Forests and Carbon Dioxide

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In the past century the carbon dioxide content of the earth's atmosphere has increased by about 25% and is presently continuing to rise approximately 0.4% annually. At that rate the pre-industrial level of 280 ppm (parts per million) will have doubled by roughly the middle of the next century. Increased levels of CO_2 in the atmosphere create the so-called greenhouse effect - i.e., global warming resulting from the fact that atmospheric carbon dioxide traps the warmth radiated by Earth.

Table 1: 1980 balance of atmospheric CO_2 released by human activity (figures based on average of two recent studies).

Origin of atmospheric CO_2	*Billion t CO_2/year*
Burning of fossil fuels	20.2 ± 2
Destruction of tropical rain forests	5.1 ± 2.6
Destination of the CO_2:	
Increase in atmosphere	11
Absorbed into oceans	8.1 ± 0.7
Other reservoirs (e.g., biosphere)	5.9 ± 5.1

The best models of the world's climate now available estimate that average mean temperatures near the Earth's surface will increase between 2.8 and 5.2 degrees centigrade (~5.2 – 9.4 degrees F) with a doubling of present carbon dioxide levels. This increases will be greatly exceeded in some regions, particularly in polar latitudes, where the computer models predict temperature rises of more than 10 degrees C. This warming trend will have severe consequences in the future. Major shifts in climatic zones are anticipated, which could seriously damage agricultural production in large parts of the world. Temperature changes may occur so swiftly that certain ecosystems will be unable to adjust and will collapse. The level of the seas will rise, possibly flooding large low-lying areas by the middle of' the coming century. The overall consequences of the greenhouse effect, however, cannot even be clearly anticipated today.

Each year the burning of fossil fuels sends approximately 20 billion (20,000,000,000) tons of carbon dioxide into the atmosphere, compared to estimated emissions of only 72 million tons a century ago. Since the Second World War the use of fossil fuels has roughly doubled every 10 years. In addition, the present destruction of tropical forests is probably releasing more than 5 billion tons of carbon dioxide annually. Of this annual increment of more than 25 billion tons, 11 billion (44%) remain in the atmosphere and the rest is absorbed by the oceans and other reservoirs. In the Northern Hemisphere, for example, because of warmer temperatures the limits of forested areas are shifting northward and the biosphere is expanding because of the increased carbon dioxide content in the air. In this way the imbalance created by the rapid increases of CO_2 emissions in recent decades has intensified the absorption of CO_2 by oceans and other reservoirs, and this should continue to be the case for some time to come. An annual reduction of about 11 billion tons in manmade carbon dioxide emissions would therefore halt the CO_2 enrichment in the atmosphere that is now taking place.

Solving the carbon dioxide problem is very difficult, because 88% of the world's energy supply depends on fossil fuels. At the recent Nordwijk conference on world climate problems, the only thing the 69 participating countries could agree on for their final communique was to stabilize carbon dioxide emissions by the year 2000. Four major users of fossil fuels, the USA, the USSR, Japan and' Great Britain, were reluctant to support even such a minimal agreement.

