increased energy prices. Thus, some have argued, the Europeans were unwilling to agree on sinks, since this put them at a competitive disadvantage, while at the same time they were unable to make an agreement that involved serious energy requirements, since their domestic political climate was hostile to more severe energy constraints.

The problems associated with the failure at The Hague were compounded by a number of additional events in 2001. One was the nearing of completion of the IPCC Third Assessment Report (TAR). Although the report will not be officially released until fall 2001, it tends to support the view that the evidence for warming is becoming more compelling thereby increasing the pressures for some definitive actions. Furthermore, the TAR concludes that sinks have the potential to be a significant tool in atmospheric carbon mitigation reduction, although clearly they would function in a secondary support role to more fundamental efforts to reduce fossil fuel emissions. The second set of events, and clearly the most important, are the changes generated and implied by the recent action of the newly elected Bush administration. These include, firstly, the decision to abandon efforts to reduce carbon dioxide emissions through the imposition of "caps" in the energy sector and focus instead on an energy policy to increase energy development and production capacity. Secondly, are the recent statements by the Bush Administration essentially abandoning the targets of the Kyoto Protocol. Although abandoning the Kyoto Protocol, the Bush

4 A recent study (Sedjo et al. 2001) suggests that the potential for sequestration of carbon through forestry is substantially larger in North America than in the EU. This study is discussed later in this report.

Administration appears to be willing to continue participating in the Kyoto Process.⁵ This is reflected in its decision to attend the COP6 Part II meeting in Bonn last July.

Although in many respects this reorientation by the U.S., if it persists, bodes poorly for the near-term chances of achieving an international consensus on energy policy, it could also enhance considerably the likely role of biological and forest sink policy in addressing the global warming issue. It has often been argued that sinks are among the low-cost approaches to addressing carbon dioxide build-up in the atmosphere. This general perspective has been supported in the IPCC *Special Report on Land Use, Land Use Change and Forestry* (LULUCF), which suggested that there is substantial potential for biological sinks, including forestry, to capture large volumes of carbon. The *Special Report* includes estimates of additional carbon that could be captured in agricultural soils through appropriate agricultural practices. This general finding was also supported by the findings of the TAR, particularly Chapter 4, of volume III, dealing with biological mitigation, which will be formally released this fall. This chapter argued that biological sinks, and particularly forestry, can be an important vehicle for mitigation of atmospheric carbon. It suggested that up to 100 Gt of carbon could be sequestered by biological sinks over the next 100 years. It estimates that over the next 50 years up to 10-20 percent of human-generated net carbon emissions could be offset.⁶ The chapter cited various studies that indicated that the costs of using forestry to sequester carbon could be modest, especially when compared with other approaches. The chapter was particularly positive about the potential for capturing carbon in tropical and subtropical regions. The chapter further suggested that forestry's greatest potential for sequestering carbon is likely to be found in the first several decades of the 21st century, since the technology of managing and establishing new forests is well developed and society is not dependent on the development of new technologies before carbon sequestration can proceed. Thus, forestry's greatest potential may be in its ability to address the atmospheric carbon problem in the near term thereby "buying time" to allow for more fundamental non-fossil fuel, or carbon-free or controlled energy technologies to develop.

The general proposition that forests can be an important vehicle for controlling atmospheric carbon

was given further credibility by a recent study done for the US Department of Energy (Sedjo et al. 2001). This study examined the potential of global forests to sequester additional increments of carbon in an environment that provided various economic incentives and found that up to 137 Gt of carbon could be sequestered over the next century. Finally, there is the very recent change in the U.S. position on the Kyoto process and its wide-ranging implications.

