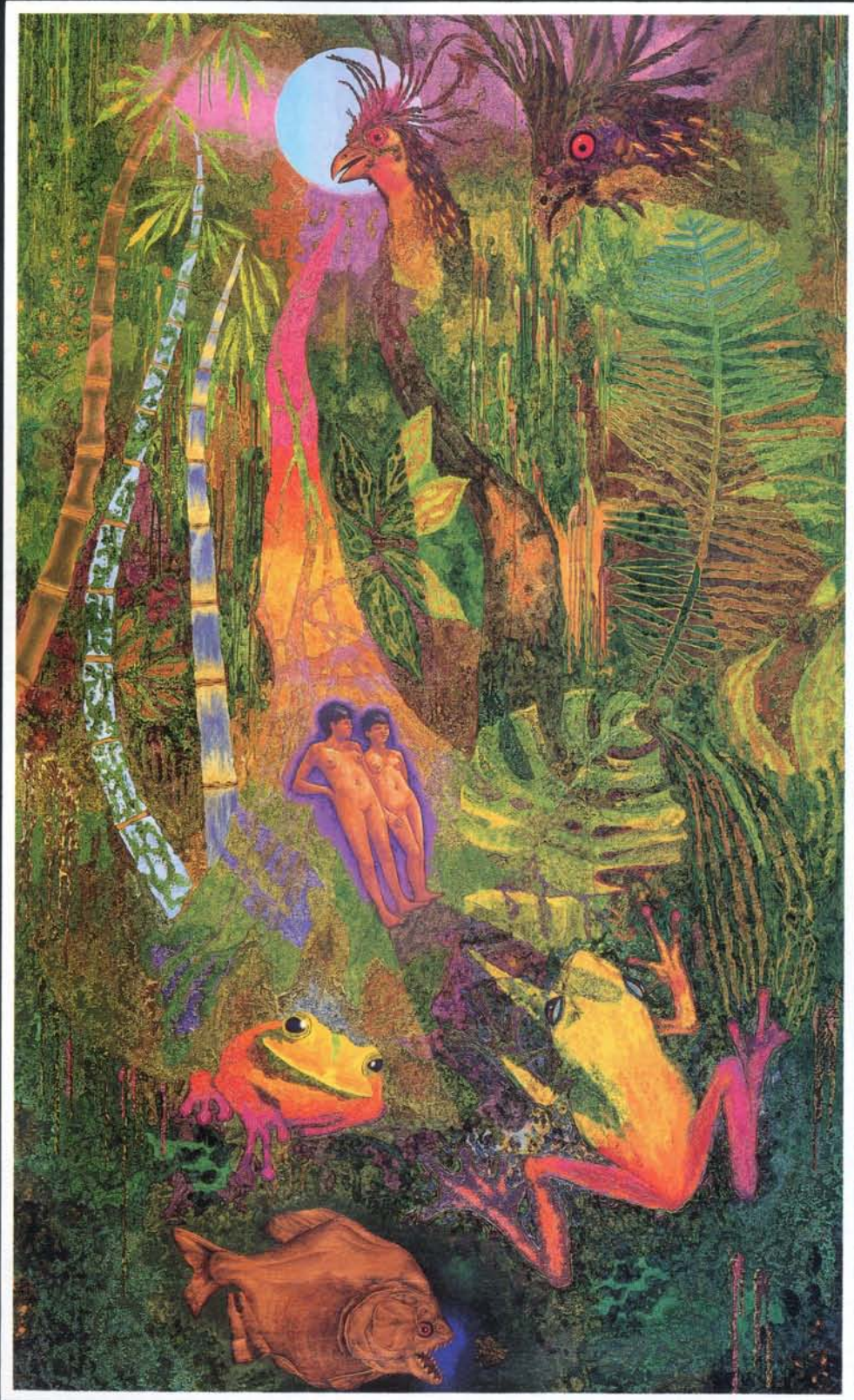


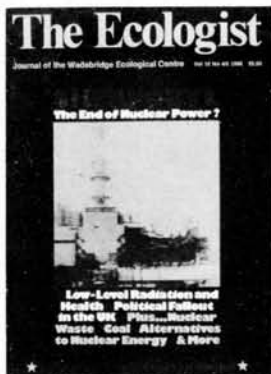
The Ecologist

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- Jayanto Bandyopadhyay **The Ecology of Drought and Water Scarcity** 88

The increasingly severe droughts that India now suffers every year are generally blamed on a lack of rainfall. But meteorological data show that the worst affected areas have not seen any appreciable changes in rainfall. The real cause of the drought lies in the extension of modern, water-intensive agriculture, and the destabilisation of the water cycle.

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Cover: 'The Frog Who Loves Bamboo' by Martin Jordan, Oil on Canvas, 6 x 11 feet. After an expedition on the Maroni and Tapanahóni Rivers, Surinam.

Cover Lay-Out: John McIntyre

Aid: Enlightened Self-Interest or Gun-Boat Politics?

Those with a superficial knowledge of the development process often remain convinced that aid is designed to help the peoples of the Third World. Even many environmental institutions still appear to believe this and persist in campaigning for increased aid. Yet, surely, if the governments of the industrial countries were really concerned with the welfare of the people of the Third World, they would have provided some of our vast food surpluses, which cost hundreds of millions of dollars to store, to the starving people of Africa — even if this would not have solved any long-term problems. Alternatively, they could have spent on famine relief the money which the US farmers are paid *not* to produce food.

Needless to say, no politician has even suggested we do anything of the sort. On the contrary, in Britain, in 1985-86, in the face of the worst and most widespread famine Africa has ever known, our government actually reduced its aid to the people of that continent, so that, as John Madeley notes, "There is more in the kitty for better off countries such as Turkey and Mexico" — which, unlike the countries of Africa, have the money with which to buy British manufactured goods.

This is the crux of the matter. Indeed, the US Department of Agriculture admits that American food aid is a means of creating a demand for imports from the US. "Food Aid", it declares, "can pave the way for US commercial exports. For example, in 1956-58, the United States food aid to 17 overseas markets was \$3.1 billion, and commercial sales of all goods were \$3.6 billion. Two decades later, food aid from the United States to these same countries was only \$756 million, and commercial sales had grown to \$43 billion."

Aid and Trade

One of the main reasons why aid is sound commercial practice is that much of it is officially tied. In the same way that colonies were once forced to buy their manufactured goods from the country that had colonised them, today's recipients of aid must spend much of the money they receive (money that is supposed to relieve poverty and malnutrition) on irrelevant manufactured goods that are produced by the donor countries. What is more, if they dare refuse to buy any of our manufactured goods or to sell us some resource — generally, because they want to keep it for themselves or to conserve it for the future — they are immediately brought to heel by the simple expedient of threatening to cut off further aid, on which they have become increasingly dependent.

Thus, a few years ago, a WHO study revealed that only a minute fraction of commercial pharmaceutical preparations were of any real therapeutic use. Bangladesh, one of the poorest countries of the world, decided to take the study seriously and

announced that it would ban all superfluous drugs. The US government immediately reacted by threatening to withhold food-aid if Bangladesh discriminated in this way against US pharmaceutical manufacturers. So too, in 1979, the Bangladesh government decided to stop selling rhesus monkeys (a threatened species) to a US company called Mol Enterprises for experimentation in its laboratories. The US government's response was, as *New Scientist* notes, "swift and strong" and "even included a suggestion that American aid could be cut off if Bangladesh refused to honour its contract with Mol Enterprises, the monkey importers."

The British government behaved in a similar manner with the government of India by threatening to cut off aid if India did not go ahead with plans to buy 21 Westland helicopters at a cost of £60 million — an effort which, it is encouraging to note, was bitterly opposed by responsible elements within the ODA.

All this is simply a slightly more sophisticated means of achieving what Commodore Perry achieved by bombarding Nagasaki in order to force the Japanese to trade with America, and what Britain achieved by going to war with China so as to force it to buy opium from British merchants in India.

Bretton Woods

It was at the Bretton Woods Conference in 1944, held under US leadership that aid was institutionalised as the Industrial World's principal tool of economic colonialism. At that conference, 44 nations agreed to set up the key international institutions. They were: the International Monetary Fund (IMF); the World Bank (IBRD); and the General Agreement on Tariffs and Trade (GATT). These highly interconnected 'agencies' formed a single integrative structure for manipulating world trade, which until the early seventies was basically dominated by the United States of America. The original role of the IMF was to make sure that member nations pegged their currency to the US dollar or to gold, 72 per cent of world supplies of which were in the possession of the USA. This expedient would, among other things, make it difficult for Third World debtors to get out of their financial obligation to the Western Banking System by manipulating their currencies.

