INTERACTION COUNCIL

ECOLOGY AND THE GLOBAL ECONOMY

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I. Ecology and the Global Economy

Can the world economy can continue to expand without environmental repercussions that increasingly undermine living standards? The question is unavoidable because all economic activity depends on natural resources and inherently limited biological and chemical processes. Biological productivity and living organisms' resistance to climatic variations and other stresses are limited. The capacities of air, water and soils to assimilate wastes are also limited. Overstepping these limits alters natural systems.

Since World War II population has more than doubled and world economic activity has expanded roughly five-fold. Extensive environmental changes have resulted. In industrial countries, emissions have concentrated in the atmosphere, in surface and underground waters, and in land disposal sites. In developing countries, along with urban pollution, agricultural expansion and tree felling far beyond regeneration rates have greatly reduced natural forest cover and increased soil erosion.

Environmental impacts have become global. Greenhouse gases such as carbon dioxide, methane, and chloroflourocarbons are

building up in the atmosphere. Burning fossil fuels and deforestation have increased CO2 emissions to levels substantially above natural rates of withdrawal. Higher CO2 concentrations in the air affect the heat balance of the earth, and consequently surface temperatures, ocean and air currents, precipitation and evaporation. Emissions of greenhouse gases can affect climate continents away and generations into the future. These effects are complex and not well understood, but are highly non-linear and irreversible, and may be compounded or mitigated by second and third-order repercussions.

Other environmental changes of global scope include the accelerating loss of genetic diversity due to tropical deforestation and loss of other species-rich habitats, the pollution of oceans, and the depletion of stratospheric ozone.

Such changes in natural systems have profound economic significance. Direct economic losses are suffered when supplies of minerals, forest products and other natural resources commodities are depleted. Renewable resources such as forests also yield valuable economic services -- water and soil retention, for example. Losing them raises economic costs associated with flooding, sedimentation, and the like. The "services" that greenhouse gases provide in mitigating temperature extremes are so substantial that should concentrations rise or fall beyond a limited range, human life on earth would be impossible.

Less obviously, natural systems provide demonstrably large economic benefits in themselves, by enhancing the quality of life,

although such values are not captured in standard economic accounts. One is not used to thinking of a favorable climate as an economic good, although people will incur substantial migration costs and accept lower monetary earnings to live in well-endowed regions. Adverse climate changes would impose direct economic losses by reducing the quality of life, as well as extra outlays on heating or cooling to mitigate the loss and a variety of other effects on productivity.

Because of these economic losses it is a serious concern that as economic activity depletes natural resources and disturbs natural systems, net economic welfare might fall. Those who use up the resources might benefit, but at the expense of others who suffer the environmental impacts and of future generations, for whom the resources and their services would be unavailable. Current economic welfare would then be obtained at the expense of future reductions in living standards.

The challenge of sustainable economic progress is leaving natural resources and systems sufficiently intact to permit continuing gains in economic welfare into the foreseeable future. In this spirit, the Brundtland Commission's definition of sustainability is development that "meets the needs of the present without compromising the ability of the future to meet its own needs".

Whether sustainable progress is possible globally is by no means obvious. Four decades of post-WWII economic development have left at least a billion people in dire poverty, and most of the

developing and the socialist countries in economic difficulty. It has created enormous economic disparities between rich and poor (such that the average American uses as much energy as 20 Indians) without abating in the slightest the pressures for further economic growth in the most affluent countries. These currently receive net resource outflows from the less developed of $50 billion per year, the size of Egypt's total gross national product. Arrested economic development has delayed the demographic transition to such an extent that demographers now project world population ultimately stabilizing at 12 to 14 billion. Minimal forecasts of the economic expansion needed to provide decent living standards for all, in the absence of radical and unlikely redistribution of resources towards the world's poor, imply a further seven to ten-fold expansion of the world's economy over the next 50 years.

In view of the disruptions already occurring in natural systems, such an attempted expansion, absent a markedly different mode of economic activity, will result in substantial further accumulation of greenhouse gases, deterioration of air and water quality over large regions, accumulation of industrial and household wastes, depletion of natural resource stocks, and accelerated loss of biological diversity.

II. Making Economic Accounts Reflect Environmental Realities

The economic significance of natural resources is not adequately reflected in economic accounting systems. The non-marketed, unpriced services that natural resources provide are typically not valued, while the expenditures forced on society by the loss of those services are. As a result, resource degradation often appears to raise, rather than lower, economic welfare. For example, should toxic substances leak from a landfill to pollute waters and soils, measured income doesn't fall, despite possibly severe degradation of natural resources. If the government spends millions to clean up the mess, income rises, because such expenditures are regarded as purchases of final goods and services. But, if industry undertakes the clean-up, even if under court orders, the expenditures are treated as intermediate costs and leave income unchanged. Finally, if the site is not cleaned up and nearby households suffer medical expenses or must purchase costly bottled water, measured income again rises, because household outlays are considered final consumption in the national accounts. Inevitably, decisions based on such one-sided accounts are biassed against resource conservation.

Moreover, natural resources are not consistently treated in economic accounting systems as economic assets. Like other forms of capital, natural resources provide a flow of economic benefits over time. Nonetheless, activities that deplete or degrade them are represented as generating income, rather than as reducing wealth.

A country could sell off its timber and minerals, erode its soils, pollute its aquifers, deplete its fisheries, and the national accounts would treat all the proceeds as current income. Mistaking a decline in wealth for a rise in income is a confusion likely to end in bankruptcy.

A widely accepted definition of income, fully consistent with the Bruntland Commission's concept of sustainable development, is the maximum amount that can be consumed in the current period without reducing potential future consumption. In both business and national accounting, a capital consumption allowance representing the depreciation of the capital stock during the year is subtracted from net revenues in calculating annual income. This depreciation allowance reflects the amount needed to keep the capital stock intact. But depreciation is narrowly applied only to buildings and equipment. Failing to allow for depreciation of natural resource stocks when they are depleted or degraded disguises the sacrifice of future consumption, overstates income and capital formation, and justifies policies that waste natural resources in the name of economic growth.

An important operational step toward integrating ecology and economics is to measure economic progress properly. Current economic accounting systems, which were evolved when natural resource limitations seemed less pressing, should be revised. Two changes are of high priority:

First, natural resources for which economic values can be established should be treated as tangible capital in

economic accounting frameworks. Additions to stocks should be treated as capital formation, while depletion and degradation should be treated as capital consumption.

Second, pollution control and other identifiable "defensive expenditures" undertaken to prevent the loss of environmental services should be treated not as final expenditures but as intermediate costs, (i.e., the cost of generating a given level of goods and services) whether undertaken by government, households, or enterprises.

There is an extensive academic research literature on these revisions, and several OECD governments are making statistical estimates. A few developing country governments have also initiated resource accounts. International organizations such as the OECD, UNEP, the World Bank, have sponsored conferences and research.

The UN Statistical Commission has a key role to play, since most market economies follow the UN System of National Accounts (SNA). In the current round of revisions to the SNA, which take place only every twenty years and will be completed in 1991, the Commission considered such changes but has tentatively decided against changes in the "core" accounts. As an alternative, the UN Statistical Office is drafting methodological guidelines for national statistical offices that wish to construct satellite resource and environmental accounts to supplement the "core" or basic accounts.