III. US and EU Comparative Advantage in Carbon Sequestration

One reason for the different attitudes between the EU and the U.S. on the use of forest management carbon sinks is probably the different degree to which this approach can benefit the respective groups. Below, in Table 1, columns 2-4, are estimates of the carbon sequestered⁷ through Article 3.4 for selected countries using data as provided in Pronk (2001). As can be seen, the estimated ability of managed carbon sinks (under Article 3.4) to sequester carbon varies greatly among countries with the U.S. achieving the largest amount of sequestration, both absolutely and as a fraction of its 1990 base. By contrast, the EU as a whole sequesters only a very modest amount of carbon, even though a county like Finland may sequester up to 10 percent of its 1990 base through forest management. Japan sequesters only a modest amount of carbon through forest management, but it is about twice the percentage of its 1990 base emissions that is estimated for the EU (2.9% compared to 1.6%). The large estimates of carbon

Table 1. Carbon Sequestered by Forest Management: Selected Countries

(1)	(2)	(3)	(4)	(5)
Countries	Forest Management (FM)	Base Year	Accounted for by FM (%)	The limit of Article 3.4 in COP6 Part II
Canada	9.11	166.17	5.5	12.00
Finland	2.20	20.51	10.7	0.16
France	2.59	148.96	1.7	0.88
Germany	8.60	330.28	2.6	1.24
Japan	9.79	334.78	2.9	13.00
UK	2.45	208.84	1.8	0.37
USA	288.40	1655.38	17.4	
EU total	18.17	1155.39	1.6	

Source: Pronk, 2001, Annex, table 1 and COP6 Part II.

5 The US will undoubtedly continue to participate in climate change discussions as a participant in the UNFCCC.

6 Interestingly, these results are consistent with the estimates made by the U.K. Royal Academy. The press, however, has tended to interpret negatively such findings.

7 The Pronk document presents a number of different estimates from different sources. In some cases data is missing from certain countries.

sequestered in managed forest sinks in the U.S. reflects the fact that its forest stock is increasing relatively due both to the age distribution of the forest, most of it is relatively young, and due to high levels of forest planting, which have been underway in the past several decades. Most U.S. forests are classified as managed, both private and public, except for forest areas designated as wilderness or parks, and thus could be viewed as falling under Article 3.4.

Column 5 in table 1 presents the country caps of carbon credits under the KP as negotiated in Bonn. Notice that the caps for European countries are all below the estimated capacity as presented in Pronk, while the caps for Japan and Canada are above those limits.

IV. Actions by the Bush Administration

Recent actions of the newly elected Bush Administration may have all but destroyed the KP as a truly global effort. In addition to the recent statements by the Bush Administration essentially abandoning the KP, these actions have included the decision to abandon efforts to reduce carbon dioxide emissions in the energy sector and focus instead on an energy policy to increase energy development and production capacity. However, the Kyoto Protocol has not collapsed following the withdrawal of support by the United States and the EU particularly has been successful in gathering enough support to proceed without the direct participation of the U.S. (e.g. see Waddington 2001). Japan has been targeted as a key participant in that it will be difficult, if not impossible, to have the required representation of developed countries should Japan choose not to participate.

Additionally, even should the KP collapse, which now appears unlikely, concern about climate change will almost certainly continue using other forms and taking other channels. Furthermore, it is now apparent that the U.S. plans to continue its involvement in the Kyoto Process (as opposed to the targets and constraints of the Protocol). Also, the U.S. will undoubtedly continue involvement in climate issues through its participation in the Framework Convention on Climate Change (FCCC). Furthermore, the abandonment of the KP by the U.S. does not imply that the Bush Administration is rejecting the hypothesis that warming is occurring. To the contrary, the administration has affirmed that it takes global climate change very seriously. This position has been strengthened by a recent report, specifically requested by the Administration, from the U.S. National Academy of Sciences, which essentially supports the

findings of the TAR that global warming is a real phenomenon, probably driven importantly by human actions. Rather, the Administration's rejection of the KP probably reflects the Administration view that the KP is fatally flawed because it is politically unacceptable in the U.S. and elsewhere, because it involves an insufficient commitment by the developing world, and because it tends to focus on short-term rather than long-term types of solutions (Stavins 2001, Victor 2001).

Additionally, in this post-Bonn environment the concept of forest sinks offers advantages that are likely to make it important in any successor policy to address climate change. Since President Bush has also moved away from support of caps on carbon dioxide emissions, because of his concerns about energy supply, this could imply that sinks are all the more important particularly in the early phases of any long-term comprehensive carbon mitigation plan.⁸ Another implication of a new look at the climate problem is the likelihood that nuclear energy will once again be considered as a potential major energy source for the future. Finally, there are actions under consideration by the Congress. For example, one Republican senator has introduced legislation under which the U.S. would subsidize, although at a low level of \$2.50 a ton, carbon sinks in other countries. Meanwhile the U.S. will certainly continue its program of Global Warming research and technical development at a substantial level (Washington Post, July 19, 2001).