The World Bank's first function was to reconstruct Europe's shattered economy after World War II. Its second function was to prevent the recurrence of a 1929-style slump by systematically expanding the western economy. Significantly, as Susan George writes in her latest book, *A Fate Worse than Debt*, Article 1 of the IMF's charter prescribes six objectives, the principle being:

"to facilitate balanced growth of international trade and, through this, contribute to high levels of employment and real income and

the development of productive capacity... To seek the elimination of exchange restrictions that hinder the growth of world trade"

She goes on to comment, "Even those objectives described in the first Article that may appear strictly financial are, in fact, geared to a single overriding objective: the growth and development of world trade."

As a result, the World Bank soon moved into the business of Third World development, its main activity, for a long time being to build roads, harbours, ports etc.— in effect, to supply the infrastructure required to enable the importation of manufactured products and the export of raw materials and agricultural produce. It then invested heavily in energy generation, in particular in hydropower, the adverse consequences of which have been documented in our book *The Social and Environmental Effects of Large Dams* (Vols 1-3).

More recently, since the seventies, the Bank has played a leading role in financing the commercialisation of agriculture in the Third World and, in particular, the substitution of export-orientated plantations and livestock rearing schemes for traditional subsistence farming designed to feed local people. In doing this, it has made a massive contribution to the growth of poverty and famine in Africa and South and South-East Asia.

The role of GATT, the third of the institutions set up at Bretton Woods, was to liberalise trade and, hence, to ensure that Third World countries did not try to manufacture produce locally which they could buy from western countries — that is, to indulge in highly frowned-upon 'import substitution'.

IMF Conditionalities

The IMF has, of course, complemented the work of GATT in this respect. Loans, either from the IMF itself or the World Bank, have only been provided to governments that have undertaken to observe the IMF 'conditionalities'. This had meant above all, abolishing import quotas and reducing import tariffs to a minimum, thereby preventing Third World countries from protecting their fledgling industries against competition from the established and highly capitalised enterprises of the industrial world — industries that during the early stages of their own development, were themselves well protected from foreign competition, and many of which still are.

Third World governments have also been required to devalue their currencies to make their exports more attractive to the industrialised countries — which has also meant that they must pay more for their imports. They are also required to abolish expenditure on social welfare and, in particular, on food subsidies which are often badly required to protect the mass of the population from the disruptive effects of the rapid socio-economic changes that development inevitably brings about. Such expenditure is seen as being better spent on western imports or on building up a country's industrial infrastructure.

Significantly, if the Fund was really interested in the fate of the people of the Third World, it would not cut down on food subsidies to the poorest people of the world, most of whom only need food handouts because they have been deprived of their land to make way for large-scale development schemes, largely funded by the West, but rather on the import of non-essential items — armaments being a prime example. Yet, as Susan George notes:

"The IMF consistently demands that its pupils make drastic reductions in civil spending, but arms budgets remain untouched. When asked about this anomaly, Fund personnel recoil and explain in pained tones that such measures would be 'interfering in the internal

affairs of sovereign nations' (which is exactly what the fund does every working day). . ."

Similarly, the IMF could insist on a purge on corruption and, in particular, "capital flight", which could be responsible for the loss of as much as \$100 billion a year.

Apart from being made to devalue their currencies and cut social expenditure, Third World governments must also undertake to mechanise their food production, that is, to adopt the Green Revolution, thus providing an important market for Western agricultural machinery and agro-chemicals. They must also replace subsistence agriculture with export-oriented agriculture so as to provide us with the agricultural produce we require, though this they have to do in any case in order to pay for the capital equipment they need for mechanising their agriculture and for financing the mass of manufactured goods that must now inevitably flow into their countries.

This package of policy prescriptions has been imposed on Third World countries by all the multilateral development banks. Rupesinghe, for example, quotes a report by the Asian Development Bank on S.E. Asia's economy:

"Countries must move away from inefficient import substitution policies and free the economy of import controls and price controls. The Green Revolution must be promoted as a 'genuine dynamic force' of economic development. The agribusiness should be invited to cooperate in a country's drive towards self-sufficiency. Resource allocations must shift from domestic production to export crops for the world market. Local support, generous tax incentives, profit registrations, should be provided for foreign investors, and legislations must be enacted to create a 'climate of stability' for foreign investment."

Recycling Stranded Capital

Since the early seventies, the amount of capital pumped into the Third World to finance such policies has increased massively, as has the destruction it has financed. One reason has been the need to recycle the vast sums of money accumulated by the OPEC countries into the western economic system.

This is fully admitted by the US Government in one of its publications:

"In the 1970s the large increase in petroleum prices gave rise to large amounts of what were called petrodollars, since petroleum was (and still is) paid for in dollars. Commercial bankers were enjoined by the United States and international agencies such as the International Monetary Fund to reloan or recycle these dollars to keep the international economy from collapsing. This they did to a fault, giving rise to what later came to be known as the international debt crisis."

Unfortunately, the process is about to be repeated, since, with the aid of the World Bank, we now plan to recycle, via the economies of Third World countries, Japan's annual 80 billion dollar surplus — which is equivalent to the OPEC surpluses of the late 1970s.

The impact that the vast development schemes, which alone can sop up all that money, must inevitably have on the already devastated environment of the Third World is too awful to contemplate.

Edward Goldsmith



Commercial irradiation of strawberries. The bugs may not be killed and carcinogenic substances are created as an additional menace.

Food Irradiation: Contaminating our Food

by Richard Piccioni

Food irradiation has long been promoted by the nuclear industry as an effective and safe means of preserving food at minimum risk to the public. In fact, irradiation not only depletes the nutritional value of food but it also masks the bacterial contamination of rotting food. Moreover, irradiation exposes the consumer to a whole new range of carcinogens. Indeed, food irradiation should be seen for what it is: an unscrupulous attempt to find a commercial use for nuclear wastes.

In the last three years, the approval and implementation of food irradiation has created a growing concern amongst both the scientific community and the general public. In the United States, the debate centres around a series of approvals recently passed by the Food and Drug Administration (FDA) for irradiation of all grains, fruits, vegetables, pork, and spices at doses ranging from 10,000 to 3 million rads. Approval is now pending for the irradiation of poultry at 300,000 rads to protect against bacterial contamination. A second federal agency, the Department of Energy (DOE), recently received funding to promote food irradiation technology and to continue research and development in this area. At the same time, the Delaney Amendment, which prohibits the addition of carcinogenic substances to processed foods, has recently been upheld. This amendment represents a serious legal challenge to the FDA's decisions on food irradiation.

A wide-scale food irradiation programme in the US and abroad would have an adverse impact on public health in a number of ways:

- Through the consumption of carcinogenic substances generated in irradiated foods:
- Through the use of irradiation to mask bacteriological

contamination of spoiled food:

- Through the replacement of fresh foods with nutritionally depleted irradiated foods:
- Through accidents involving leaks or the mishandling of the multi-megacurie radiation sources used in food irradiation plants:
- And, finally, through the environmental damage attending the operation of nuclear reactors and the reprocessing of spent nuclear fuel to provide the required radioactive isotopes for the food irradiation industry.

The food irradiation market is potentially enormous; irradiation of a substantial fraction of the grain and poultry consumed in the US would require the operation of hundreds of irradiation facilities.¹ Large potential markets exist in the treatment of foods and spices imported from foreign countries with lower standards of food hygiene.² Currently, the DOE is planning the construction of five demonstration plants, fuelled with radioactive caesium-137 generated during the production of nuclear weapons. If the plants go ahead, food irradiation would thus become a major (and dangerous) route by which military nuclear wastes are dispersed throughout the environment. A number of private companies which now irradiate medical equipment and other non-food items, using caesium-137 or cobalt-60, are actively seeking to expand their product line to include foods such as grains, poultry, citrus fruits, and berries.

Dr. Richard Piccioni is senior staff scientist with Accord Research and Educational Associates, 314 West 91st Street, New York, NY 10024, USA. He has testified before several US State and Federal Committees on the subject of food irradiation.