Faster reform is warranted. Few national statistical offices actually have the manpower or money to work on satellite accounts. In those few that do, politicians and the public pay little attention to the results, focussing instead on the more familiar measures of GNP and national income. Because the economic accounts are the foundation of planning, analysis, evaluation, and decisionmaking:

1) The UN Statistical Commission should establish a work program aimed at incorporating these resource and environmental accounting revisions into the core system of national accounts within a three to five year period.
2) More member governments, especially within the OECD, should adopt such changes in their national accounts.
3) The World Bank and other development agencies should increase their assistance to developing countries in initiating resource accounting.

No other change could so powerfully demonstrate that steps to protect the environment are in countries' own economic interests.

III. Integrating Environmental and Economic Objectives

A. Promoting "Environmental Productivity"

Most postwar economic growth has resulted not from capital and labor accumulation, but from improvements in the quality of inputs and the efficiency with which they've been used. Productivity gains have been driven by vigorous innovation and rapid diffusion. However, productivity measures should include not just output per worker and per unit of capital. Output per unit of natural resources used and per unit of wastes discharged are important, neglected dimensions of productivity. The rate of improvement in this environmental dimension of productivity largely determines whether economic growth can be sustained without ecological damage. Governments should devote the same attention to "environmental" productivity as to conventional indicators of economic efficiency.

Technical innovations -- energy-saving processes, for example -- might raise both environmental and capital productivity. However, there could also be important trade-offs. Should firms save capital by not installing pollution control equipment, the apparent gain in capital efficiency, at the expense of heavier environmental damage, could mask overall productivity losses.

Such trade-offs are probably important. Profit-oriented private decisions largely determine the direction of technological change. Although government R&D policies play a role, market incentives dominate the search for and adoption of new technologies. Since waste discharges are usually free, except for

regulatory limits, there are few market incentives to seek and adopt waste-reducing technologies, unless environmental efficiency gains are incidental to other cost savings, such as reduced raw material costs. On the contrary, there are considerable incentives to reduce costs at the expense of greater environmental damages not borne by the polluter.

Moreover, government market interventions often artificially reduce the costs of natural resource commodities to users or raise the profits of suppliers. These interventions reduce incentives to adopt resource-saving technologies and increase environmental impacts from primary commodity production. Examples are obvious: Many governments heavily subsidize irrigation water, destroying farmers' incentives to adopt even simple and highly economic technologies to conserve water. Overall water use efficiency is drastically reduced, and rivers, wetlands, groundwater, and soils also suffer significant loss of productivity, although few such losses impinge directly on the individual farmer. Resource subsidies create perverse incentives.

Reducing "policy failures", in government policies toward natural resource commodity markets, is important in both industrial and developing countries, whether capitalist or socialist. Tax, credit, pricing, and other government policies towards natural resource industries often discourage resource conservation, while reducing economic productivity, increasing fiscal burdens on government, and reinforcing inequities. Energy, water, forest, industrial and agricultural sectors are all greatly affected by

these interventions. Producer incentives are often biassed toward depletion or degradation of the resource base, and potentially more efficient production systems are discouraged.

Economic instruments can also correct incentives by making waste generators pay the economic costs of disrupting natural systems. Emissions charges, marketable emissions permits, non-compliance charges linked to emissions standards, deposit and return systems, and assignment of legal liability for pollution damages are among the policy instruments that can discourage pollution. They decentralize technological choices about environmental protection to the enterprise manager, who generally knows best which technologies are best in his situation, and confront managers with the full incremental costs both of abating and of not abating their emissions. For these reasons, economic instruments are generally more effective in promoting appropriate technological innovation than "command-and-control" regulations, and lead to more efficient environmental control.

These economic instruments have performed as expected when tried. Yet, few governments have used economic instruments to deal with "market failures" to the extent their potential warrants. The costs of disturbing natural systems must be incorporated much more systematically into the profit-loss calculus of enterprises and households if environmental productivity is to rise sufficiently to permit sustainable development.

B. Promoting Concern for the Future

At long-term interest rates of about 10 percent, an ecological loss of a million dollars expected to happen in a hundred years has a present cost of $75. For consumers borrowing at 18 percent per year on their credit cards, it would have a present cost of $0.06. The implication, obviously irrational, is that global climate change or loss of biological diversity, which risk potentially enormous losses over the next century, can be virtually ignored in current government and private decisions that will significantly affect those future developments.

Future costs and benefits, if discounted at all in public investment decisions, should reflect a societal valuation of future welfare. Nonetheless, many national governmental and inter-governmental agencies continue to use private market interest rates for investment analysis. The World Bank and IDA, for example, screen projects with a ten percent rate of return. The Inter-American Development Bank uses a twelve percent discount rate. Instead, project benefits and costs should be evaluated using a much lower risk and inflation-free discount rate, - say, 2 percent - and investments should then be screened by requiring a high ratio of discounted benefits to (discounted) costs. Many scientists would argue that even a 2 percent discount rate, which implies that costs incurred 35 years in the future are only half as important as those incurred now, is too myopic, but a 2 percent rate puts 1900 times more weight on consequences a hundred years hence than does a 10 percent rate. Public and international agencies,

including particularly the multilateral development banks, should be directed by their governing bodies to adopt this alternative approach to investment evaluation.

Public policy can manifest concern for future welfare most powerfully by encouraging greater private savings and investment. High private market interest rates reflect heavy competition among public and private borrowers for limited savings. United States fiscal policy, perhaps more than most industrial countries, penalizes savings and rewards borrowing. Taxation of personal dividend income as well as corporate profits, capital gains, and legacies effectively subjects savings to multiple taxation. Simultaneously, business and personal borrowing costs are lowered by the deductibility of most interest payments from taxable income. This fiscal orientation, together with heavy public borrowing, pushes market interest rates up and shortens economic time horizons.

IV. Steps Toward Integrating Economics and Ecology

A. Forests

Forests are under heavy but varied pressures throughout the world. In industrial regions, forests are threatened by local and long-range air pollution. In the US and some other affluent countries, public forests face severe problems in managing conflicting demands for the services and commodities they provide. In most developing countries, forests are being rapidly depleted and converted to other land uses, with grave economic and ecological losses.

1. Public Forests

a. Industrial Countries

Forestry traditions in most of Europe ensure that public forests are husbanded for the multiple benefits they provide, but forestry practice in more sparsely settled areas of the U.S., Canada, and Australia gives effective pre-eminence to timber production. This often conflicts with the increasingly important recreational and ecological benefits the forests provide.

Such biases can be corrected by managing public forests more economically. Budgetary subsidies for timber production should be eliminated, except for appropriations to protect biological diversity and other non-marketable services. Forest road construction and management should be financed out of net revenues.

User fees based on market values or consumer willingness-to-pay should be collected for non-timber commodity production (including mining rights), livestock grazing rights, recreational uses and other services from public forests -- thus establishing the value of other forest benefits. Such measures to ensure that governments obtain fair market value for commodities and services produced in public forests and to reduce government subsidies for resource exploitation on public lands will encourage more sustainable forest management in several temperate zone countries.

b. Tropical Countries

Tropical forests are being rapidly and wastefully depleted. In most tropical countries, inappropriate and unsustainable exploitation is dissipating much of their forest wealth. Governments are realizing little of the potential benefits. Rationalizing forest management, collecting fair market value for timber and reducing subsidies for competing agricultural uses can greatly reduce that wastage. Tropical deforestation, which threatens biological diversity and the earth's climate, is a global concern and should be addressed through international cooperation.

ECE countries and Japan are the main markets for tropical timber exports, and their multinational companies are deeply involved in tropical timber exploitation. Governments of all importing countries should ensure that these companies, their subsidiaries and affiliates, strictly adhere to all host country laws and regulations regarding timber operations, export

restrictions, and tax and royalty payments. In addition, importing countries should support and strengthen the International Tropical Timber Organization's role in monitoring compliance, publicizing violations, and negotiating remedies.