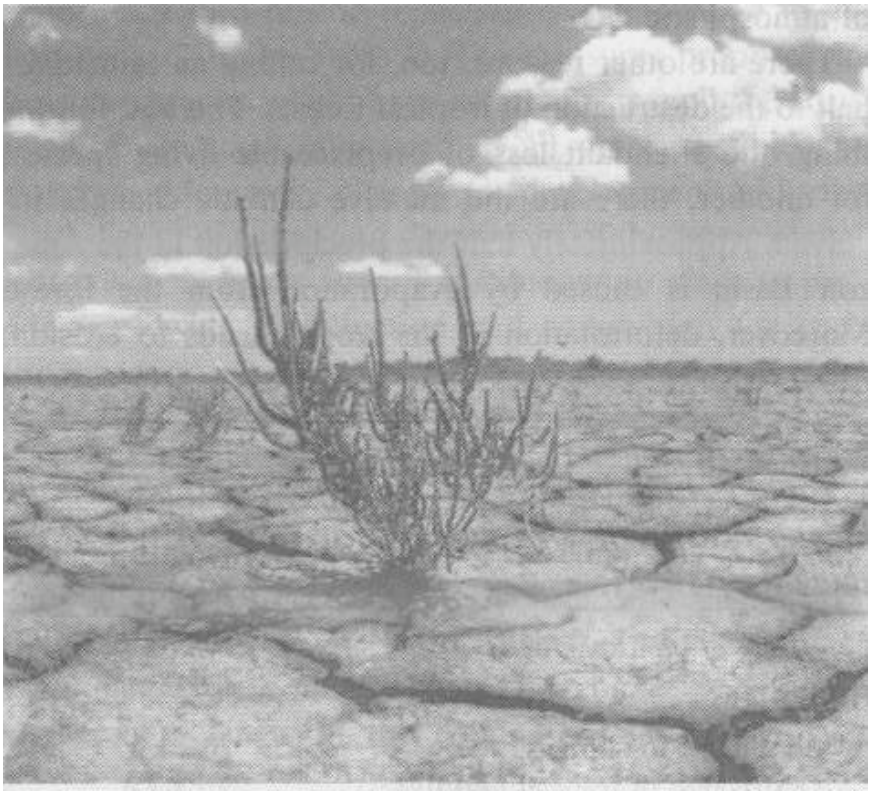
Some potential solutions, such as the replacement of fossil fuels with other energy sources (nuclear, solar, etc.), or the direct fixing of CO_2 at points of production, appear impossible at the moment for technical, political or economic reasons. So it would seem sensible to push for adoption of measures which would be of general economic value and at the same time reduce CO_2 emissions. One primary approach is to improve the efficiency of machines (automobiles, etc.) and at the same time promote energy savings and encourage the use of alternative energy sources that do not cause any carbon dioxide emissions. At best, such steps could only stabilize the rate of increase of CO_2 in the atmosphere, since worldwide energy consumption is rising sharply due to population growth and Third World development. As a result, even with energetic conservation and substitution measures the world will still be faced with an increase of carbon dioxide concentrations in the atmosphere that could have catastrophic consequences in the course of the coming century. A kind of

fatalism seems to be spreading, according to which we will simply have to adjust to the new circumstances. But in view of the global risks involved, humanity would be well advised to intensify its efforts toward an international pact and effective measures for the protection of Earth's atmosphere.

Many specialists have already pointed out that forestation helps remove CO_2 from the atmosphere. While a virgin forest produces, through the rotting of biomass, almost as much carbon dioxide as it absorbs through photosynthesis, the biomass of a young or second growth forest steadily increases, so that large quantities of CO_2 are converted into new biomass. Tracts of forest store as much as 200 tons of carbon per hectare (roughly 81 tons per acre), which is the equivalent of 750 tons of CO_2, and a fast growing forest can absorb from the atmosphere as much as 90 tons of CO_2 per hectare each year. The potential of forestation efforts is often underestimated, because only the capacity of newly planted forests is considered. Two recent studies issued by the OECD and the IEA, for example, estimated that reforestation could contribute only 8-15% to the stabilization of atmospheric CO_2. And indeed, it would require some 5 million square kilometers (just over 1.9 million sq.miles) of newly planted forest to bind all the new carbon dioxide that would be released into the atmosphere in the next 50 years if emission levels were to remain constant. So it seems on the face of it highly problematical to contemplate measures such as these in the face of such pressing current problems as annual loss of croplands and inadequate agrarian production.

The foregoing calculations, however, ignore the fact that huge segments of the biosphere have been destroyed in recent decades, especially in the Third World. Each year about 100,000 sq.km of semi-arid land are degraded to desert through overuse and an even larger area of tropical forest is destroyed every year by clearing. In recent decades, as a result, the vegetation cover on many millions of square kilometers of land has been destroyed or seriously degraded. In addition to direct increases in carbon dioxide emission, this has resulted in grave ecological losses, enormous damage to agricultural productivity, and climatic instability in the regions concerned. These developments can only be corrected through improved protection of forests, large-scale reforestation programs, and improved land utilization for farming and lumbering. Such measures would regenerate the natural vegetation and restore the soil cover, thereby fixing large amounts of CO_2 in new biomass and organic soil substance. At least of equal importance, they would also drastically reduce, or perhaps even halt, the increase of carbon dioxide in the atmosphere during the next 50 years.

Many dry and mountainous regions of our world are destroyed by excessive which make up a third of Earth's land surface, too large herds of livestock result in overgrazing, and too much firewood is gathered, without sufficient planting of new trees. All these developments weaken the vegetation cover, and hence disrupt the water economy and the climate of these regions. Once the vegetation cover has been weakened, water from heavy rains can run off unhindered, causing greater erosion and often catastrophic flooding. Unprotected soil dries out more quickly in the dry season, and periods of drought have even graver consequences. Such man-made calamities have been seen repeatedly in Africa's sub-Saharan Sahel Zone, in southern Africa, on the Indian subcontinent and in other parts of the world.