Carcinogenic and Mutagenic Risks

During radiation treatment, foods are exposed to a source of gamma-emitting cobalt-60 or caesium-137. As the radiation penetrates the food, part of the energy contained in each gamma photon is dissipated by the ionizing of water, protein, carbohydrate, fat, nucleic acids, vitamins, minerals, and other food components. The ionizing of these substances causes them to undergo drastic and complex chemical changes, resulting in a residue of chemically transformed material. This residue is referred to as a 'radiolytic product'. The complexity of food chemistry and the limitations of chemical analysis make it impossible to identify all radiolytic products. This, together with experimental results, causes concern that the diverse mixture of chemicals generated in irradiated food contains substances that are capable of causing cancer or genetic damage.

Examination of the scientific literature reveals a large number of research reports which attest to the presence of carcinogenic or mutagenic activity in irradiated foods and food components. Table I gives details of the diverse effects which have been observed and reported. One series of papers documents the mutagenicity of irradiated solutions of ribose, deoxyribose, and thymidine, all widespread constituents of food.^{3,4,5} In work by several investigators (see Table I), an increased frequency of lethal sex-linked recessive mutations was observed in *Drosophila melanogaster* cultured on an irradiated medium.^{6,7,8} Multiple effects have been reported in mice, rats, and hamsters fed an irradiated diet, including lethal mutations in developing germ cells, reduced sperm counts, and aneuploidy and chromosome damage in bone marrow cells (see Table I). Irradiated sucrose solutions have produced chromosome breaks in cultured human lymphocytes.⁹ A series of experiments, using mice, rats and monkeys confirms a finding first made in a study of malnourished children¹⁰ that a diet containing freshly irradiated wheat increased the incidence of polyploidy in peripheral blood lymphocytes.^{11,12,13,14}

The majority of these studies were carried out without any attempt to determine mutagenic activity; often irradiated material was only a small component of an otherwise non-

irradiated medium or diet. Thus the observation of genotoxicity is all the more alarming.

A number of workers have been able to analyse irradiated foods and food components chemically and to identify known carcinogenic and mutagenic compounds (see Table II). In particular, the radiolytic generation of such known mutagens as formaldehyde, formic acid, glyoxal, malondialdehyde, lipid peroxides, and quinones, is well-documented in the scientific literature (see references in Table II). Experiments performed by the US Army attest to the presence of benzene, a known carcinogen, in cooked, irradiated beef at levels over seven times higher than those found in cooked, non-irradiated controls.¹⁵ One study relevant to the proposed irradiation of fish showed a synergistic effect in which lipid peroxide intermediates, formed on irradiation of unsaturated fatty acid preparations, increased the rate of oxidation of benzo(a)pyrene (an environmental carcinogen precursor widely distributed in many foods) to its active carcinogenic form.¹⁶

Inadequate Testing

Nonetheless, proponents of food irradiation continue to argue that safety studies show no evidence of adverse effects, other than vitamin depletion at very high doses.¹⁷ The FDA has arbitrarily labelled as 'remote' the possibility that any radiolytic products are carcinogenic, and has granted permission to irradiate broad categories of foods, thereby eliminating the requirement for carcinogenicity testing of any specific food items.¹⁸ The FDA has also declared an arbitrary dose of 100,000 rads to be safe for fruits and vegetables. The proposed dose for poultry is three times higher, yet the FDA has not sought evidence from would-be irradiators to determine whether or not the irradiated carcasses are carcinogenic.¹⁹

This position is out of line both with the FDA's legal obligation to protect the health and safety of the American people, and with the agency's usual approach to the regulation of carcinogenic substances in foods, drugs and cosmetics. Companies approaching the FDA for permission to market food additives, for example, are required to provide estimates, derived from animal studies, of the maximum carcinogenic potential of their product. The studies involve animals being observed over significant periods and tested with exaggeration factors of 1,000 or more. This approach has

Table I. BIOASSAYS ON IRRADIATED ORGANIC MEDIA AND FOODS SHOWING POSITIVE MUTAGENICITY, CHROMOSOMAL DAMAGE, TERATOGENICITY, OR CYTOTOXICITY.

author(s)	date	irradiated material	observation	observed in	author(s)	date	irradiated material	observation	observed in
Kuzin & Kryukova	1961	plant leaves	Chromosomal damage	plant embryos	Vijayalaxmi	1975	wheat	polyploidy	rat (bone marrow)
Swaminathan et al.	1962	potato mash	Chromosomal damage	barley embryos	Vijayalaxmi	1976	wheat	mutagenicity	mouse
Kuzin	1963	plant leaves	mutagenicity of extracts	plant cells	Vijayalaxmi	1976	wheat	sperm count reduction	mouse
Swaminathan et al.	1963	culture medium	mutagenicity	<i>Drosophila</i>	Vijayalaxmi	1976	wheat	polyploidy	mouse (bone marrow)
Chopra & Swaminathan	1963	potato mash	devel. abnormalities	barley embryos	Vijayalaxmi	1976	wheat	aneuploidy	mouse (sperm cells)
Molin & Ehrenberg	1964	culture medium	bacteria	bacteria	Vijayalaxmi & Rao	1976	wheat	mutagenicity	rat
Berry et al.	1965	glucose, fructose	cytotoxicity	human & mouse cells	Vijayalaxmi & Rao	1976	wheat	sperm count reduction	rat
Chopra	1965	culture medium	probable mutagenicity	bacteria	Aiyar & Subba Rao	1977	various sugars	mutagenicity	bacteria
Holsten et al.	1965	coconut milk, sucrose	chromosomal damage	carrot explants	RAO/IAEA/WHO	1977	potatoes	mutagenicity of extracts	hamster
Parkash	1965	nucleic acids	mutagenicity	<i>Drosophila</i>	Renner	1977	laboratory diet	polyploidy	hamster
Rinehart & Ratty	1965	culture medium	mutagenicity	<i>Drosophila</i>	Levina & Ivanov	1978	laboratory diet	autoimmune disease	rat
Frey & Pollard	1966	culture medium	mutagenicity	bacteria	Vijayalaxmi	1978a	wheat	low antibody levels	rat
Shaw & Hayes	1966	sucrose	chromosomal damage	human lymphocytes	Vijayalaxmi	1978b	wheat	polyploidy, other effects	monkey
Hills & Berry	1967	glucose	cytotoxicity	mouse fibroblasts	Wilmer et al.	1980	nucleic acids	mutagenicity	bacteria
Hollowell & Littlefield	1967	plasma	chromosomal damage	human lymphocytes	Ivanov & Levina	1981	laboratory diet	testicular abnormalities	rat
Makinen et al.	1967	pineapple	chromosomal damage	onion roots	Wilmer et al.	1981	nucleosides	mutagenicity	bacteria
Parkash	1967	nucleic acids	mutagenicity	<i>Drosophila</i>	Wilmer & Natarajan	1981	deoxyribose	chromosomal aberrations	hamster cells
Rinehart & Ratty	1967	culture medium	mutagenicity	<i>Drosophila</i>					
Schubert et al.	1967	sucrose	cytotoxicity	bacteria					
Steward et al.	1967	sucrose	cytotoxicity	carrot explants					
Hollowell & Littlefield	1968	plasma	chromosomal damage	human leucocytes					
Meletti et al.	1968	wheat endosperm	mutagenicity	wheat					
Ammirato & Steward	1969	sucrose	devel. abnormalities	plant root cells					
Chopra	1969	culture medium	mutagenicity	bacteria					
Moutschen-Dahmen et al.	1970	laboratory diet	preimplantation death	mouse					
Schubert and Sanders	1971	various sugars	cytotoxicity	bacteria					
Kopylov et al.	1972	potatoes	mutagenicity of extracts	mouse (sperm cells)					
Bhaskaram & Sadasivan	1975	wheat	polyploidy	malnourished children					
Vijayalaxmi & Sadasivan	1975	wheat	chromosomal damage	rat (bone marrow)					

7/15/87

Accord Research and Educational Associates
New York, NY (212) 580-3889

formed the basis on which thousands of compounds have been approved or banned.²⁰

In the case of food irradiation, a special problem exists. Because radiolytic products do not represent a defined group of chemical compounds, they cannot be tested individually at high concentrations. The alternative, feeding animals thousands of times as much food as they would otherwise eat, or irradiating the food at doses thousands of times higher than is proposed, is not possible. There is no simple way to achieve the dose exaggeration factor required to protect the health of large populations consuming irradiated foods. As long ago as 1967, the FDA itself acknowledged the special difficulties of ascertaining the safety of irradiated food,²¹ and, in 1968, the agency rescinded its earlier approval of food irradiation after serious questions arose regarding the conduct and interpretation of the experiments on which the FDA had relied. Originally, the FDA claimed that early experiments showed irradiated food not to be carcinogenic. In fact, these experiments showed a significant increase in tumours in animals fed irradiated food.²²

In 1979, after over a decade of controversy, the FDA set up the Bureau of Food's Irradiated Food Committee (BFIFC) to develop criteria for establishing the safety of irradiated foods.²³ This group developed a theoretical model to predict levels of what they called 'unique radiolytic products' (URPs). It was the assertion of the BFIFC that only URPs – that is, substances found to be unique to irradiated foods – were of regulatory concern. To take an actual example, irradiation of beef generates the carcinogen benzene as a radiolytic product; however, because charcoal broiling also generates benzene, benzene will not qualify as a URP and is excluded from further consideration as a hazard accompanying radiation processing.