The Tropical Forestry Action Plan is an international effort to identify and fund high priority actions to strengthen forestry management, research, conservation, and policy affecting tropical forests. With a secretariat located at the UN Food and Agriculture Organization, participation from all interested constituencies, and national plans underway in more than fifty countries, it is a vehicle for international cooperation. Industrial countries should provide financial and technical support for both planning and subsequent implementation. Sponsors should ensure that the TFAP generates higher long-term returns to tropical countries by designing forest revenue systems that promote sustained yield management and collect fair market value for tropical timber and non-timber products.

The multilateral development banks are now formulating forest sector loans that address the need for improvement in forest revenue policies along with institutional strengthening and other concerns. Member countries should support these activities in the Banks' governing bodies and through co-financing.

As part of the TFAP and other development assistance programs in forestry, investments in reforestation should be markedly increased. In most countries, the private sector has a better record in plantation and community forestry than does the

government, but because forestry is a long-term investment, private participation depends on security of tenure and predictable policies. Development agencies and host governments in developing countries should cooperate in expanding reforestation, community forestry, and plantation programs.

2. Managing Long-Range Air Pollution Damage

Throughout most of Europe and North America, airborne emissions of sulphur and nitrogen compounds, reacting with volatile organic compounds and drifting over long distances, are acidifying forests and aquatic ecosystems, among other damages. Considerable research into emissions sources, atmospheric transport and chemistry, and ecological responses has justified public concern. Governments have tightened emissions standards on both mobile and stationary pollution sources, but actions have been limited by the high costs of emissions reductions from coal-fired power plants, vehicles, and industrial furnaces. Decisions have also been complicated because much of the pollution drifts across jurisdictional boundaries. Jurisdictions exporting pollution gain only part of the benefits from clean-up, while those importing pollution have no authority over the damaging sources.

Governments in Europe and America have recognized that precursor emissions should be reduced by international agreement, and are negotiating the difficult issue of responsibilities for abatement in different jurisdictions. Economic studies show that the costs of achieving any predetermined overall abatement level

can be greatly reduced if policies allow flexibility as to where and how abatement should take place, and avoid prescribing either specific technologies such as flue gas desulfurization or rigid allocations of emissions reduction among sources.

Innovative regulatory instruments such as the "bubble" and "marketable emissions reduction credits" can provide this flexibility. The bubble merely prescribes an overall emissions reduction for a group of sources, allowing them discretion on how best to achieve it. It has recently been applied in United States acid rain legislation by setting overall sulphur abatement targets for each State without specifying how those targets should be met. This policy allows each State to concentrate on low-cost sources and means of abatement.

Marketable emissions reduction credits that are transferable across jurisdictional boundaries are an innovative economic instrument that could further strengthen long-range pollution control. In operation, each source would be allowed to transfer all or part of its permitted emissions to another agency for monetary compensation. Sources that would incur high abatement costs could compensate low-cost sources in other jurisdictions to cut back further than otherwise required. Differences among jurisdictions in marginal pollution control costs would thus tend to narrow. Moreover, should some jurisdictions experience exceptionally high damages from pollution originating elsewhere, they could compensate sources in the offending region to cut back more than the minimal prescribed amount.

Intergovernmental institutional cooperation is essential to realize these benefits. A mechanism to record and enforce these transfers across jurisdictional boundaries would have to be created. In Europe, the ECE might consider this innovation. In North America, the EPA should be authorized to operate such a mechanism in tandem with its existing emissions trading program, and to open discussions with its Canadian counterpart on international transferability.

B. Water

In most regions inland and coastal water quality is increasingly threatened by pollution. Regulations requiring large industrial and municipal sources to treat their wastes before discharge need to be strengthened in many countries. In dense urban and industrial areas even the sheer volume of treated discharges can degrade water quality. Moreover, few countries effectively control "non-point source" emissions from agriculture, construction, and transport. These emissions are a large, rapidly growing source of water pollution. They include discharges to air and soils that finally find their way into water bodies. Regulations requiring wastewater treatment by large sources cannot combat these broader problems.

Semi-arid areas, such as the American West, also face increasingly competition for water. Agriculture has long used most of the available water, disturbing rivers and wetlands. Good dam

sites have been occupied, underground aquifers depleted, and municipal and recreational uses have increased, so the costs of supplying agricultural demands have risen sharply. Fertilizers, pesticide residues, and salts washed from irrigated fields have created increasingly intractable environmental problems. Yet, highly subsidized public water supplies, the weakness of institutional mechanisms to transfer water among potential users, and lack of regulatory control over agricultural emissions have insulated farmers from these rising problems. To safeguard this vital resource, governments must resolve to treat water as a valuable economic resource and impose its full costs on those who use or degrade it.

1. Water Pricing

In most countries urban and rural water charges are far below incremental supply costs. Flat rate fees unrelated to use, average cost pricing, and declining block tariffs are widely employed. They are inferior to marginal cost pricing structures combining incremental capital costs and volumetric charges covering operating costs. Volumetric charges should incorporate drainage costs for irrigation waters, and sewage costs for household users. Industrial users, who can usually control the volume and content of water-borne discharges by technical modifications, should face distinct sewage and wastewater treatment charges based on the incremental costs of treating discharges with specific characteristics and volumes.

Marginal cost pricing encourages water conservation and thereby reduces the need for new storage and diversions, while providing financial resources for maintenance and improvements. Pollution from contaminated return flows also diminishes. Wastewater treatment and drainage charges also encourage enterprises to control and prevent discharges on site through relatively efficient process modifications.

Adopting marginal cost water pricing approaches may require worthwhile investments in metering, and certainly faces political resistance, especially from highly subsidized users. Nonetheless, pricing that incorporates full supply and environmental costs is the strongest instrument available to encourage efficient water use, promote the adoption of less polluting technologies, and conserve increasingly scarce water resources.

Bilateral and multilateral development assistance agencies contribute to these wasteful approaches in developing countries as well, by financing highly subsidized water projects and failing to insist on pricing approaches that encourage efficiency in water use. The result is gross inefficiency in water use in most developing countries, overinvestment in new construction at the expense of maintenance of existing systems, and serious ecological damage to soils and river basins. Although food security and poverty alleviation are advanced to justify the situation, the principal beneficiaries are better-off landowners and urban middle classes. Imposing economically realistic user charges is virtually the only way to put a stop to the pervasive pork-barrel politics

of water project investments. Member governments should ensure that bilateral and multilateral development assistance agencies adopt and enforce in water projects the same principles of financial autonomy, cost recovery, and marginal cost pricing that are applied to other public utilities.

Several European governments have also used pricing mechanisms in the control of water pollution by levying fees or charges on emissions. Other governments should emulate them. For the most part, however, charges have been revenue devices ancillary to administrative emissions control, and the rates have been too low relative to treatment costs to limit the discharge of wastes to the assimilative capacity of water bodies. Higher rates and less reliance on technology-based emissions standards would encourage further abatement and efficient process changes.

2. Water transfers

Governments should also provide greater scope for voluntary transfers of rights to use water, either as a production input or as a receptacle for wastes. In the United States, limited sales and lease markets for water transfers among irrigation users, and between rural and urban users, have emerged despite high transaction costs and considerable uncertainty over property rights to in-stream and return flows. Instituting explicit legal mechanisms for establishing and transferring such rights and protecting the interests of third parties would encourage these transactions, which reallocate water to more valuable uses. Issuing

shares in public irrigation projects that would entitle shareholders to a proportionate fraction of available water each year, and allowing leases and sales of such shares, is such an institutional mechanism.