V. The TAR and the IPCC *Special Report on Land Use, Land Use Change and Forestry*

Chapter 4 of the TAR examines the potential of biological sinks to sequester carbon. The chapter is designed to be a stand-alone piece, independent of the KP. Thus it does not deal directly with the issues, definitions and details of the KP. The conclusions of the chapter are quite optimistic with respect to the potential of sinks, forestry and agricultural soils, to sequester carbon in a useful manner. The chapter concludes that the potential of biological sinks, and especially forestry, is substantial, as high as 100 Gts. over the next 50 years. This includes consideration of a decrease in the rate of deforestation as well as the increase of carbon sequestered in an expanded stock of wood products. Additionally, carbon sequestered by forestry is generally a relatively low-cost choice. The cost range cited in the chapter are from \$0.10 to \$100 per tonne. Furthermore, the question of forest permanence, measurement and monitoring appears to be manageable (Sedjo and Toman 2001). Also, many forest carbon activities generate

8 It may be noteworthy that sinks are receiving increasing coverage in the press, although in many cases the press fails to properly understand the implications of new research (Sedjo et al. 2001a).

positive external effects and often contribute to sustainable development, objectives that are also considered important. Finally, forestry and biological sinks appeared to offer the greatest potential in the next several decades, but can not be relied upon to provide continuing additional carbon sequestration. In summary, chapter 4 of the TAR supports the view that carbon sinks ought to be taken seriously as one of the tools available to the global community to address the GHG problem.

The *Special Report on LULUCF* was specifically designed to address many of the questions, details and implications related to the choice of alternative definitions, as these had not been clarified in the KP. As such the report was designed to help clarify the implications of a number of potential definitions and thus assist in the subsequent resolution of issues by COP6. Of course, most of these issues were not resolved. The *Special Report* did, however, generally take the position that biological sinks could sequester large amounts of carbon both in forests directly, in agricultural soils, pastures, rice paddies and so forth (table 4, p14). Although it did not address directly the question of the magnitude of the potential of forestry to sequester carbon over the longer term of 50 or 100 years, the *Special Report* did make estimates of the potential for carbon sequestration of forests, agricultural soils, and other sinks for shorter periods of time of one decade and in some cases of up to four decades. Additionally, the report estimated that the costs of monitoring carbon sinks would run about US\$1-5 per hectare or about \$0.10-0.50 per tonne (p 16). Other areas of interest are the report's investigation of various selected carbon mitigation projects (e.g. pps. 291-300).

VI. Recent research with respect to sinks, including estimates of the global potential for forest carbon sink capability by region

A recent study (Sedjo et al 2001) traces out the relationship between an intertemporal price path for carbon, as given by carbon shadow prices, and the cumulative carbon sequestered from the initiation of the shadow prices, assumed as 2000, to a selected future year (2010 and 2100).⁹ The report provides estimates of the carbon sequestration potential of forests globally. The research estimates long-term forest cumulative

carbon quasi-supply curves under three different sets of price scenarios. The quasi-supply curves suggest that a policy of gradually increasing carbon prices will generate the least costly supply curves, particularly in the shorter periods of a decade or so. Intuitively, this is probably due to the choice of low-cost projects in the near term. However, over longer periods of time, such as 50 or 100 years, these advantages seem to dissipate as these higher cost projects are undertaken in the face of higher carbon prices.

One of the findings of the study is that the effect of the short-term approach on long-term costs is of some policy relevance. The fixation on short-term targets without consideration of the longer-term objectives can lead to the choice of less cost effective sequestration approaches. This problem could apply to the Kyoto Protocol approach where the targets for 2008-2012 are given independently of any clear knowledge of longer-term targets.