Arbitrary Limits

Lacking meaningful toxicological data, the BFIFC made a theoretical estimate of the possible risks of eating irradiated foods. At

a dose of 100,000 rads, BFIFC predicted that some 30 parts per million (ppm) of total radiolytic product would be formed, and that 10 per cent of this could be unique to radiation processing; in other words, food treated with 100,000 rads would contain at most 3 ppm of URPs. The committee then made an extraordinary leap of faith: without any experimental evidence, they used their hypothetical arguments to lay down regulations defining actual use. Moreover, they stated that the 3 ppm of chemically and toxicologically undefined substances, formed in food as a result of radiation processing, would be "similar to natural food components" and safe to include as a substantial part of the diet of some 240 million Americans. Given the possible consumption of many kilograms of irradiated food per person per year by virtually the entire US population, the acceptance of the 3 ppm level is an extreme departure from known precedents for regulating numerous food substances hazardous at far lower concentrations.²⁴

Currently, the FDA has adopted the BFIFC's recommendation to permit the irradiation of a wide range of food at up to 100,000 rads, without the necessity of actual toxicological testing. The BFIFC has also recommended that spices, because of their smaller contribution to the total diet, be exempted from testing at up to 3 million rads.²³ The FDA undertook a literature survey before adopting the BFIFC's theoretical approach. Of over 400 studies reviewed, only 69 satisfied the criteria for technical acceptability. Of the 69 acceptable studies, 32 reported adverse effects from feeding irradiated foods, while 37 "appeared to support safety".²⁵ When further selection criteria were applied, only five studies remained (roughly one per cent of published reports). These five studies reported the absence of statistically significant increases in tumours in numbers of animals fed whole irradiated foods. In none of the studies was there a significant dose exaggeration factor, leading the FDA to report:

"... the extreme dilution of the potentially toxic unique radiolytic products in proportion to the high levels of the irradiated foods themselves, would result in an inability, as in traditional toxicology testing, to exaggerate the dose of the

Table II. IDENTIFICATION OF MUTAGENIC, CARCINOGENIC, OR CYTOTOXIC RADIOLYTIC PRODUCTS IN IRRADIATED ORGANIC MEDIA OR FOOD.

author(s)	date	irradiated material	radiolytic product	comments
Phillips et al.	1958	dextrose, fructose	glyoxal formaldehyde	mutagenic mutagenic
Kuzin	1963	plant tissues	organic peroxides orthoquinones	mutagenic carcinogenic
Frey & Pollard	1966	minimal cell medium	hydrogen peroxide	mutagenic, generates secondary mutagens
Kuzin	1966	plants, rat thymus, tyrosine	orthoquinones orthophenols	carcinogenic carcinogenic
Schubert et al.	1967	sucrose	hydroxyalkyl peroxides glyoxal	mutagenic mutagenic
Steward et al.	1967	sucrose	formic acid	mutagenic
Brooks & Klammerth	1968	glucose	glyoxal malonyldialdehyde	mutagenic, binds to DNA mutagenic, binds to DNA
Chopra	1969	glucose	organic peroxides	mutagenic
Schubert & Sanders	1971	D-glucose, D-fructose, D-mannose, D-rhamnose, D-galactose, D-fucose	alpha, beta-unsaturated carbonyl sugars	cytotoxic (toxicity increased upon heating irradiated solution)
El Zeany	1980	buffalo meat	peroxides carbonyl compounds	mutagenic cytotoxic
Wilmer et al.	1981	deoxy-D-ribose, D-ribose	hydrogen peroxide malonaldehyde carbonyl compounds	mutagenic mutagenic cytotoxic
Gower & Wills	1986	benzo(a)pyrene, starch & oil mixtures	benzo(a)pyrene (oxidized) quinones malonaldehyde lipid peroxides	carcinogenic carcinogenic mutagenic mutagenic

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test compound. For these reasons it would be difficult to devise a traditional toxicology study of sufficient sensitivity to provide assurances of safety for the population exposed to unique radiolytic products from irradiated foods constituting a major portion of the total diet."²⁵

In spite of this, the FDA concluded that "studies with irradiated foods do not appear to show adverse toxicological effects", and it reverted to the same theoretical '3 ppm' argument which it had been supposed to replace with toxicological data.²⁶

There is an alternative approach to the carcinogenicity testing of irradiated foods; namely, to prepare concentrated extracts of foods after radiation exposure, and to compare the biological activity of such concentrates with similar preparations for non-irradiated controls. In a letter to *Science*, published in 1984, Drs. Samuel Epstein and John Gofman called for caution over the approval of food irradiation, and specifically suggested the testing of concentrated extracts of irradiated foods, using methodologies that have been applied elsewhere in the analysis of naturally occurring carcinogens and mutagens.²⁷ A small amount of work of this kind has been done, indicating the occurrence of dominant lethal mutations in the spermatozooids, spermatids, and spermatocytes of mice fed an alcohol extract of gamma-irradiated potatoes, as compared to extracts of non-irradiated controls.²⁸ The effect was not reproduced, however, by a Japanese group.²⁹ A report on food irradiation by a joint committee of the Food and Agricultural Organization (FAO), the International Atomic Energy Agency (IAEA), and the World Health Organization (WHO), notes, without citing references, that mutagenic activity has been detected in alcohol extracts of irradiated wheat.³⁰ Significantly, the effect, which was described as "worthy of further study" is not mentioned in the joint committee's 1981 report.³¹

Nuclear Waste and Irradiated Foods

Worldwide, there are currently some 132 large irradiation facilities in operation of a size appropriate for food irradiation; 50 of these are in the US. With minor exceptions, these facilities process exclusively non-food items, primarily disposable medical equipment.³² If dedicated to food irradiation, each of these large irradiation plants could process approximately 150,000 metric tons of food a year at a dose of 100,000 rads.¹ Since the average North American consumes roughly 800 kg of food annually (directly or in the form of feed fed to animals), irradiation of the US food supply at 100,000 rads would require the operation of over 1,200 irradiation plants.³³ Higher doses would require more plants. For example, consumption of poultry (primarily chicken) is expected to rise to 8.6 million metric tons per year in 1987.³⁴ A total of 170 plants would be required to irradiate this commodity alone at the dose level laid down by the USDA (300,000 rads). Thus, in order to implement the irradiation of food on a wide scale, the number of large irradiation facilities in operation will have to increase dramatically.

Large irradiation facilities (of the type assumed in the preceding calculations) contain one million curies of gamma-emitting cobalt-60 or 4-6 million curies of caesium-137. To compensate for radioactive decay, either type of plant will have to be resupplied with approximately 120,000 curies each year. Given the number of facilities required, the quantity of installed radioactive material which would be needed for extensive food irradiation in the US alone would be in the range of one to several billion curies.³⁵ Thus, by pressuring the FDA to approve food

irradiation, the US government has created a market for enormous quantities of radioactive material.