Governments that have not yet done so should "adjudicate" the rights of corporate and individual claimants to groundwater. Clarifying these rights would strengthen private incentives to conserve groundwater, and enable interested parties to seek compensation for damages from contamination. In countries where rights over groundwater will remain vested in government, charges for withdrawal and penalties for contamination can still bolster administrative regulations.

3. Controlling Non-Point Source Emissions

This growing problem can be addressed not by traditional source-by-source regulation, but only through more far-reaching policies, including the use of economic incentives. In agriculture, for example, overuse or inefficient application of fertilizers, pesticides, and irrigation water, and intensive cultivation of erodible soils adjoining water bodies have resulted in serious pollution of surface and underground water in many areas. In the Netherlands, nearly 25 percent of groundwater supplies contain nitrates in concentrations hazardous to health, and 20 percent of acid deposition has been traced to ammonia released by farm operations. Higher prices for chemical and water inputs, whether through fees or reduced subsidies, can induce more efficient use,

and encourage the diffusion of agricultural technologies that are less input-intensive. Several ECE countries have already imposed charges on farm chemicals to discourage excessive use and finance environmental programs, in accordance with the Polluter Pays Principle.

More fundamental changes in farm support policies in EEC countries, the US, and Japan would reduce non-point source pollution from agriculture even more powerfully. At present, measures that raise farmers' income by supporting agricultural commodity prices induce farmers to apply chemical and other inputs more heavily to their cultivated acreage. Despite acreage limitations built into some agricultural support programs to control production surpluses, the net effect of price supports is to raise total input use. Regulations such as "cross-compliance" provisions in US agricultural policy are designed to mitigate these environmental effects by discouraging cultivation of highly erodible soils. In addition, specific regulations on pesticide use and for the protection of drinking water supplies seek to balance agricultural benefits against health risks. However, such regulations cannot reverse the strong overall incentives farm support programs create to intensify chemical use. Providing targeted farm income supplements and subsidies more directly, instead of by manipulating farm prices, would lead to less intensive cultivation and less agricultural pollution.

C. Promoting Sustainable Agriculture

The agricultural sector has recorded remarkable gains in output and yields. Yet it suffers from serious economic and ecological distortions that may prove unsustainable. In advanced regions output gains have been achieved at the cost of heavy and rising energy inputs, both mechanical and chemical, which make the agricultural sector quite vulnerable to rising energy costs. Farmers in many irrigated areas are squeezed between rising real supply costs for water and rising environmental costs due to soil salinization and drainage problems. Intensive cultivation has raised erosion rates in some regions to levels that imply serious soil fertility losses and even larger off-site sedimentation costs. Despite doubled and redoubled pesticide applications, the fraction of many crops lost to pests has not declined, and the number of pests resistant to one or more chemicals has risen sharply. Financially, the farm sector has become increasingly dependent on government support. These trends are potentially unsustainable.

Moreover, the agricultural sector is a major contributor to off-farm environmental problems. In the United States, for example, 70 percent of nutrients and 33 percent of sediments reaching waterways come from agricultural land. Twenty percent of the nation's wells are contaminated by nitrates from fertilizers, and in the Iowa cornbelt, where three out of four people drink well water, 40 percent of tested wells show pesticide contamination and 40 percent exceed EPA's maximum health limits for nitrates. In the

agricultural areas of Western Europe, the same problems of water pollution, soil erosion, and exceedingly heavy input use have been documented.

Agricultural policy in the United States, the European Community, and Japan exacerbates these environmental problems. Supporting farm incomes through import restrictions and export subsidies, through direct price supports and supplemental payments linked to historical production levels, and through input subsidies induces farmers to expand the acreage of crops under support programs and to use more inputs on those crops.

Import restrictions on sugar, dairy products and others, raise domestic prices and thus increase both acreage and inputs used in protected regions. These restrictions involve economic losses to consumers and more efficient producers (located mainly in less developed countries), and increase pollution problems. Direct price supports also expand acreage and input use, with similar economic and environmental costs but also large fiscal costs if supported by government stockpiles or export subsidies. Price support programs have typically needed acreage limitations to reduce surpluses, but farmers respond by retiring their least productive land (not necessarily the land most prone to environmental damage) and using even more inputs on the rest. The environmental benefits of acreage limitations can be increased by targeting cutbacks on sensitive areas, including stream borders and groundwater recharge zones.

In the United States, supplemental "deficiency" payments increase the net receipts of producers of cotton, wheat, corn, sorghum, and rice. Payments represent the difference between target and market (or floor) prices, multiplied by historical production levels. These levels are calculated as past average acreages and yields. Such supplemental payments keep more acreage in relatively erosive, chemical-intensive program crops. They also discourage crop rotations involving non-program crops, such as leguminous cover crops, because they reduce "base acreage" and potential future support payments. Since crop rotations are fundamental to low-input regenerative farming systems, this policy promotes intensive monocultures.

Governments have tried to reduce these environmental damages by additional interventions, such as "cross-compliance" provisions regulating farming of vulnerable soils or inappropriate input use. In addition, land retirement schemes, such as the Conservation Reserve Program, have been targeted toward soil conservation. These are stop-gap mitigating measures, however, and don't obviate the pressing need, on both economic and environmental grounds, for more fundamental change. Farm policy in the US, Japan and Western Europe has been economically inefficient, raising producers' income at a much larger cost to consumers and taxpayers, exceedingly burdensome fiscally, disruptive of trading relations among these regions, harmful to agricultural producers in other regions, particularly in developing countries, and highly regressive (since benefits are proportional to the amounts produced). In addition, these policies

encourage environmentally damaging and ecologically unsustainable farming systems.

These countries should move swiftly to alternative agricultural policies based on direct income support for targeted producers and practices, and dismantle interventions that support farm prices and distort production decisions. "Decoupling" support programs from market interventions in this way would greatly reduce fiscal costs of agricultural policy, and allow governments to target subsidies much more accurately on worthwhile policy objectives. Decoupling would also greatly reduce the economic costs of agricultural policies by allowing undistorted market incentives to reallocate crop production to regions and nations with comparative advantage, while inducing farmers to make efficient profit-maximizing choices among alternative technologies. It would greatly reduce environmental damage from agricultural production by eliminating policy-induced incentives for excessively intensive acreage cultivation and input use and by encouraging sustainable and regenerative cropping systems.

Undoing fifty years of market intervention will necessitate considerable structural adjustment in agriculture, a painful process many politicians, farmers, and agribusinesses are unwilling to undertake, although gains will greatly outweigh losses. Ironically, the structural adjustments that the industrial countries are calling on developing and socialist countries to make are much more extensive, and those countries have far fewer resources with which to cushion the process. The present value of

future fiscal and economic savings from eliminating agricultural distortions would provide ample resources with which to finance an agricultural structural adjustment program. This program would include, a) eliminating all market interventions, b) replacing them with direct income supports subject to reasonable ceilings and phasing down over several years, c) refinancing facilities to deal with changes in land and other agricultural asset values, and d) temporary financial assistance to cushion agribusiness dislocations.