Some of the results of the Sedjo et al (2001) study as they relate to the issues of this current report are presented below. They demonstrate that very recent research, too recent to be included in the TAR, supports the finding of the TAR by indicating that the potential of sinks is relatively large. It should be noted that although the results of this study do not suggest that the entire 100 Gt can be sequestered through forests in the next fifty years, as suggested by the IPCC TAR Report, the total projected carbon sequestration is still substantial. The recent study is focused more narrowly, looking only on forests, whereas the IPCC TAR and *Special Report* looked at a broader set of biological sinks.

Fig.1 compares global carbon stored in forests over the 21st century for the base case, e.g., zero carbon price, and for that of two of the scenarios examined.¹⁰ The total carbon sequestered over the century in the high price scenario (scenario 1, case 2) is estimated at a very substantial 138 Gt., or an average of 1.38 Gt. per year for the century. The figure indicates that in the business-as-usual scenario, e.g., a zero carbon price, the forest carbon stock is projected to fall by about 29 Gt over the 100-year period or roughly a decline of 3.5 percent in total forest carbon. However, that decline can be reversed through policies that treat the forest output as a joint product, timber and carbon, and provide payments

9 For a detailed presentation of this work it is recommended that the reader obtain a copy of the study, which is available on the internet at http://www.rff.org/disc_papers/PDF_files/0119.pdf

10 Scenario 1: There are two cases in scenario 1. In each, the carbon price is set at a given level for year 2000 and increases 2.5 percent annually until year 2150. The first case begins at a carbon shadow price of \$5 per year and increases at an annual rate of 2.5 percent. The second case begins at a carbon price of \$20 per year and also increases at a 2.5 percent rate through 2150.

Scenario 2: The carbon price is set at a given level in year 2000 and held constant indefinitely. Case one sets the carbon price at \$50 per ton. The second case sets the carbon price at \$100 per ton.

Scenario 3: Carbon price level given for year 2000 and increases 2.5 percent annually until it stabilizes in the year 2060. There are three cases beginning with the initial price of carbon at \$5, \$20 and \$50 per ton.

for carbon. Under scenario 1, case 1, it is estimated that total carbon sequestered over the 21st century would be 47.8 Gt higher than in the baseline (Fig.1). This increase above the baseline is equal to 3-9 percent of the anticipated total increase in atmospheric carbon, about 1600 Gt, should the business-as-usual case prevail. Hence, although not overwhelming, the sequestration of forest carbon can make a significant contribution to overall atmospheric carbon mitigation over the next century.

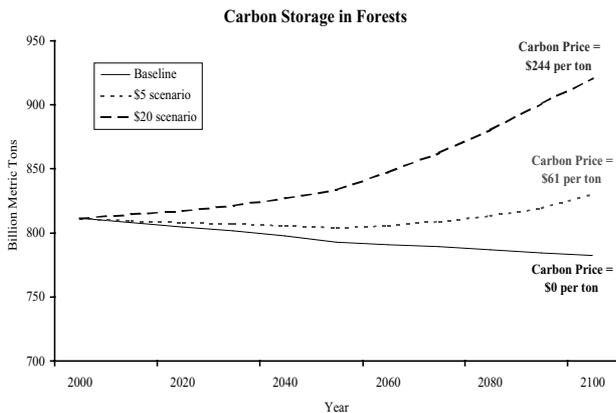


Fig.1. Carbon Storage in Forests Baseline: \$5, \$20 Scenarios

The breakdown by global regions also provides some interesting insights. Fig.2 presents a breakdown of sequestered forest carbon by region for 2010, a period of only one decade. Africa (AF), the Asia/Pacific (AP), South America and the Former Soviet Union (FSU) show the greatest potential. North America (NA) has modest potential while the EU, and Oceania (OC). China (CH) and India (IN) have little.

Over the longer period some of these findings change. Fig.3 presents a breakdown of forest carbon storage by region for 2100 for the high-carbon-price scenario (scenario 1, case 2). By far, most of the carbon sequestration in response to price still occurs in South America, Africa and the Asia-Pacific regions. Much of this is related to a reduction in the rate of deforestation as forest carbon values become large enough to discourage forest conversion to agriculture. In 2010, 60 percent of the storage occurs in these regions, with another 26 in the region of the former Soviet Union. North America accounts for 8 percent, and the European Union only 2 percent. By 2100, the shares of sequestered carbon of South America, Africa and the Asia-Pacific remain roughly the same. However, the carbon share of North America has doubled while that of the former Soviet Union has fallen to roughly one-third of its 2010 share. China and Oceania's potential increase substantially. Over that century the share of the EU increases by 200 percent, albeit from a small base.

