The Scientific and Policy Uncertainties Surrounding The Use of Ocean Fertilization to Transfer Atmospheric Carbon Dioxide to the Oceans

Preamble

The concentration of carbon dioxide (CO_2) in the atmosphere is predicted to more than double over the next 100 years under present fuel consumption rates and projected increases in demand worldwide. The consequences of this increase are not completely understood. However, there is broad agreement among the scientific community that a doubling of CO_2 will cause significant global warming, with many environmental consequences.

In response to these projections, a concerted effort by government agencies, industries, universities and other non-government organizations is underway to study the feasibility of sequestering and storing a portion of atmospheric CO_2 in various repositories including reforestation to store carbon in the biomass of trees, and direct injection of the gas in geologic formations such as oil wells and into the deep ocean. Still another proposal is to sequester CO_2 by fertilizing certain areas of the ocean, thereby stimulating the growth of microscopic marine plants which would ultimately sink and store carbon in the deep sea.

A recent workshop sponsored by the American Society of Limnology and Oceanography (ASLO) on April 23-25, 2001, focused on the last option: sequestering CO_2 in the deep ocean by utilizing the ocean's 'biological pump'. The ocean covers over 70% of the earth's surface. These waters team with tiny cells called phytoplankton that utilize CO_2 and water in photosynthesis to reproduce, fueling marine food webs. In addition to CO_2 and water, phytoplankton require macronutrients such as nitrogen and phosphorus and micronutrients, notably iron. In large stretches of the Equatorial Pacific Ocean and the Southern Ocean near Antarctica, macronutrients go unutilized because iron is in short supply. Several scientific expeditions have added iron to small patches of these areas and produced dramatic increases ('blooms') in phytoplankton cells thereby priming the ocean 'biological pump'.

There is also commercial interest in stimulating phytoplankton blooms to sequester CO_2 for potential carbon credits. At least three private-sector groups are now studying the feasibility of large-scale commercial operations. The idea sounds seductively simple — add iron to the ocean to spur phytoplankton growth; then the phytoplankton cells die and sink to the deep ocean, taking atmospheric CO_2 in the form of organic carbon with them. There are, however, many reasons to question this proposed carbon sequestration technology. To mention a few:

- Nutrient enrichment of aquatic ecosystems causes dramatic changes in species composition at all levels of the food chain, and it is known to cause toxic algal blooms.
- Sustained fertilization would cause areas of the deep ocean to be deprived of oxygen, which could stimulate the growth of bacteria that release other gases, notably N_2O, that is 290 times more powerful than CO_2 as a greenhouse gas.
- The effects of nutrient enrichment of ecosystems are very difficult to predict and to fix when problems arise.
- Models show that sustained fertilization of certain oceans with iron could paradoxically cause others to become less productive, possibly influencing the worldwide distribution of fisheries.
- Models also show that even the most comprehensive plan of ocean fertilization could at best forestall the increase of atmospheric CO_2 by only several years.
- The High Seas — areas outside the Exclusive Economic Zones of individual countries — are a "Commons" owned by all nations. Yet, legal questions about ocean fertilization have not been addressed. Does ocean fertilization constitute "ocean dumping" prohibited by the London Convention? If the Ocean Commons were fertilized, who would provide the framework for quantifying the effects and ensuring environmental protection? Who would assume the risks?

The ASLO-sponsored workshop is the first-step to move the scientific and policy agenda forward on ocean fertilization. Future plans include a larger and more comprehensive symposium on this issue as well as development and dissemination of documents for government agencies and the general public. See the ASLO website for more details (http://www.aslo.org).