D. Economic Policies to Promote Pollution Prevention

1. Pollution prevention or pollution control

Environmental policies in all countries have emphasized "pollution control" (treating emissions to reduce their environmental impact) rather than "pollution prevention" (reducing the amount of waste produced), although the latter has many advantages:

- Controlling pollution in one medium often merely transfers wastes to another medium, at considerable cost and sometimes little environmental gain;

- Designing waste reducing processes into industrial plants is often much cheaper than controlling pollution through end-of-pipe techniques or cleaning up degraded environments;

- Producing less wastes also saves costly raw materials, a double bonus.

Many governments have established programs, such as sponsored research and information exchange programs, to encourage the adoption of low-waste technologies. Such programs are useful, but only if enterprises face strong incentives to seek ways to reduce emissions and wastage of materials and energy. Economic instruments can help create those incentives.

Ideally, pollution could be efficiently prevented by comprehensive emission charges or transferable emission permits, which would put the correct environmental price on all wastes going to air, water or land. For the enterprise, a large waste stream would inevitably result in heavy costs. Firms would respond according to their circumstances: some would install cleaner technologies now, others later when equipment is replaced. Some would recycle more wastes into other processes, others would modify their products. These flexible, incentive-driven responses would achieve environmental quality standards at the lowest possible cost and promote technical innovations.

However, in the real world ideal economic instruments are impossible, partly because it is costly for regulators to get information about abatement costs and emissions damages in various media. Environmental and health damages might not come to light for years, for example. Information for enforcement is also hard to obtain: illegal disposal or discharge is often difficult to detect.

Charges imposed on emissions at rates related to the marginal damages they cause might encourage "midnight dumping", or concentrate emissions in less strictly regulated media.

Ideal policies also ignore the political reality that heavy charges may put disruptive financial burdens on industry and risk increasing local unemployment. Realistic pollution prevention policies must, like ideal instruments, create incentives for flexible, efficient responses and innovations to prevent pollution in many different circumstances, but take account of information costs and political realities.

Governments should move toward controlling emissions in all media with economic instruments. Emissions charges can be made more palatable by refunding some of the revenues to the industry as subsidies for technological innovation, or by exempting small amounts of emissions from the charge. Transferable emissions permits can also be granted free to existing emission sources, instead of being auctioned off or sold. These modifications reduce the financial burden on industrial sources while retaining the same incentive effects at the margin.

Other economic instruments that take account of information and enforcement costs may be more feasible in some circumstances. For example, making emitters clearly liable for any damages they cause, with the burden of proof on the industry to establish harmlessness unless the emission level falls within established safety standards, has proven effective in obtaining industry's cooperation in standard-setting. By contrast, when the burden of

proof is on the victim to establish that emissions above a standard have caused harm, industries have frequently resisted standard setting.

Economic instruments applied to process inputs rather than to waste outputs are especially relevant if wastes are hard to monitor and there is a fixed relation between inputs and wastes. Thus, a tax on the carbon content of fuels purchased will work better than a tax on CO2 emissions. Even if the input is incorporated into the product, like cadmium in batteries, an input tax may be appropriate if eventual product disposal will cause problems.

Deposit-refund systems may be appropriate if monitoring discharges is difficult, as with many hazardous wastes. Deposit-refund systems not only discourage the discharge of waste, but also encourage sources to dispose of it properly. Such systems work by taxing some industrial input or consumer product (such as a beverage container or a car), and granting a refund when an approved method of disposal or recycling is followed. Deposit-refund systems have worked successfully (in the form of "bottle bills", for example), and ECE governments should apply them more widely.

Raw material prices play an important part in preventing pollution. If prices are "too low", there is little incentive to use less raw material per unit of output, and because raw materials are not destroyed in the production process but only transformed, the excess inputs will end up as increased wastes of one form or another. Also, low raw material prices undercut the demand for

recycled inputs. Raw material prices must at the very least reflect the full private costs of extraction, so as to avoid an unjustified bias in favor of virgin instead of recycled (and hence waste-reducing) materials. Government should examine their tax and tariff codes to eliminate allowances that reduce prices of virgin materials, and remove other implicit subsidies to virgin materials users. Furthermore, taxes on virgin materials coupled to rebates to purchasers for use of recycled materials are analogous to deposit-return systems, and can help provide broader markets for recycled materials.

When regulatory rather than economic instruments are the prime method of pollution prevention, enforcement is handicapped because in many ECE countries fines for violations are so low that it pays polluters handsomely to break the law. To avoid time-consuming litigation, it is better to use non-compliance fees rather than criminal prosecution, provided that these fees are set so that firms have a strong incentive to abide by the regulations. Non-compliance penalties should be related to the extent and duration of the violation, and exceed the source's estimated costs of compliance.

E. ENERGY

Energy is essential for every industrial and commercial process and cannot be recycled. The finite and non-renewable supply of fossil fuels means that future generations may not have the same access to cheap energy sources that we do. Moreover, extracting, transporting and converting all forms of energy imposes environmental costs, although some forms are less damaging than others. Ecologically sound development must include policies that achieve a sustainable energy system, and take the environmental costs of energy use fully into account.

1. Promoting Energy Efficiency and Sustainability

Promoting energy efficiency is the least-cost and most effective immediate option for reducing the local, regional, and global environmental problems associated with energy use. In all countries, and particularly in developing countries, the scope for economically and technically feasible investments in energy efficiency is large. Grasping these opportunities offers attractive returns over expanding energy supplies, and can save many tens of billions of investment dollars over the next decade. Promoting energy efficiency requires governments to reduce energy subsidies. Governments in most countries are deeply involved in energy markets, through public ownership, regulation, and fiscal interventions. As a result, while some energy sources and uses are heavily taxed, others are available to users at far less than the

incremental costs of supply, which includes environmental side effects. Government ownership or regulation of some energy supplies, although theoretically justified by economies of scale in conversion or distribution, has usually been a vehicle for direct and indirect energy subsidies. The belief that cheap energy is essential for economic growth motivates energy subsidies, but low energy prices typically mean low and stagnant energy efficiency, not rapid economic growth. On the contrary, many countries have achieved rapid economic growth since 1973 with relatively high energy prices and little increase in energy consumption.

All governments should therefore seek to eliminate unwarranted subsidies in energy industries, whether direct or indirect. At a minimum, energy prices should reflect full incremental supply costs, including the costs of adequate environmental controls. Coal industries, in particular, are subsidized in many countries, despite coal's high environmental costs. Using public funds to cushion the redeployment of coal miners would be economically and ecologically preferable. Nuclear power has also been heavily subsidized in many countries. If nuclear power stations were transferred from the public to the private sector and hidden subsidies removed, electricity rates would better reflect real supply costs, encouraging energy conservation. Such changes are particularly likely to raise energy efficiency in Eastern European economies, where prices are well below world levels, and energy use per unit of GDP is roughly twice as high as in Western Europe.

The regulated monopolies and public ownership typical in the electricity generation industry constitute barriers to efficient investment and energy use. Electric utilities should be reoriented to become profit-seeking vendors of energy services, not mere suppliers of kilowatt hours. To accomplish this, the link between electricity output and utility earnings must be broken. Generating companies must be able to profit by reducing sales, so long as costs fall faster than revenues.

- Governments should ensure that cogenerators and independent electricity generators have a fair chance to compete with large centrally owned power stations, by inducing power companies to accept all competitive supply offers and to ensure independent suppliers access to transmission and distribution grids.
- Regulations should also create appropriate incentives for power companies to accept "demand side" bids from suppliers of electricity conservation, and to supply energy efficiency services themselves. Electricity rate regulations should allow suppliers to retain profits from efficiency gains and investments in energy efficiency.
- Tariff policies should replace average cost pricing and declining block rates with economically rational marginal cost pricing systems.