Significantly, the only isotope which is available in sufficient quantities for widespread food irradiation is caesium-137, a waste product of nuclear weapons production and of the civil nuclear power programme. The US Department of Energy and its predecessors have long promoted the use of caesium-137 'byproduct material' in the treatment of foods.³⁶ A statement from congressional testimony submitted by the DOE in 1983 provides an illuminating glimpse into the nature of the DOE's interest in food irradiation:

"The strategy being pursued by DOE's Byproducts Utilization Program is designed to transfer federally developed caesium-137 irradiation technology to the commercial sector as rapidly and successfully as possible. The measure of success will be the degree to which this technology is implemented industrially and the subsequent demand created for Cs-137".³⁷

With the DOE as supplier, food irradiation has the purpose of ridding the military of vast amounts of its nuclear wastes. The DOE has made immediately available 77 megacuries of caesium-137, obtained from military plutonium production reactors at the Hanford facility in Richland, Washington. This source of the isotope will be immediately used for the irradiation of agricultural commodities in the five prototype demonstration facilities to be constructed in the next few years. This material is only a small portion of the inventory of caesium-137 at the DOE's Hanford and Savannah River weapons plants.³⁸

The quantity of caesium-137 which has been and will be produced in commercial nuclear power reactors dwarfs even the

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amount produced in military installations. The cumulative total of caesium-137 produced in commercial US reactors amounted to some 1,100 megacuries by the end of 1985, with an annual production rate of approximately 200 megacuries per year.^{39, 40} This would be sufficient to fuel 540 food irradiation plants with 5 megacuries of caesium-137 in each. Congressional testimony presented by DOE officials in 1984 indicated that the DOE is interested in using caesium-137 obtained from reprocessed spent fuel from civilian reactors for food irradiation.⁴¹ A widely circulated brochure, produced by CH2M-Hill, a major DOE contractor, presents commercial reprocessing of spent fuel as virtually the only means of supplying sufficient radioactive material to implement food irradiation on a large scale.⁴²

In order to obtain caesium-137 from spent commercial reactor fuel, the fuel must first be reprocessed. Although the DOE's Barnwell facility in South Carolina is complete, no facilities are yet in operation in the US for reprocessing spent commercial fuel. Reprocessing is being carried out in England at the Selafeld facility and in France at Cap La Hague. Work has been underway for several years to modify the existing chemicals separations facility⁴³ at Hanford to accommodate high burn-up, zirconium-clad fuels, which would include those obtained from commercial reactors. The programme is currently on hold because of a shortage of funds. However, the DOE is apparently considering using the existing submarine fuel reprocessing facilities at Idaho National Engineering Laboratory (INEL).⁴⁴

The DOE does not advertise its interest in commercial spent fuel reprocessing, probably because of the 1982 Mitchell-Hart-Simpson Amendment to the 1954 Atomic Energy Act, which specifically prohibits plutonium obtained from the reprocessing of spent fuel from civil reactors being used in nuclear weapons. This amendment, which was actively opposed by the DOE at the time of its enactment⁴⁵ contains a loophole in an exclusion clause permitting weapons use of civil plutonium "in case of national emergency". Thus the future of plutonium from commercial spent fuel has been kept open. The DOE continues the construction of its laser isotope separation facility at INEL which would enable DOE to make weapons grade plutonium from commercial reactor waste.

Pesticide replacement

In the absence of quantitative studies to estimate the carcinogenic risk posed by consuming irradiated foods, there is no basis to the claim that food irradiation could replace the use of carcinogenic pesticides as a means of food preservation. In 1987, the National Academy of Sciences identified 23 pesticides which together were held responsible for the vast majority of the total carcinogenic risk from pesticide residues in the US food supply.²⁰ Food irradiation would not eliminate these pesticides since most are herbicides, insecticides, or fungicides applied in the field to prevent pre-harvest losses.⁴⁶ In fact, since irradiated products are more susceptible to infection by moulds and fungi,^{47, 48} irradiation may well increase the need for post-harvest fungicides on fruits and vegetables.

Pathogens in Poultry

The highly automated and poorly regulated nature of many of the poultry production plants in the US has led to the increased danger of widespread contamination of supermarket chicken

with Salmonella and other pathogenic bacteria. As part of a recent study of the poultry industry in the US, the National Academy of Sciences (NAS) estimated the health effects of the bacterial contamination of chicken carcasses during slaughter. The NAS committee called for the upgrading of hygienic standards in slaughterhouses, and recommended the setting up of a comprehensive quality assurance programme with improved methods of monitoring compliance by poultry producers.⁴⁹ These recommendations are in line with those of other critics of the poultry industry, who see the current problem of bacterial contamination as the result both of regulatory lassitude on the part of the US Department of Agriculture and of the drive to increase production on the part of the poultry producers. Reform of the industry is the subject of pending federal legislation.

Hazards of Food Irradiation Facilities

A large food irradiation plant contains roughly 100 times as much radioactivity as a typical cobalt-60 source used in hospital cancer therapy. The inventory of caesium-137 present in a large irradiator is comparable to that in a 1000 megawatt nuclear power reactor.⁴⁰ Furthermore, irradiators are inevitably open structures since food must be able to pass freely in and out of the irradiation chamber.

Workers therefore run a high risk of exposure to lethal or near-lethal doses of gamma radiation.^{50, 51, 52} Equally, the opportunities for sabotage are numerous. The contamination of shielding pools from leaking source elements has been documented in existing irradiation plants, as has the leakage and spillage of shielding water into the surrounding environment. The mishandling of discarded gamma sources has led to two serious contamination incidents in recent years.^{53, 54} Indeed, as a result of mismanagement at an irradiation plant, the Nuclear Regulatory Commission (NRC) revoked the licence of a major company in the US irradiation industry.⁵⁵

In the light of these facts, it is extraordinary that the US Environmental Protection Agency (EPA) does not require an environmental impact statement prior to the siting of irradiation facilities, and that the NRC does not require special security measures. Clearly, the pressure to 'solve' the nuclear waste problem is guiding agency decisions, as non-regulation will greatly facilitate the licensing of hundreds of new irradiation facilities. Such facilities, however, cannot be in the best interest of those who work in or live near them, nor of the general public who will have no choice but to eat food which has effectively been legally contaminated.

Conclusion

The viability of food irradiation as a processing technology is based upon three false assumptions: first, that ionizing radiation can be used safely and effectively to destroy living organisms in food without producing dangerous changes in food chemistry; second, that hazardous by-products of nuclear weapons manufacture can be used safely and effectively in the civilian sector; and third, that dispersing radioactive materials into the environment results in an acceptable level of radiation exposure for any single individual.

In fact, the chemical changes in food produced by ionizing radiation are already known to be hazardous, and the FDA's claimed ignorance of that well-documented hazard is unques-

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tionably in violation of the law: recently, the Justice Department upheld a decision against the FDA by the District Court of Appeals in Washington, DC, charging that FDA had violated the Food, Drug and Cosmetic Act when it approved the use of two dyes shown by animal testing to be weak carcinogens.⁵⁶ The effect of this decision is to strengthen further the Delaney Amendment, which forbids the addition of any known human or animal carcinogen to food, drugs, or cosmetics. Since food irradiation is defined as a food additive,¹⁸ the evidence set out in Table II shows it would be a violation of the Delaney Amendment to permit the treatment of food with irradiation.⁵⁷

The view that the FDA's actions in the field of food irradiation have been unlawful and dangerous to public health has also been expressed at the state level; legislation banning the sale of irradiated foods has been enacted in the state of Maine, and is pending in New York, New Jersey, Alaska, Vermont, New Hampshire, and Pennsylvania. Citizen initiatives to ban irradiated food are underway in Florida and Oregon. Efforts to disperse into society at large the wastes from the manufacture of nuclear weapons is hardly a proper basis for food and public health policy. It represents a real threat to our existence, comparable to, if more protracted than, the direct use of those weapons on civilian populations. It cannot be allowed to continue.

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The Three Gorges Debacle

by Nayna Jhaveri

China is set to build the world's largest dam project at Three Gorges on the Changjiang River. Officials estimate that the project will uproot a third of a million people, although the true figure is likely to be closer to one million. In addition, the dam will increase waterborne disease; do little or nothing to alleviate flooding; destroy valuable fisheries and wildlife habitats; and cause severe salinisation problems downstream due to salt-water intrusion. Moreover, the energy provided will be used to power some of China's most polluting industries. China should set an example by abandoning such high-tech projects in favour of environmentally and socially benign alternatives.