Inappropriate human use, coupled with climate extremes, has resulted in the desertification of large stretches of land, especially in semi-arid zones. Regeneration of such areas through forestation and other appropriate means would absorb large quantities of carbon dioxide from the atmosphere and fix it in soil and biomass

Parts of these over-used areas become totally useless and infertile every year. Some 3 million sq.km of land have become desert during the last 30 years, and unless circumstances change another 5 million sq.km. (1.93 million sq.mi.) will be added soon. If this is to be prevented, urgent measures must be taken to regenerate the vegetation cover. It is estimated that about 1.3 million sq.km of new forest must be planted in order to put a stop to erosion and desertification. If this were done, not only would vast tracts of farmland and pastureland be retained or regenerated, but in the next 50 years about 110 billion tons of carbon dioxide would be drawn from the atmosphere and fixed in new biomass. That is about one fifth of all the additional CO_2 that is expected to be trapped in our atmosphere during that span of time. Such measures, which would cost only a few billion dollars per year, would have extremely positive effects on the economic development of some of the world's poorest countries.

The degree to which the destruction of tropical forest contributes to the $C0_2$ problem is a matter of controversy. For the year 1980 it has been estimated that between 4.4 and 7 billion tons of carbon dioxide were released into the atmosphere through the destruction of rain forests. But those figures have a large margin of error

(see Table I), arising from the unknown extent of tropical forests cleared annually (estimated at about 100,000 sq.km.) and the uncertainty over the quantity of biomass involved in the cleared forests (200-450 tons per hectare). Since more forest has been destroyed in Brazil alone in recent years than is assumed for the entire world in the figures cited here, the numbers would certain seem to be under rather than over estimations of present conditions. In any case, a decline in forest destruction would immediately produce a massive downturn in the increase of atmospheric CO_2.

There are other reasons, too, for calling an immediate halt to the destruction of tropical forests. There is, for one thing, the attendant loss of irreplaceable living species; for another, there are the massive climatic changes involved. Approximately half the precipitation in the Amazon Basin is caused by evaporation from the forest. Moreover, deforestation in the tropics leads to erosion, flooding and desertification even in areas with ample precipitation. The world's tropical forests are also a tremendously rich source of raw materials, promising far more long term economic gain than can be gotten from agricultural use of the forests. In Brazil alone, the value of unused forest that goes up in smoke each year is estimated at 40-60 billion dollars. Unfortunately, it is impossible to simply halt the destruction of tropical forests overnight, by decree. The reasons for the destruction must be analyzed and strategies worked out to deal with them. In view of the rising worldwide use of wood, it would be illusory to think of putting forests off limits. Yet, without immediate reforestation, lumbering and clear-cutting in tropical forests can have alarming consequences. Without a thick covering of vegetation, soil immediately washes away and loses its fertility. The forest can then recover only very slowly if at all. It should be the responsibility of the wood-consuming industrial nations to make sure that the wood they import is obtained in accordance with sound conservation principles.

In Brazil most destruction of the forests occurs in order to create new pastureland for cattle. Until last year this shortsighted procedure was actually encouraged both by the brazilian government and such international organizations as the World Bank and IMF, because it promised short-term increases in exports. The potential for longterm development that was thereby being destroyed, however, was utterly ignored. This year, because no more subsidies are supporting such activities, the clearing of Brazil's forests has already slowed - an illustration of how easily self-destructive activities in developing countries can be reduced. Land-seeking farmers are also responsible for much destruction of forests. But the agrarian value of newly cleared land is minimal. Despite vast amounts of clearing, developing countries have not succeeded in substantially increasing their total cropland. Unless farmed with special techniques, the soil of newly cleared forestland is depleted in just a few years and must be abandoned.

After such mistreatment, the forest often regenerates only with great difficulty. (It has recently been discovered however, that ancient inhabitants of the Amazon and their present-day descendants have evolved techniques of crop and soil rotation which yield a far better balance between cleared and secondary-growth areas. With these methods, cleared areas are deliberately farmed for only a few years, then permitted to lie fallow for 10-15 years. During this time the forest begins encroaching again, the soil's fertility is gradually restored and, at the same time, a whole range of natural products - fruits, medicinal herbs, etc. - become available.