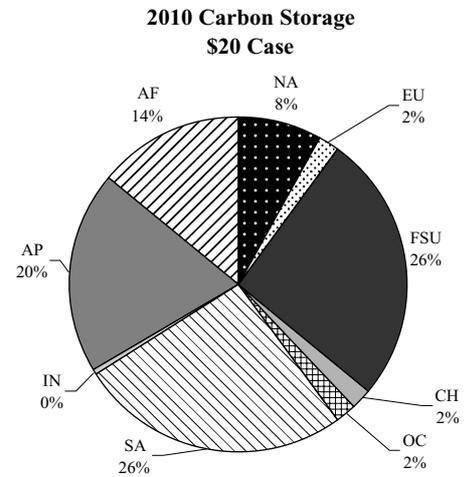


Fig.2. Regional Carbon Storage: High Price (\$20 Scenario) - 2010 Carbon Storage

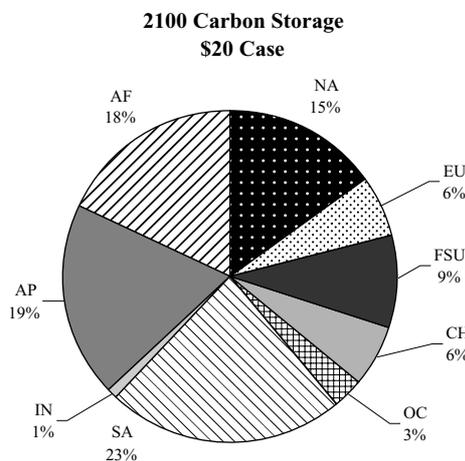


Fig.3. Regional Carbon Storage: High Price (\$20 Scenario) - 2100 Carbon Storage

These findings support the hypothesis that the sinks' potential for Europe is small compared to that of the U.S. Furthermore, they suggest that sinks could be an important vehicle for mitigating carbon releases for many regions of the world.

VII. Some issues related to carbon offsets, Joint Implementation (JI) and the CDM in the light of recent events

Some groups are moving toward undertaking carbon offset credits outside of either the JI or the CDM. In the U.S. for example, the national association of private power utility companies, the Edison Electric Institute, has created a company called Utilitree Carbon Company, the purpose of which is to undertake forestry projects for the principal purpose of obtaining carbon sequestration credits. Similarly, forest trusts are being created in the

state of Oregon to reforest areas, with a principal objective being to create the related carbon credits (Landauer 2001). Also, some insurance companies are offering investments involving both timber and carbon. In Australia, the APT Company is combining planted forests for timber with carbon sequestration rights, which can be marketed separately. The intent is to sell options to the purchase of the carbon rights separately from the timber.¹¹ It is noteworthy that these actions and transactions are occurring outside the framework of the KP, even as the future of the KP is in doubt. This suggests that many believe that atmospheric carbon levels and global warming will continue to be an issue even if the KP fail and actions to hedge against future carbon liabilities and uncertainties are appropriate.

Other actions taken as part of the set of activities covered by JI in the KP include a number of forestry projects (Moura-Costa 2000). These investments tend to be made by investors in countries such as the U.S, Netherlands, the UK, Denmark France, Norway and Australia. Furthermore, organizations are gearing themselves to handle JI and Clean Development Mechanism (CDM) forestry projects. For example, the Forest Absorbing Carbon-Dioxide Emissions (FACE) Foundation in the Netherlands aims to decrease the amount of CO₂ in the atmosphere by afforestation and the management and protection of forests world-wide. In addition to providing consultancy services on the identification, preparation, implementation and monitoring of forest CO₂ projects, the organization will offer to certify the amount of sequestered CO₂. (*Greenhouse Issues* 2001).