The largest, most expensive and potentially most disastrous dam project in history is being planned in China with considerable backing from the World Bank. The dam is to be located at the mouth of the Three Gorges on the Changjiang (Yangtze River: 'jiang' means 'river'), the third largest river in the world. Rising in the snowy Tibetan plateau and cutting through the middle of China before finally emerging into the East China Sea some 6,300 kilometres (km) later at Shanghai, the Changjiang passes through a series of rapids in the 650 km between Chongqing and Yichang. Here, the channel is only 200 metres wide and almost sheer walls rise 500-600 km above the river.¹ This narrow passage makes up the Three Gorges or Sanxia.

The possibility of a dam at the Three Gorges has been discussed for about sixty years. Initially it was the dream of Sun Yat Sen, the founder of the Republic of China. In the 1920s, he described in his book *A Programme for National Construction* his idea of using the Three Gorges to generate electricity and improve navigation on the Changjiang.² Early reconnaissance work and planning carried out by Chinese engineers goes back to the 1930s and 1940s. The US Bureau of Reclamation proposed a 10560 MW scheme in 1944.³ Since 1949, a considerable amount of surveying work on the dam site has been carried out by the Changjiang Valley Planning Office (CVPO) and the Ministry of Water Resources and Electric Power (MWREP).⁴ The dam is expected to generate a maxi-

mum of 13,000 MW of electricity and to cost more than 15 billion yuan (about US\$ 4 billion).⁵ The dam site finally chosen is at Sandouping, 40 km upstream of the massive — and now operational — Gezhouba dam project near Yichang city.⁶

The present plan is to build a dam between 150 metres and 180 metres in height. The major benefits of the project are said to be:

- Alleviation of the threat of flooding;
- Provision of large amounts of 'clean' energy
- Improvement in navigation on the Changjiang.

Opposition

The project has sparked a major controversy both internationally and within China, particularly in Beijing where many warn of its dangers. In April 1986, a member of the Chinese People's Political Consultative Conference (CPPCC), Professor Qian Jiaju, a noted economist, spoke forcefully against the project. The need for huge investment and the tremendous detrimental effect it would have on the ecology of the area were unacceptable, he said. He went on to call for proper feasibility studies to be carried out before any decision on the dam's future could be made.⁷

Many Chinese experts have expressed concern about the huge investment; the long construction period; sedimentation problems and their effect on the inland port of Chongqing; the difficulties of resettlement; and China's technical capabilities in undertaking such a massive project. There

are also doubts about the ability to contain the project budget within the 15 billion yuan estimated by the Changjiang Valley Planning Office in May 1985. Indeed, the CPPCC calculates that the investment will in fact come to over 60 billion yuan, once the cost of building an accompanying thermal power plant to provide a stable and reliable power supply has been taken into account.⁸

China's State Council has now set up three bodies to co-ordinate feasibility studies, one of which was composed of members of the National People's Congress and CPPCC; it thereby included most of the opponents of the project.⁹ A team from the Chinese People's Political Consultative Conference Economic Reconstruction Team carried out a field survey in May 1985, essentially to canvass the opinions of over 400 people in the departments of economic reconstruction, transportation, geology, and hydroelectricity as well as some local, national and regional ministers.¹⁰

The battle continued to rage until a feasibility study funded by the Canadian International Development Agency (CIDA) was undertaken in June 1986. This study was originally scheduled to be completed by summer 1987; however, present timetables suggest that the report will not be ready before the Autumn of 1988.

The Feasibility Study

The terms of reference for the feasibility study provided by the MWREP in June 1986 indicated that the study's principal

aim is to secure financial support from outside China:

"The Government intends to start construction of the main works of the Three Gorges project in the near future and is considering the possible arrangement of international financing for this project. For this purpose, MWREP has decided to use a consultant to prepare a high-quality feasibility report which will form the basis for securing assistance from international financial institutions."¹¹

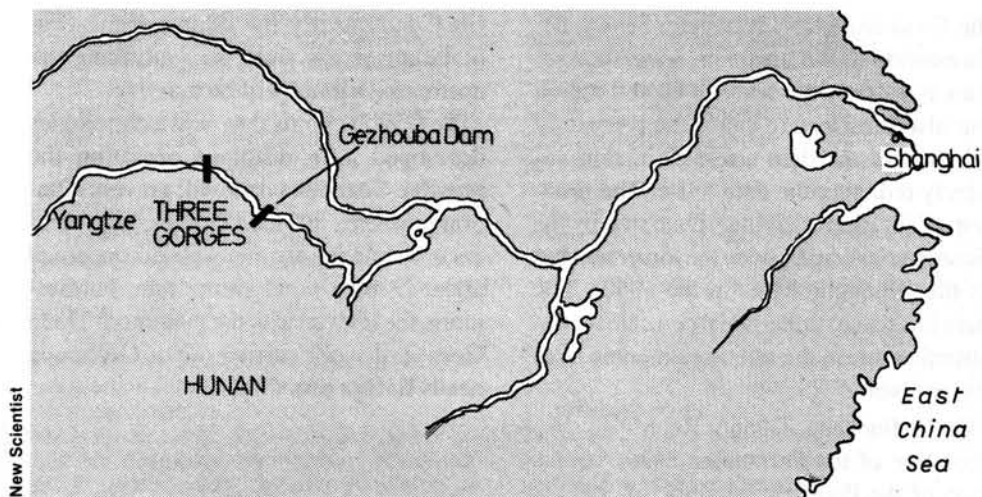
MWREP states that extensive studies have already been undertaken by the Chinese agencies on technical issues and resettlement plans. The work of the consultant will thus be simply to collate and present the results of all the studies carried out to date and 'establish' the technical, economic and financial 'soundness' of the Three Gorges Project. Furthermore, the World Bank, as MWREP's adviser, will play a lead role in assisting MWREP in co-ordinating and supervising studies.¹²

Although the final decision on the Three Gorges dam has been delayed, preparatory work on the site (such as the construction of highways, in addition to water and power supply projects) is being carried out by workers no longer needed at the now completed Gezhouba dam project nearby.

Indeed, in all likelihood, the feasibility study will simply act as a rubber stamp on the project, concluding that the dam is economically worthwhile, but recommending that the usual routine of monitoring and 'mitigating' measures be implemented to reduce the environmental impacts. However, in the case of a project as huge as the Three Gorges, minor design changes on a huge wall of concrete 150 metres (or more) high, blocking the third largest river in the world, are unlikely to prevent the environmental and social disaster which will undoubtedly follow the dam's construction.

The Changjiang Basin

The Changjiang basin is the centre of China's agricultural and industrial production. The cities along the Three Gorges have grown up gradually over thousands of years.¹³ Indeed, the Changjiang basin holds such an important position in the Chinese economy that any major changes to the river's ecological system and its ability to provide water should be approached with great care. About 347 million people live in the basin cultivating a total area of 24 million hectares of fertile land.¹⁴ Agriculture in the basin has been developed over centuries and, today, accounts for over 50 per cent of the nation's



main crops and products (see Fig.1). The basin is also vital for the production of hemp, oil-bearing crops, tea, tobacco, fruit and other cash crops.¹⁵ In addition, the estuary near Shanghai, together with the East China Sea, is one of the key production areas for aquatic products. The Changjiang basin is also the major waterway in Southern China and is known to the Chinese as the "golden waterway".

Controlling Changjiang Floods

A primary role of the Three Gorges dam, proponents claim, will be to control the severe floods which regularly threaten Changjiang residents. During the 2000-plus years between the Han Dynasty and Ming Dynasty, the Changjiang overflowed its banks more than 200 times. Since 1860, six serious floods have occurred in the Changjiang basin.¹⁶ Following the last major flood in 1954, a complicated series of dykes and reservoirs were built to provide flood control. Even so, floods still pose an ever-present threat to the residents of the basin.

The potential of the Three Gorges dam for controlling these floods is likely to be limited. Firstly, there are uncertainties as to which watersheds are the sources of the floods; and, secondly, deforestation, soil erosion and siltation, rather than poor water management, lie at the roots of the flooding problem.

The CPPCC survey report indicates that the Three Gorges dam would not provide much flood relief for the middle and lower reaches of the Changjiang on the grounds that the Chuanjiang (the main tributary upstream of the dam) alone is not a major cause of flooding. Storms that occurred in 1984 resulted in disastrous flooding in Sichuan but left the middle and lower reaches quite unaffected. However, the torrential rains which fell over the Hanji-

Figure 1.