If these incentives are put in place, very extensive investments in energy efficiency will be possible at high rates of return.

Enormous savings are also possible developing and previously centrally planned economies. It would be a costly mistake for those countries to equate "development" with a quantitative expansion of energy supplies, ignoring highly profitable opportunities to adopt energy efficient technologies and systems in making new investments. International investment banks, particularly the multilateral development banks, should be instructed by their Directors to increase significantly the focus on energy efficiency in their new lending to developing countries and to Eastern Europe. Since many energy efficiency programs require interventions that are dispersed and relatively small-scale, institution-building and expanding private sector participation are essential to success.

Consumer make most choices about energy use indirectly, when buying cars, houses, and appliances. Unless consumers are fully informed about the energy efficiency of such durable purchases, they are likely to buy cheaper but less efficient ones. Information may not suffice if incentives are lacking, as is the case when the owner of commercial real estate does not pay the energy bills, and thus has no incentive to invest in energy conservation. Incentives are also weak if industries have "soft budget constraints" and can simply pass along higher energy costs to customers or to government financing agencies. Policies to promote energy efficiency must permit market forces to function effectively by ensuring that people have sufficient information to make wise choices on energy use, and by creating appropriate incentives.

- Much more rigorous "energy labelling" of refrigerators, washing machines, domestic furnaces, the insulation structure of houses, and vehicles is clearly needed.
- Industrial standards and building codes should also be revised to promote greater energy efficiency.
- Legislation should ensure that energy service companies have the information and legal structure they need to realize the tremendous potential for profitable investments in energy efficiency in commercial and residential buildings. Mandatory energy labelling and metering of all new buildings and legal rights for tenants to hire energy service companies will help to achieve the potential for energy saving.

Transportation imposes environmental costs on the economy from air pollution, noise, congestion and accidents. Predictions of dramatic traffic growth in many ECE countries over the next decade or two largely ignore these costs, and such growth may therefore be neither sustainable nor desirable. Policies are needed to ensure that environmental costs are reflected in the prices that transport users pay. Substantial increases in gasoline and diesel taxes are warranted, especially in countries such as the US and Canada where they are now relatively low. This one change will simultaneously create pervasive but flexible incentives for more efficient engines, smaller cars, shorter journeys, better public transport and (in the long term) less dispersed city layouts, without impinging on personal freedom of travel.

However, administrative controls on specific environmental impacts are also necessary. Vehicle emission standards should be enforced in all ECE countries. More traffic-free areas should be introduced in urban areas, and speed limits, which also affect safety, need to be enforced. But opportunities for economic incentives should be used wherever possible:

- by relating vehicle taxes more closely to fuel consumption and environmental impacts;
- by introducing tolls and road pricing schemes where practicable in congested city areas;
- by relating aircraft landing fees to noise and air pollution generated, and to the time of day;
- by uncoupling revenues from transportation and fuel taxes from public expenditures on particular transport modes (e.g., by abolishing the U.S.Interstate Highway Fund).

2. Environmental impacts of energy use

The environmental impacts of energy use are pervasive. Burning any fossil fuel releases CO2 into the global atmosphere. Coal use also causes water pollution and subsidence or landscape scarring when it is mined, and particulate and sulfur dioxide pollution when it is burnt. The lignite burnt in many East European countries is particularly polluting. Petroleum extraction results in oil spills at sea and the methane flared at large oil-fields is a greenhouse gas. Attempts to "disperse and dilute" SO2 and other pollutants by building tall chimneys results in acid

precipitation many hundreds of miles away. Gasoline (petrol) use in automobile engines releases a variety of air pollutants such as nitrogen oxides, carbon monoxide and volatile organic compounds (VOCs) that cause photochemical smog in urban areas. Natural gas (methane) is relatively free of impurities, and produces the lowest CO2 per unit of heat of all fossil fuels, but is itself a powerful greenhouse gas. Leaks from natural gas wells and pipelines are sources of global warming.

Nuclear power, while not a greenhouse gas emitter, creates environmental problems from uranium mining wastes, accidents in operating nuclear plants, long-lived nuclear wastes, and the proliferation of nuclear weapons, and for these reasons has suffered a dramatic loss of public confidence in most ECE countries. Renewable energy sources are inherently low density, so that large areas of collectors (whether windmills, wave generators, tidal barrages, solar mirrors, solar cells, or biomass fuel plantations) are needed to collect energy in significant quantities. These inevitably affect the environment, both visually and ecologically.

Policies to control the environmental impacts of energy use in ECE countries have largely concentrated on administrative or "command and control" methods, which usually impose very uneven control costs on users and so increase the total cost of achieving any abatement. They also provide little incentive to industries to develop new and more efficient technologies for emissions control. ECE governments should therefore strive for greater efficiency in

energy pollution control by steadily introducing economic instruments that reflect the environmental costs of energy use. Two well-known economic instruments are emissions charges and transferable emissions permits, but others, such as differential taxes on energy-using equipment (such as automobiles) may be appropriate.

The most important pollutants in the energy sector are SO2, VOC, NOx and CO2. Transferable emissions permits would lower the costs of achieving negotiated targets for reducing SO2, VOC, and NOx emissions, and are discussed in connection with acid rain damage to forests, but they are potentially applicable to local as well as to transboundary pollution control programs. "Bubble" policies can greatly reduce abatement costs for multi-source enterprises, while "offsets" and other systems of transferable permits provide flexible, effective incentives for control of conventional atmospheric emissions.

By contrast, CO2 is a pollutant with many emissions sources, both large and small. Basing national or international control programs on a system of quantitative permits would be administratively expensive and economically risky, for reasons discussed below. Individual national actions and international agreement to reduce CO2 emissions are better supported by carbon taxes. An international agreement to stabilize the world climate should include coordinated national taxes on fossil fuels at rates proportionate to their CO2 emissions per BTU and at levels designed to reduce overall global CO2 emissions substantially.

Effective carbon taxes would produce considerable revenues. In order to avoid macroeconomic disruption, they would have to be phased in gradually and be partially offset by reductions in other taxes. It would be possible to design a revenue package that would avoid the regressive impacts of energy taxes, offset some of the impacts of higher energy taxes on business costs, and maintain overall fiscal balance.

F. Promoting Sustainable Development Internationally

Meeting the pressing needs of their increasing populations for better living standards without further depleting and degrading their natural environments is a desperate task for developing countries. Economic recovery is no less desperately needed in Eastern European nations. Moreover, it must be achieved predominantly by their own efforts, through far-reaching changes in priorities and policies. What the developed market economies can and should provide is a more supportive policy framework for international trade, investment, and finance, that will at least remove the severe impediments to sustainable development that less affluent countries now face.

1. Trade Policies

International trade is still an engine of development. Despite pleas by trade pessimists and political utopians for self-sufficiency, countries must trade to gain access to technology,

finance, and goods they can't produce efficiently. However, countries without ample capital resources or advanced technology can profitably export only labor-intensive or natural resource-intensive products. Despite concern in the North about natural resources depletion in developing countries, the North's trade barriers strongly discourage developing countries from exporting more labor-intensive commodities. Facing such barriers, many developing countries rely heavily on natural resource-intensive mineral and agricultural export industries.