What is needed in order to improve agricultural utilization of forest areas are methods which permit long term, sedentary (rather than nomadic) cultivation of tropical soil

and at tile same time provide increased yields. Some such methods have been developed and successfully applied. For example, covering the soil with chipped vegetable matter permits farming even of steeply sloped land without serious erosion and increases yields by 20-80%. The material for covering the soil may be obtained by planting rows of trees, which also help hold the soil in place, provide shade or windbreaks, and are a source of firewood. The use of fertilizer in the form of slow-dissolving pellets has also proved useful, since a major problem in tropical regions is the soil's low capacity to, bind nutrients. In Central America an ancient system has been rediscovered which was apparently developed by the Mayas: it involves the farming of plateaus surrounded by canals, with mud from the canals regularly being distributed over the fields, which thus retain their fertility for long periods.

These and similar methods are relatively labor-intensive and have not (yet) been restructured for mechanized farming. They are, however, eminently well suited for application in many parts of the Third World. Yet they are not being promulgated there to any notable extent. Such improved farming techniques would make it possible for large areas of young, second-growth forest to regenerate completely, because they would help eliminate the kind of tropical farming which involves moving on to newly cleared fields every few years. Millions of square kilometers of young, regenerating forest would be able to absorb huge amounts of carbon dioxide (approx. 60,000 tons per sq.km.), and at the same time food-crop harvests in the tropical regions would increase.

To approach a total solution to the $C0_2$ problem, the use of fossil fuels would have to be eliminated entirely. Of course, the burning of biomass as an energy source also releases carbon dioxide, but the gas is absorbed again by vegetative regeneration. If no more is burned during a given time span than can regenerate during that same period, biomass becomes a renewable energy source which pumps no additional CO_2 into the atmosphere. There are various models of how enough biomass could be produced to replace all fossil fuels. The world's forests already produce (in the form of wood) several times the global total of energy consumed. Through selection and improved forestry techniques, this productivity could be increased further. An intensive tree farm which could yield up to 50 tons of wood per hectare per year would be the equivalent of a solar power station which converts nearly 1% of its received sunlight into storable energy.

Of course, as long as the Third World continues to be faced with food shortages and ongoing environmental destruction it is impossible to consider solving the fundamental problem of atmospheric $C0_2$ by cultivating enough biomass to serve as a chief energy source. In Brazil, for example, distilling ethanol from sugar cane is highly controversial for both ecological and ethical reasons. But the fact is that billions of tons of wood are already being burned as a primary energy source in the Third World, and in many places wood is becoming a scarce and precious item. Hence the most urgent step at present would be to plant large groves of trees near villages in developing countries, in order to counteract the ongoing destruction of existing woods. Tree farms can serve the same protective functions as natural woods and forests, and their proximity and ready availability would help limit the growing use of fossil fuels.

Wood could be used more advantageously in the industrial nations too. In Switzerland, for example, naturally growing wood is a potential source of more energy than is produced by all the country's atomic power stations combined. The

industrial countries could also plant large scale tree farms on surplus farmland, instead of paying subsidies to farmers for growing nothing. And the large quantities of naturally occurring deadwood could be used as an energy source, burned cleanly in furnaces equipped with scrubbers. Unlike coal, burning wood leaves no toxic residue, and the ashes make excellent fertilizer.

Table 2) Reductions in atmospheric CO_2 through improved biosphere protection and regeneration (all figures +/- 50%)

Measure	*Billion t CO_2*	*Advantages*
Forestation of dry regions *Regeneration of semi-arid living space*	*110*	*Prevention of erosion and desertification* *Maintaining farm Productivity*
Protection of tropical forests *Regeneration of 2 Mill. Km^2 of tropical forests*	*270* *140*	*Maintaining tropical forests* *Development of agriculture and forestry*
0.5 million km^2 of tree farms for energy production	*55*	*Substitution for l5% of fossil fuels; energy self-sufficiency*
total CO_2 absorption	*575*	*Approx. 50 years at present rate of increase*

Large-scale reforestation in semi-arid regions and improved care and regeneration of tropical rain forests could result in a drastic reduction of the increase in atmospheric CO_2 (see Table 2). The measures proposed in these paragraphs would have rapid effects, and the costs involved are small compared to all other possible approaches. Moreover, thanks to development aid, the North-South dialogue and discussions of the international debt crisis, there are already institutions in place to provide worldwide coordination and supervision for such activities.

Over and above all other considerations, the measures discussed here would have a broad range of positive effects on the Third World's ecological stability, agricultural productivity and economic development. And they could be fully financed by a "carbon dioxide tax" of only 1% on the value of unrefined fossil fuels. On the other hand, if nothing is undertaken to counteract global environmental damage, in the coming century the carbon dioxide problem could dwindle to insignificance in the face of a worldwide ecological collapse.