VIII. Emerging role of emissions trading as it relates to carbon dioxide

The potential role of emissions trading as it relates to carbon dioxide is under continual discussion. As noted above, this has been one of the more contentious issues with the KP discussions. The discussion relates not only to the energy sector but also to biological sinks such as forests. A host of recent papers have been written on aspects of this topic. A paper out of the Ministry of Environment in Colombia (Blanco and Forner 2001) discusses certified emissions reductions (CERs) as they relate to carbon sequestration. Another paper from the International Institute of Applied Systems Analysis (Obersteiner et al 2001) discusses the problems with some mechanisms and proposes approaches to solve these problems. Additionally, the development of

emissions trading markets is progressing. Michael Butters (2001) describes how the Pilot for Emission Reduction Trading (PERT) has been learning the mechanics of how to conduct reviews and construct an effective trading system. Table 2 gives an idea of the types and volumes of emissions that are beginning to be traded globally through organized emissions markets.

Table 2. Emissions Registration

Type of Emission	Registered or in Progress (metric tonnes)
VOC	43
SO ₂	30,491
NO _x (Ozone)	50,471
NO _x (Non-Ozone)	42,873
CO	17,768,077

Source: *Emissions Trader*, March 2001, page 1

Furthermore, as Mihelic and Wilder (2001) point out, companies and national governments are moving forward in developing mechanisms to reduce GHG emissions. They are "conducting private party-to-party trades of these reductions despite the failure to reach a final agreement on the Kyoto Protocol at COP6 last November." They argue that "where clear emission reductions can be demonstrated, the potential to create tradable units of emissions reduction can prove to be enormous." They acknowledge, however, that current projects should be structured consistent to the framework already agreed upon to maximize the probability that they will conform to any future agreement.

Companies mentioned as involved in early private party-to-party trading of emission reductions include, BP Amoco, Shell, Ontario Power Generation, Trans Alta, Tokyo Electric Power Company and Dupont. They also mention governmental groups such as New South Wales State Forests and the Dutch Government. Although in many cases trading will involve reduced emissions from energy facilities, the presence of an emissions market provides an entry for trading in carbon sequestered through forestry projects.

IX. Conclusions and implications of recent events related to the KP to Japan

With the withdrawal of the U.S. from the KP, the politics and dynamics of the Protocol have been substantially changed. However, as noted, the EU has successfully, thus far, been working toward establishing the Protocol's viability even without U.S. participation. Japan is playing a critical role in deciding what elements

11 It was reported that negotiations were underway whereby a major Japanese petroleum company would purchase an option for over 5 million tones of carbon rights phased in over an 11 year period for a reported price of about A\$1 million. The rights would terminate at harvest in the 11th year.

of Kyoto are to be rescued, and how the world takes its next step to address global warming.

The inability of the COP6 to reach substantive agreement among all the developed countries on a variety of issues, despite numerous delays and supporting reports by the IPCC, demonstrates the complexity of the difficulties within the KP. The initial failure to agree on sinks is only the tip of a host of difficult and so far intractable problems. These include the notion of "meaningful participation" by the larger developing countries, e.g., China and India, which was a prerequisite of the former Clinton Administration for submission of the KP to the U.S. Senate for ratification. Other issues include the extent to which countries can buy emission permits abroad thus including the extent to which the JI and the CDM can be used in the attainment of Kyoto targets and the question of compliance and enforcement. However, the Bush administration's decision that it will not continue to participate in the Kyoto process has ended the first phase of the KP as we have known it. Nevertheless, the administration's acknowledgement of a climate change problem suggests a willingness to continue discussions, perhaps in another venue. Furthermore, the concern in the U.S. about energy availability and its recent decision not to try to limit carbon dioxide emissions suggests the possibility that other approaches may gain ascendancy. One option that may become increasingly important could be that of the role of biological sinks in carbon mitigation. Another energy source that could be reconsidered is nuclear power. A third possibility is the development of low cost technologies for capturing CO₂ released in fossil fuel burning and providing a permanent storage facility, e.g., the oceans or underground.