Restrictions on market access, such as the Multi-Fibre Agreement and other quantitative restrictions, which apply most widely to labor-intensive manufactures from developing countries, constitute the most serious barrier, since no comparative advantage can surmount them. These barriers are also expensive for the US, Japan, and countries in the EEC that maintain them, since every protected relatively low-productivity job costs several times its worth in higher costs to consumers. But worse, barriers discourage developing countries from less environmentally burdensome labor-intensive manufacturing exports and contribute to unsustainable natural resource depletion. Governments should quickly phase out quantitative import restrictions on labor-intensive manufactures, using domestic policy measures to facilitate the necessary redeployment of labor and capital. If used at all, quantitative restrictions should be imposed to deny international markets to products based on endangered species, tropical timber harvested in

contravention of host country forestry regulations, and other ecologically hazardous exports.

Along the same lines, industrial country trade policies protect their own processing industries, and make it difficult for developing countries to increase the value added to raw materials prior to export. Industrial country tariffs are almost invariably substantially higher, the more highly processed the material. Thus, for example, if logs can be imported duty-free, sawn timber would pay a tariff of 5 percent and furniture a tariff of 15 percent. Such tariff "escalation" provides much higher effective protection for the processing industry in the importing country, and forces the developing country to earn more foreign exchange by increasing the tonnage of primary production rather than by adding more value to each ton. In the current round of GATT negotiations, industrial countries should offer to do away with tariff escalation of this kind on processed agricultural, wood and mineral products.

Dumping of surplus products by industrial countries on world markets can also impede sustainable development abroad. The most egregious example, disposing of hazardous wastes, banned pesticides, and other abominations by exporting them to developing countries, should quickly be stopped as the result of negotiations now underway. Less blatant but also important is the subsidized export of agricultural surpluses, which benefits consumers but penalizes farmers in importing countries by lowering world prices. Lower agricultural commodity prices may discourage farmers on marginal soils in poor countries from making the investments in

soil conservation, water management, and agroforestry that are essential to maintaining productivity. Lower output prices act like a tax on the returns to those investments, another reason for "decoupling" farm income supports in industrial countries from market-distorting interventions.

Not only can trade policies have environmental effects, differences in environmental policies among countries can also affect trading relations. Although international "competitiveness" is of great concern to both industries and governments, it should be remembered that whenever tighter environmental standards in one country reflect higher environmental damages there, those tighter standards imply that the country has a real cost disadvantage in that particular line of production. Alternatively, whenever tighter standards reflect lower abatement costs, then they entail no loss of international competitiveness. Therefore, although the EEC has chosen to "harmonize" environmental standards to a considerable extent in creating a unified internal market, the fundamental GATT principle that domestic environmental protection measures do not distort international trade is economically sound.

2. Investment and Technology Transfer

Restoring private capital flows from Europe and North America is vital to sustainable development in Eastern Europe and developing countries. The steep decline in private lending and investment in the 1980s deprived many capital importing countries of access to critical imports and technology, and forced a severe

retrenchment. The resulting economic crisis has aggravated environmental degradation in many ways: by accelerating resource depletion to increase export earnings, by driving more landless and jobless people to frontier areas as migrant farmers, and by reducing available funds for environmental protection programs.

Because private international capital movements, including capital flight, are both larger and more variable than public flows in response to international market conditions, restoring them requires joint efforts by borrowers and lenders. The United States, which has been the largest international borrower during the 1980s, must restore internal fiscal balance and thereby reduce its demands on international capital markets, lowering real borrowing costs for other capital importing countries.

Other capital-importing countries must also create more favorable conditions for private capital flows. For heavily-indebted countries, this means restoring creditworthiness, in large part by undertaking vigorous structural adjustment programs with the assistance of the World Bank, the IMF, and other international financial institutions. Within structural adjustment programs, modifying policies that result in wasteful and unsustainable exploitation of natural resources, -- by raising resource prices and eliminating public subsidies and expenditures that exacerbate environmental damages, for example -- can help restore fiscal balance and raise economic productivity. Member governments should see that the Multilateral Development Banks and the IMF take full

account of these opportunities in their structural and sectoral adjustment lending.

Governments in creditor countries should recognize, as financial markets have already recognized, that present levels of debt in many countries are inconsistent with resumed growth and creditworthiness. Debt reduction negotiations in the spirit of the Brady Plan should be accelerated. Governments should explore mechanisms to reduce the transactions costs of these negotiations and reduce the temptation of commercial banks to "free ride" on the process, sharing in the benefits of restoring creditworthiness but not in the costs.

Creditworthiness is a necessary but not sufficient condition for increased private capital and technology transfers. Also important are political and economic stability, reasonable, predictable, and non-discriminatory laws and enforcement policies toward private enterprise, and appropriate market incentives.

Market incentives for technology transfer include both prices and regulations. Low-polluting technologies may be available internationally, but they will certainly not be widely adopted in the technology-importing country unless its government requires effective pollution control. Nor will resource-efficient technologies be widely adopted unless resource prices in the host country reflect full incremental supply costs.

Under appropriate conditions, many investments that promote sustainable resource use and sound environmental management provide attractive opportunities for the private sector. Financial

intermediation by specialized investment banking facilities, venture capital funds, and the like can help identify and realize these opportunities. Industrial country governments should encourage the International Finance Corporation, the European and Nordic Investment Banks, the Overseas Private Investment Corporation, export credit agencies and similar institutions to pay special attention to commercially feasible investments that promote sustainable development in Eastern Europe and developing countries.

Similarly, the World Bank and regional development banks are considering ways to channel additional resources to high priority natural resource management projects, especially to protect biological diversity, tropical forests, regional seas, and the global atmosphere. Given the limits on members' borrowing capacities and the fact that benefits from investments in these fields are not fully captured by the borrowing country, there is a clear case for concessional terms for such loans. Member countries should support these initiatives by the multilateral development banks, and promote greater cooperation among them, since such initiatives are much more valuable to borrowing countries if donor coordination is improved.

Many of the poorest countries in Subsaharan Africa and elsewhere, where outstanding publicly owned or guaranteed debt has been rescheduled and reduced under Paris Club agreements, will clearly need additional debt relief, as well as continued flows of new money. Paris Club members should seriously consider converting a substantial additional fraction of outstanding debt to local

currency bonds, interest from which could be used to finance high priority programs to protect human and natural resources. These resources could provide the local currency counterpart funds for increased capital flows for natural resource and environmental protection projects.

G. Managing the Global Commons

The most worrisome environmental problems today are large-scale disturbances to the world's atmosphere, oceans, forests, and genetic resources. Climate change, depletion of stratospheric ozone, accelerating deforestation and extinctions of species in the tropics demand attention because of their potentially massive worldwide risks to economic welfare, health, and even life. Europe is affected by decisions taken in China, and the Soviet Union by events in Brazil, just as Africa depends on policies adopted in the United States.

Global environmental interdependence poses new challenges. Each country's actions affect itself and the rest of the world as well, but there are few institutional mechanisms through which the interests of other countries can effectively be represented in national decisions. Each country bears the full costs of its own protective measures, but captures only part of the rewards. Naturally, each country would prefer that others bear the burden of global environmental protection, and share the benefits while avoiding the costs. Managing the global commons is endangered by

the "free rider" problem. Should most countries restrict fossil fuel use to reduce CO2 emissions, those that did not would gain a competitive advantage from lower energy prices while still benefitting from a stabler climate. For these reasons, responding effectively to global environmental disturbances requires international cooperation.

The 1985 Vienna Convention on the Protection of the Ozone Layer and the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer provide useful models of an international framework convention and implementing protocols. They are also critically important steps toward climate control because CFCs, in addition to scavenging stratospheric ozone, are 20,000 times more efficient in absorbing infra-red radiation than CO2 is, molecule for molecule. Replacing CFCs with less potent substitutes would be perhaps the most cost effective step to mitigate climate change. Industrialized countries should agree to phase out ozone-depleting gases by the end of the century, as recommended by the Helsinki meeting of May 1989.