Basic Facts about the Changjiang Basin

Items	% of national total
Area	20
Population	33
Farmland	25
Grain Output	70
Cotton Output	50
Freshwater Fish Output	66
Total Agricultural Output Value	40

ang and Xiangziyuanli basin in 1954 caused severe inundation of the middle and lower reaches. The Three Gorges dam cannot possibly control the flow from these water catchments, since they are located downstream of the dam.¹⁷

In addition, the dam will only serve to exacerbate flooding in the upper reaches due to siltation. The reduced flow into the reservoir will increase the silt deposition rate in the Minjiang and Peijiang rivers (both tributaries upstream of the dam) which in turn will raise the river bed and, therefore, the probability of flooding.¹⁸ The temporary evacuation of some 4000 people would also be required if a 5 per cent frequency flood hit the Chongqing-Hechuan-Jiangin area.¹⁹

The capacity of such lakes as Poyang Hu and Dongting Hu ('hu' means 'lake'), critically important in aiding retention of floodwaters downstream of the dam, have been extensively reduced due to increased siltation rates and reclamation activities over the last few decades.

Siltation

Clearly, the dam will not be able to control flooding in the Changjiang basin to any significant extent. Indeed, the solution to

the flood issue lies elsewhere. Severe deforestation in the upstream watershed region is not only the cause of local flooding but also threatens to cause the premature siltation of the dam's reservoir, thus severely reducing the dam's life. The problem of siltation is vividly illustrated by the Sanmenxia dam, built on the lower reaches of the Huanghe River in the 1950s. The dam has had to undergo large-scale reconstruction due to the rapid sedimentation of its reservoir.²⁰

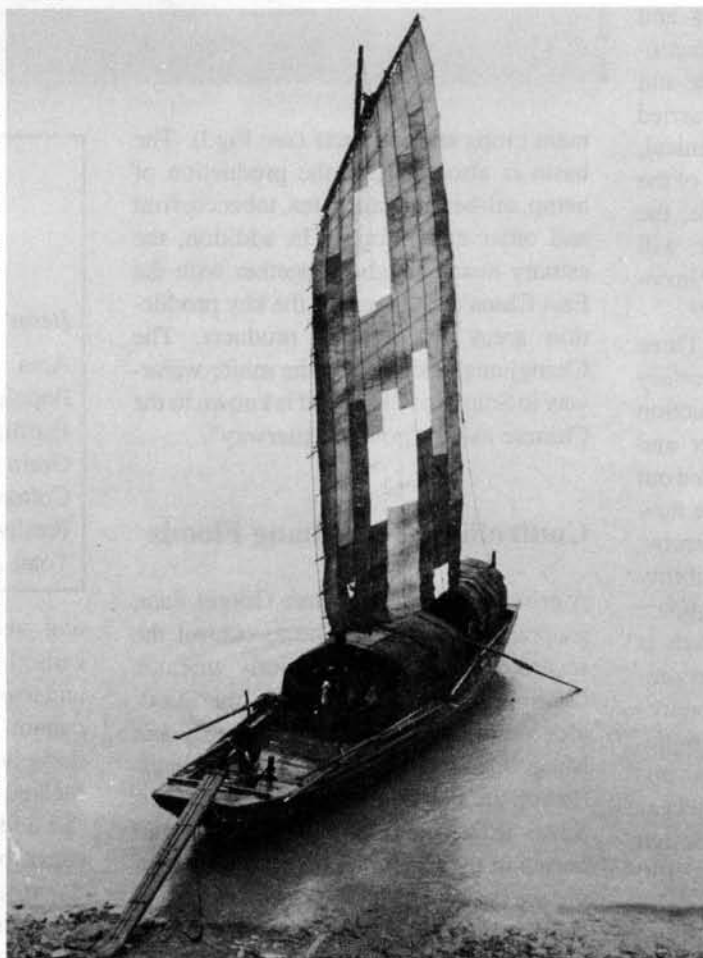
Dr. Li Jinchang, Deputy Representative of the Permanent Mission of the People's Republic of China to the United Nations Environment Programme noted that, every year, the three major rivers in Sichuan province carry an estimated 250 million tons of silt which represents about 5 cm of topsoil over an area of 166,000 hectares of cultivated land. Soil erosion due to deforestation in the upper reaches of the Changjiang produces most of this silt. An expert committee from China's National Science Association indicates the extreme extent to which deforestation has taken place in Sichuan: of the 193 counties in Sichuan, only 12 had forest cover exceeding 30 per cent of their land area, while of the 53 counties in Central Sichuan, almost half had forest cover which was less than three per cent of land area, in some cases, less than one per cent. Wuzheng county, one of the areas worst hit by floods, had more than 10,000 hectares of forest in the early 1950s, but by 1975 its forest cover was reduced to a mere 56 hectares.²¹

The total volume of sand discharged into the Changjiang has also increased markedly in recent years, primarily due to the indiscriminate logging of the forests in Sichuan, but also to extensive farming on steep mountain slopes. With recent economic reforms, designed to encourage the profit motive, the rate of deforestation is likely to increase. Between 1981 and 1984, the average volume of silt increased from 529 million tons to 680 million tons.²² A mathematical model produced by the Hydraulic Research Institute has shown that 61-67 per cent of the river sediments will be intercepted by the dam.²³ Naturally, the greatest volume of silt flow will occur during the flood season when the dam will not release its waters and so will trap the

silt. Consequently, the volume of silt accumulating on the river bed all along the upstream channel will be massive.

The CVPO claims that new technologies developed as a result of operating the massive Gezhouba dam will prevent siltation problems at Three Gorges, but workers at Gezhouba are themselves concerned about its own rapid silting rate. Furthermore, the relevance to the mammoth Three Gorges of work carried out at Gezhouba needs further proof.²⁴

Jhaveri



A traditional fishing boat at work near the Sandouping dam site. Dams on the Changjiang have already severely disrupted fisheries: the Three Gorges project could prove the final blow to the industry — and hence the livelihood of millions.

Improving Navigation?

A second reason for building the Three Gorges dam is to improve navigation on the Changjiang. One major restriction to navigation has been the stretch between Chongqing and Yichang which is full of reefs and dangerous shoals. It has been claimed that with the construction of the dam, these will be submerged, thus facilitating navigation. However, the problem of siltation in the backwaters upstream will negate this benefit. The dam will only improve the navigation channel up to 500 km upstream from the dam, whereas Chongqing, a major bustling port on the Changjiang (970 km upstream) will become a totally dead harbour as a result of

siltation.²⁵

Inundation and Relocation

The construction of the Three Gorges dam will create a huge reservoir which will stretch as far back as the port of Chongqing. The land which will be inundated will require the uprooting of vast numbers of people. A wide disparity exists between the various estimates that have

been made both of the numbers requiring resettlement and of the related costs. Assuming that the dam is 150 metres high, the CVPO calculates that 330,000 people will have to be moved. However, the Academy of City Planning and Design estimates 860,000 people. The CVPO calculates relocation costs at 3.5 billion yuan, whilst the Academy claims the cost will be about four times that amount, amounting to some 11 billion yuan. Following discussions with local officials in the affected provinces, the CPPCC has found the latter figure to be more realistic.²⁶

The reservoir will submerge 14 counties, 848 villages and 3214 isolated farmer households. About 10,000 hectares (ha) of farmland, 2300 ha of orange orchards and 800 ha of woodland will also be destroyed.²⁷ The CVPO's 3.5 billion yuan estimate for resettlement costs takes no account of the indirect loss in agricultural production, or of the loss of historical sites and of relics damaged by the project. The CVPO plans to remove most of the 330,000 inhabitants to higher ground above the new water level

and very few will be relocated to places outside of the reservoir region.²⁸

Plans are in hand to accommodate about half of the displaced farmers within the agricultural sector, the remainder being re-employed in construction work, industry and tertiary commerce systems.²⁹ Evidence from previous, unsuccessful resettlement programmes involving water development projects in China, combined with the limited potential for agriculture and industry to accommodate the resettled people locally, suggest that the entire resettlement scheme is totally unfeasible, thereby making the dam's construction unacceptable.