As this paper demonstrates, the evidence of the viability of biological sinks, and particularly forests, has been well established in the literature as reflected in the TAR and the Special Report. Sinks have the potential to have significant impacts on atmospheric carbon, especially in the relatively near term, e.g., over the next 50 years. With a diminished emphasis on capping carbon emissions related to fossil fuel energy, sinks are likely to become a more critical component of any future climate policy. In addition, the evidence suggests that some regions, e.g. the U.S., have a comparative advantage in biological sinks vis a vis other regions, the EU, especially in the nearer term.

In such an environment, what is a sensible sink strategy for Japan? The general conclusions of the TAR suggest that the global warming issue will continue to be important with the global community regardless of any single U.S. administration or, indeed, the fate of the KP. Despite the resistance of Europeans and some others, it

is now more difficult than ever to envisage an international agreement that does not have a major role for biological sinks and sink sequestration. This is reflected in the agreements, despite the ambiguities, that have emerged from Bonn.

Additionally, there is likely a future role for carbon offsets trading, both within individual countries and internationally. Thus, activities to promote carbon sequestration are likely to continue, if not as part of the KP, then as part of a likely successor arrangement. A period of indecision, such as we may now be entering, provides a time to rethink strategies. A hiatus in the negotiations process can provide a period for a careful assessment and quantitative evaluation of the opportunities available to Japan to meet the emission reduction objectives by sink activities. Furthermore a break in negotiations can provide an opportunity to provide a fresh strategic overview of important considerations for a country with Japan's particular circumstances, resources and needs.

Despite all of these changes, the long-term appropriateness of sink strategy for Japan seems clear. Forests are a major part of the Japanese landscape. Many of these forests are relatively young and Japan has a number of domestic opportunities to sequester carbon into the future. It appears likely that Japan's potential for carbon sequestration through forestry is larger than recognized in the documents commonly used, e.g. Pronk (2001). Furthermore, forest management can substantially enhance the sequestration abilities of forests. The potential for forest carbon offsets outside of Japan is great and includes China, eastern Russia, Australia and parts of Southeast Asia. Variants of the JI and the CDM offer substantial potential for Japanese initiated forest carbon sequestration in these regions, particularly in the context of trading regimes that are likely to emerge. Additionally, such activities are likely to be consistent with Japan's desire to maintain an economic and political presence in the various regions.

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吸収源に注目した京都議定書の運用方法：日本の展望

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要 旨

この報告は共同実施（JI）とクリーン開発メカニズム（CDM）についてCOP6会合の結果を検討したものである。また、気候変動政府間パネル（IPCC）の「土地利用、土地利用変化、林業に関する特別報告書」と「第三次評価報告書（TAR）」及び他の吸収源関連文献について考察を加え、それをもとに日本の温暖化政策関係の幾つかの事項について提示している。ブッシュ政権が京都議定書からの米国の離脱を決めたことにより、この報告は議定書を巡る政治的な動きについての分析も含めている。

報告の中で明らかにしたように、生物とくに森林の炭素吸収源としての可能性は文献から十分に確認できる。近い将来、具体的にはここ50年ほどの森林の吸収源としての働きは、大気中の炭素に重大な影響を与える。少なくとも米国では化石燃料からの排出量に上限を設定することが強調されなくなり、代わりに吸収源は将来の気候変動政策のより重要な要素になってこよう。

このような環境下で日本にとって何が賢明な吸収源戦略だろうか。TARの全般的な結論は、米国や京都議定書の如何にかかわらず、温暖化は地球規模で重要な問題であり続けるとしている。最近の交渉の難しさと関係なく、日本にとって長期的かつ適切な吸収源戦略を定めることが重要である。森林は日本のランドスケープの主たる部分を構成しており、しかも炭素の吸収が旺盛な若齢林が多いことから、将来的にも炭素固定の重要な働きをする。加えて中国、東部ロシア、豪州、東南アジアを中心とした日本の周辺地域をみれば、森林は炭素吸収源として大きな可能性を秘めている。そして、様々な形でのJIやCDMが日本主導の炭素吸収活動としての大きな可能性を有している。こうした活動は温暖化対策をしつつ経済を維持でき、しかも、この地域での政治的存在を示そうとしている日本の狙いに一致している。

キーワード：京都議定書、炭素吸収源、吸収源の運用方法

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