They should also assist developing country signatories financially and technically to phase down more rapidly. The economic rationale for such assistance is not that developing countries would lose by phasing down CFCs. With large agricultural sectors at risk from ultraviolet radiation and climate change, and relatively small industrial demands for CFCs, developing countries have much to gain on balance from rapid implementation. For this reason, non-signatory developing countries should quickly adhere

to the agreements. The case for international transfers rests on the self-interest of industrial countries in helping the rest of the world phase out CFCs and adopting substitutes as rapidly as possible.

Economic instruments can help in the transition. In the short run, deposit-return or tax-rebate systems could provide useful economic incentives to recover and recycle the large stock of CFCs outstanding in cooling systems and industrial processes. Moreover, taxes or fees on CFCs can stimulate develop and adoption of substitutes, whether imposed in conjunction with marketable permit systems or alone.

The scale of the global climate problem and the uncertainty surrounding it will make international agreements more difficult. Although the emergence of the Antarctic ozone hole was an eerie surprise, it is clear that there would be no winners from ozone depletion, and the costs of prevention are relatively modest. The potential costs and benefits countries face from climate change are poorly understood, although the greenhouse principle is well established. Scientists agree that continued accumulation in the atmosphere of trace gases that absorb long-wave radiation will eventually raise surface temperatures, with profound effects on atmospheric circulation and precipitation. The greenhouse effect is well established and documented.

There is also no doubt that concentrations of greenhouse gases, CO2, methane, CFCs, and NOx have increased at historically rapid rates. Extrapolations of past trends would lead to a doubling

of CO2-equivalent gas concentrations in the atmosphere within the next fifty years.

However, there are still many unknowns in the determinants of climate, such as the roles of clouds and oceans. Clouds trap 7 times as much energy as would be trapped by greenhouse gases even with a doubled concentration, but at the same time reflect 11 times as much back away from earth. Relatively small changes in the area, altitude, and water content of clouds in response to the greenhouse effect could powerfully amplify or offset it.

The oceans play an equally important role. Each year 200 billion tons of carbon are exchanged between oceans and atmosphere, 30 times more than annual greenhouse gas emissions. Small changes in this exchange balance could overwhelm the direct greenhouse effect. Shifts in ocean currents could also dominate regional climatic change. Because of these and other important unknowns, and the complex, non-linear dynamics of the underlying geophysical systems, the effects of many other influences, and the intrinsic variability of weather patterns, detailed predictions over time and space of future climate are exceedingly difficult, if not impossible. Therefore, scientific uncertainty, differences among simulation models, and the lack of close correlations between recent weather patterns and changes in greenhouse gas concentrations are currently unavoidable.

Governments must therefore make decisions in the face of this uncertainty, by assessing the consequences of possible future climatic states of the world, and formulating policies as a

response to those risks. At issue is whether those policies should be risk-neutral (acting on expected outcomes), moderately risk-averse (partially insuring against adverse risks), or extremely risk-averse (minimizing the maximum possible losses).

An international framework convention and implementing protocols should at this stage promote coordinated research and monitoring activities, and a moderately risk-averse mitigation strategy. Such a strategy would immediately adopt relatively low-cost measures to abate greenhouse gas emissions and slow the pace of climate disturbance, and reasonable measures to adapt to climate changes to which past and present actions have probably committed us. A slower rate of climate change would of itself lower the economic costs of adaptation, and, by allowing more time for better understanding of the problem through research and experience, would reduce the risks of costly policy mistakes.

There is consensus that low-cost actions to abate greenhouse gases are available, although their extent is debated. The relevant measure of "cost" is one that is net of other benefits unrelated to climate change. For example, phasing out CFCs prevents health and ecological damages from ultraviolet radiation, reducing deforestation in the tropics also preserves genetic diversity, and raising energy efficiency helps with other environmental and economic problems. These "side benefits" reduce their costs as instruments for stabilizing climate.

Engineering and econometric estimates of the availability of economically feasible improvements in energy efficiency vary

widely. The latter are based on past market behavior, and implicitly incorporate all sorts of inertia, market frictions, adjustment lags, and information gaps that engineering estimates ignore. They are also based on past, rather than current or future, technological and market opportunities. Engineering estimates, on the other hand, reflect hypothetical long-run supply conditions rather than current market possibilities. The two estimates probably represent upper and lower bounds on actual possibilities.

Despite the need for an international agreement, immediate actions by a small group of countries, a "Climate Protection Club", are economically rational. By virtue of population and economic size, the large countries, even individually and a fortiori collectively, would capture a substantial fraction of the benefits of their abatement actions, although benefits also "spill over" to smaller nations. These large countries, the US, USSR, China, Japan, Brazil, India, and (collectively) the EEC are also the largest sources of greenhouse gases. For this reason, as well as to insure themselves, these large countries should immediately adopt available low-cost policies to reduce greenhouse gas emissions by:

1) accelerating the phase-out of CFCs, among the most potent greenhouse gases;

2) promoting energy efficiency vigorously;

3) encouraging shifts to natural gas, a relatively clean-burning fuel;

4) accelerating research on non-fossil energy systems, including efficient gas turbine systems, passively safe nuclear and advanced solar technologies;

5) promoting reforestation domestically and reducing deforestation internationally by supporting the Tropical Forestry Action Plan and other measures discussed above.

Several large countries, notably the United States but also the Soviet Union and China, have relatively low energy taxes and prices, and consequently low average energy efficiencies by international standards. These countries should take appropriate steps to raise domestic energy prices. In the United States, the most appropriate measure would be a broadly based carbon tax sufficiently high to stabilize greenhouse gas emissions by encouraging energy conservation and shifts in the fuel mix toward natural gas. Phased in over several years, and partially supplanting other tax sources, a carbon tax could have positive macroeconomic effects as well.

In addition to these national level actions, all countries should contribute to the formulation and conclusion of a framework convention on stabilization of global climate, as recommended by the UNEP governing council, the 1989 G-7 economic summit, and other bodies. This should follow closely the review of the interim findings of the Intergovernmental Panel on Climate Change in November 1990.

Proposals have been made to set global and national limits on greenhouse gas emissions, and create mechanisms for international trading of "offsets" and emissions permits. These proposals raise serious issues of monitoring and enforcement. Tradable permit systems are not yet well enough established within countries, even for limited numbers of major emissions sources, to be readily extended to global trading among many diverse sources of greenhouse gases.

Moreover, because both the climate response to greenhouse gases and the extent of potential gains in energy improvement and low-cost abatement options are uncertain, it makes economic sense to set a maximum limit on the acceptable cost of abatement measures rather than a minimum limit on the acceptable amount of abatement to be accomplished. Greenhouse gas taxes or charges have this desirable feature: they encourage adoption of all (and only those) methods of reducing emissions that involve less incremental cost than the amount of the tax that can be avoided. Carbon taxes, user fees on CFCs, and other pricing instruments should be phased in.

Simultaneously, OECD countries should use existing mechanisms to assist developing and Eastern European countries in taking low-cost steps to reduce greenhouse gas emissions. In particular, international financing institutions should be encouraged to channel sharply increased financial and technical resources into energy efficiency, renewable energy systems, CFC substitutes, and forestry. The World Bank and regional development banks should be encouraged to develop special lending facilities to expand

investments in these fields, and member governments should be prepared to channel resources through them. Revenues from higher energy taxes and charges on CFCs represent one possible way of providing additional financial resources for these facilities.