Greenpeace Corner: Ocean Disposal

Sequestration of Carbon Dioxide from Fossil Fuel Production and Use

An Overview of Rationale, Techniques and Implications

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Executive Summary

Introduction

In 1992 167 nations signed the United Nations Framework Convention on Climate Change. The Convention includes the objective to achieve "*stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous interference with the climate system*". The Kyoto Protocol to this Convention, adopted in 1997, sets legally binding commitments to reductions in emissions of greenhouse gases. Although many gases arising from anthropogenic activity contribute to climate forcing, carbon dioxide (CO_2) is quantitatively by far the greatest contributor (64%).

A key intention of the Kyoto Protocol was to achieve emissions reductions at source. Despite this, a number of proposed approaches to climate change mitigation rely instead on the development of technical mechanisms for the "management" of anthropogenic CO_2 in the environment. In broad terms, such approaches endeavour to limit the magnitude of atmospheric increases in CO_2 concentration through attempts either to influence the partitioning of carbon between different environmental compartments or to isolate generated CO_2 from the atmosphere over long time-scales. Proposed strategies include direct disposal of liquid or solid CO_2 at sea (both above and beneath the seabed) and the enhancement of uptake of CO_2 by natural biological processes in the oceans. In each case, the techniques involve a high degree of intervention with ecosystems and the global carbon cycle, involving manipulations on the scale of "planetary engineering".

At best these proposals are subject to enormous uncertainties, regarding both their likely effectiveness and the potential for adverse impacts at local, regional and global level. At worst they are increasingly portrayed not merely as measures to mitigate climate change to which we are already committed but also as mechanisms which will permit continued exploration and exploitation of fossil fuel reserves. This document examines a range of proposed carbon management options, some of which are currently under development, with a particular focus on issues of technical feasibility, environmental impact and legality under existing international law.

Understanding the Global Carbon Cycle

Understanding of the global carbon cycle remains limited, both in terms of the role of biological processes and the physics of, for example, ocean circulation and gas exchange. However, it is known with certainty that human activities are significantly perturbing the global carbon cycle. This has resulted in a substantial increase in atmospheric CO_2 and an observed flux of anthropogenic CO_2 into the world's oceans.

The oceans represent the largest global reservoir of carbon, present primarily in the inorganic form bicarbonate. On a global, decadal scale, and without anthropogenic influence, the atmosphere and the oceans may be seen to be in equilibrium with respect to carbon exchange. On a seasonal and regional scale, however, substantial net fluxes of carbon occur, resulting from both physical and biological processes. Although the main driving forces are understood, the magnitude of reservoirs and fluxes of carbon remain relatively poorly quantified. Knowledge of interactions between physical, chemical and biological processes is also limited.

At present, quantitative understanding of the sinks for all of the anthropogenic carbon added from fossil fuel burning, land use change and cement production is incomplete. Nevertheless it is possible, based on current understanding, confidently to predict that continued anthropogenic emissions of CO_2 to the atmosphere will result in substantial increases in atmospheric CO_2. A substantial fraction of anthropogenic emissions will be taken up by the oceans and stored in the terrestrial biosphere. It is also clear that CO_2 sequestered or disposed into seawater will not be isolated from the atmosphere indefinitely. Moreover, the potential exists for continued climate change to impact directly on ocean circulation patterns and marine biological activity and, as a consequence, affect the global carbon cycle, significantly affecting the fraction of anthropogenic emissions which remain in the atmosphere. Despite this, development of oceanic CO_2 sequestration and disposal strategies continues.

Ocean Fertilisation

A number of measures designed to increase draw-down of CO_2 to the oceans through enhanced biological fixation have been proposed, based on widespread fertilisation of ocean areas with nutrients (e.g. nitrogen, iron) which otherwise limit primary productivity. Although these techniques have not to date been portrayed as climate manipulation strategies, but rather as programmes for the research of biogeochemical processes or for the enhancement of fisheries productivity, their potential as techniques for the management of carbon has not gone unnoticed.

Direct Disposal of CO_2 to Seawater

The approaches to carbon management which are currently receiving the greatest focus involve the direct disposal of CO_2 to the oceans, either to seawater (*via* pipeline or through dumping from ships) or to geological formations beneath the seabed. These proposed strategies raise substantial technical, ecological and legal concerns. Moreover, the disposal of CO_2 requires its initial capture from facilities generating the gas, followed by compression, transport and final disposal, processes which represent substantial energy and CO_2 penalties in themselves.

Injection of CO_2 to Sub-Seabed Formations

Much attention has also focussed on the potential for disposal of CO_2 in geological formations beneath the seabed. Although standard practice for enhanced oil recovery within the offshore industry, proposals to use sub-seabed injection as a major sink for the disposal of anthropogenic CO_2, primarily to address emissions from power generation facilities, are relatively recent.

Injection as a CO_2 disposal, rather than oil recovery, technique has been practised by the Norwegian state oil company Statoil in the North Sea Sleipner field since 1996. Approximately 1 million tonnes of CO_2 derived from the gas field are injected annually into a porous sandstone aquifer located beneath an impermeable shale. A similar, but much larger, programme is planned for the Natuna gas field in the South China Sea. Estimates indicate that substantial capacity exists for CO_2 disposal in this manner.

However, relatively little consideration appears to have been given to the long-term effectiveness and impacts of such practices. Although seemingly confining CO_2 to containment over geological time-scales, again substantial uncertainties exist. Direct physicochemical impacts of the introduction of high pressure CO_2 on formation chemistry and physical integrity remain to a large degree unknown, although considerable dissolution of some rock types may be expected. While some formations may chemically sequester CO_2, the potential for complex and poorly predictable interactions is clear. In addition, the very fact that formations have to be drilled at one or more locations in order to permit disposal threatens to connect otherwise isolated formations with contemporary time-scales.

Legal Considerations

One aspect which has received perhaps the least consideration to date is the interpretation and acceptability of ocean disposal of CO_2 under existing international legal conventions. CO_2 derived from power generation and other industrial activities would clearly fall under the definition of industrial waste. As such, disposal of CO_2 at sea, including below the seabed, from ships, platforms and other man-made structures would violate international law, both under the London Convention and, more widely, the United Nations Convention on Law of the Sea (UNCLOS), as well as under some regional conventions. The illegality of such practices was most recently highlighted by the United Nations Group of Experts on Scientific Aspects of Marine Environmental Protection (GESAMP), which stressed that changes to international law would be required before such practices could be pursued.

Some aspects of the proposed CO_2 disposal/sequestration strategies for climate mitigation may also be inconsistent with the provisions of the Kyoto Protocol, an issue which demands further consideration. The Independent World Commission on the Oceans (IWCO) concluded recently that "*The Framework Convention on Climate Change and its Kyoto Protocol do not provide for Parties to dump or store CO_2 in international waters and thereby to offset their emissions.*"

Prospects for the Future

More fundamentally the IWCO stressed the essential need for states "*to exploit as a first priority the manifold opportunities that exist for reducing carbon emissions*". This implies the necessity for measures to address emissions at source, a necessity which is inconsistent with continued reliance on, and expansion of the use of, fossil fuels. The "Carbon Logic" approach, developed by Hare (1997), stresses that combustion of all identified fossil fuel reserves is an unsustainable option in climatic terms. Based on estimates of climate sensitivity and the scale of climate change and concomitant effects to which the majority of ecosystem components may be able to adapt, the approach calculates a theoretical maximum quantity of fossil fuel combustion which cannot be surpassed, representing only a fraction of known reserves.

Environmentally effective implementation of the Kyoto Protocol would maintain industrialised country emissions at approximately 1995 levels in the period 2008-2012. Globally, however emissions would continue to grow over this period. Further measures, including greater emission reductions for the industrialised countries, which achieve much deeper and long-lasting cuts in emissions are essential. Ongoing development of unsustainable disposal/sequestration strategies will continue to draw vital resources away from the research, development and implementation of energy efficiency programmes and renewable energy alternatives.

The 1992 Rio Declaration on Environment and Development enshrined the principle that "*the right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations*". The potential for unpredicted, and possibly serious or even irreversible, effects on current or future generations resulting from the various carbon management strategies outlined above is indisputable and threatens to violate this principle of sustainability. At the same time, the assumption that ocean sequestration or disposal of CO_2 will be effective in mitigating committed climate change remains very much open to debate. Moreover, the use of such strategies to meet the provisions of the Kyoto Protocol and to justify continued reliance on fossil fuel reserves into the future clearly represents an abdication of transgenerational responsibility.

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Conference Announcements

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Papers or posters are invited on any of the topics listed. Authors who are interested should submit an abstract in English (max. two DIN A 4 pages, fivefold) not later than **October 31, 1999**.

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