Past relocation projects do not bode well for the relocation scheme planned by the CVPO for Three Gorges. Resettlement

work has often been considered a necessary but unimportant part of water development projects and has therefore been completed with minimum work and money. Where problems have been encountered, accusations of 'class conflict' have been used to ensure that the programme went ahead regardless. Residents neither had much say in the development of the relocation sites nor any opportunity to put forward demands for financial compensation. Little consideration was ever paid to the social impact of resettlement. Many projects were inadequate in terms of their housing, the employment opportunities and income they provided, the local environmental conditions, and their development potential.³⁰

In the case of the Three Gorges dam, an additional problem is that the land in the Three Gorges region is already densely populated and cannot accommodate any new pressures or support an increased population. Therefore, relocation into these uplands will exceed the ecological capacity of the land. As it is, the Three Gorges area is poor, having been unscrupulously deforested, cultivated and terraced for many years. Much of the farming in this mountainous region is carried out on steeply sloping fields. Multiple cropping is common. Field size is very small (0.07 ha), with food consumption and availability being much lower than the average for Sichuan province or Hubei. The area is therefore already overpopulated and degraded.³¹ The forest cover has declined from 20 per cent in the 1950s to 10 per cent at present.³²

While the CVPO only plans to spend 1.1 billion yuan on constructing new towns and cities with adequate housing for resettlement, the Academy of City Planning sees the need for 5 billion yuan. Long-term poverty will not be alleviated by the Three Gorges dam which will serve only to worsen present conditions.³³ Many of the local people only know one way of life and work. Their society and environment will be destroyed and this loss cannot be compensated financially. The negative impacts of resettlement will be felt immediately, whereas many of the claimed 'benefits' from the dam will only accrue 20 years after construction begins.

Historical experience in China also demonstrates that people who have lost their basic livelihood and land due to the construction of large and medium-sized reservoirs do not become more affluent, even though they are provided with electricity. After decades of resettlement, their average income still remains at 200 yuan and



Traders at Fengjie, a riverside town which will be submerged. All told, 14 counties, comprising 848 villages, will be drowned, requiring the resettlement of one million people.

therefore within the category of the poor. This can be illustrated by several projects in the Dabai mountain and Yimeng mountain regions.³⁴

On paper, the relocation plans for Three Gorges look well-conceived but they are unlikely to materialise. For example, the development of the Three Gorges salt mine is seen as a possible source of employment for a large number of resettled residents, as it is believed that there is enough salt to provide the world with salt for 30,000 years. However, the reality is that the salt is too deep to be extracted. Extraction will result in pollution and destroy the potential for tourism. Competition from well-established salt industries in Zigong and Leshan will be very strong as well.³⁵

No consideration of the conflicts between tourism and industrial development, with its attendant pollution problems, have so far even been broached.³⁶

Impact on Agriculture

The dam will have both direct and indirect impacts on Changjiang's agricultural systems. The direct effect will derive from a changed ecology. No attempt has been made to understand how the water table will change, nor how the loss of nutrient-bearing sediments will affect soil fertility nor how salt-water intrusion into the estuary will affect one of China's agricultural heartlands. Yet the impact of these major changes in the ecosystem can only serve to deliver a severe blow to China's agricultural economy, which is already badly hit by the increasing disappearance of farmland due to desertification, soil erosion and the rapid growth of new towns. The effect

will surely be to reduce further the presently declining grain production from China's main agricultural region.

Downstream, the coastal provinces of Anhui and Jiangsu, which are constantly being built up from the Changjiang's sediment, will also suffer. Four new counties have been created in northern Jiangsu as a result of such coastal 'landbuilding'. Conditions in these coastal areas are favourable for the cultivation of two or three crops of grain a year.³⁷ If the dam is built, up to 800 km of this coastline could be lost to coastal erosion.³⁸

Fisheries

The Changjiang flows into the East China Sea at Shanghai. This estuarine area, combined with Jiangsu's shorelands, provides one of the most productive fisheries in China. The reduced water flow into the estuary of the Changjiang will narrow the area flushed by freshwater, allowing saline water intrusion into the estuary and thereby critically affecting its productivity. Productivity will be further reduced by the nutrient-deficient waters which will result from silt entrapment by the dam. The ecological changes in the river downstream from the dam and in the estuarine wetlands will be very dramatic. In the offshore fishing grounds, changes in salinity patterns will affect the migratory paths of certain commercially important fish, such as yellow croakers and hairtail.³⁹

Along the Changjiang's middle and lower reaches, fishing is a major occupation. The river itself, together with the two largest lakes in China (Poyang and Dongting), as well as the complicated network of fish farms, produce much of the local



A ship lock at Gezhouba Dam. The Three Gorges scheme is intended to improve navigation along the Changjiang, but siltation is likely to negate any benefits: the port of Chongqing is predicted to be totally silted up within a few years.

food supply. Sandouping, the dam site, has been a fishing village for centuries. Furthermore, fishing resources off the southeast coast are already being exhausted as a result of changes in the environment and gross overfishing;⁴⁰ the dam will further reduce catches. The amount of freshwater aquatic produce obtained from natural sources in 1976 was about half of what it was in 1954.⁴¹

Dramatic changes will also take place upstream from the dam, due to the switch from a fast flowing river to a reservoir. As a direct result, some 60 species of fish would be deprived of a habitat. The Chongqing-Zigui-Jianglin stretch of the river is an important fry base for four Chinese native fishes: *Genopharyngodon idellus*, *Mylopharyngodon plicatus*, *Hypophthalmichthys molitrix* and *Aristichthys nobilis*. These fish would be severely depleted or would disappear totally after completion of the project. Changes in the water flow downstream could significantly affect the future of several fish which are rare not only in China but throughout the world, such as Chinese sturgeon (*Acipenser sinensis*) and Chinese paddlefish (*Psephurus gladius*), which now only exist in the middle reaches of the river.⁴²

Saltwater Intrusion

The problem of saltwater intrusion has been a major problem in the Changjiang estuary for many years now. Once the dam begins to store water, intrusion of saline water into the estuary will become even more severe, infiltrating its network of streams and canals. Already in the dry season saltwater intrusion is a serious

problem affecting industrial, agricultural and domestic water use in Shanghai, as well as areas along the river in Jiangsu province. The dam will also prevent the drainage of pollution from the Huangpu Jiang which relies on the flushing effect of Changjiang water for removing industrial and domestic wastes. The Huangpu Jiang is the main source of Shanghai's industrial and agricultural water. There are eight waterworks along the river. Here, during a saltwater intrusion episode between the winter of 1978 and spring of 1979, chloride values of 3,950 parts per million (ppm) and 3,820 ppm were recorded at two waterworks. Drinking water should not exceed 250 ppm chloride content; rice seedlings require less than 600 ppm and general irrigation less than 1,100 ppm. Numerous industries were affected by the incident, including textiles, foodstuffs, medicines, metallurgy, chemicals and electronics. Preliminary calculations indicate a direct economic loss to industry in excess of 14 million yuan. Agricultural losses were also considerable.⁴³ With the dam's construction, such incidents can only become significantly more extreme.

Wildlife

The habitat for wildlife at China's two largest lakes — Poyang and Dongting — located along the Changjiang have been rapidly shrinking due to siltation and reclamation activities. Dongting Hu was described by ancient poets as a "boundless stretch of freshwater", but the description sadly no longer holds.⁴⁴ The impact of decreased water flows due to the damming of the Changjiang will severely intensify the ecological stresses already being faced

in the lakes, which not only support a spectacular range of wildlife, but also a large freshwater fishing industry.

Poyang Lake, the largest in China, abounds with fish, clams and shrimps making it well-known for its very productive fisheries (2 million metric tons a year). It is also famed as a nature reserve, providing wintering habitat for migrating birds, many of which are rare. It is one of the most important places on earth for wintering cranes; over 95 per cent of the world's wild endangered Siberian cranes winter here. Of an estimated world population of 4,500 White-naped cranes, about 1,600 have been counted at Poyang. The reserve also has world significance for Oriental white storks, swan geese and many other water birds.⁴⁵ The dam will be responsible for the possible disappearance of the Siberian crane, which is a Chinese symbol of well-being pictured abundantly in Chinese and oriental art throughout the ages.

The sea shore and the numerous islands off Jiangsu's coastline are natural habitats for 250 bird species, including 37 species under state protection such as the black stork, white stork, mandarin duck and swan. About half the red-crowned cranes found in the world winter in central Jiangsu's shoreland wilderness.⁴⁶ With the gradual erosion of the coastal lands, the habitat of these birds will be disrupted.

Other endangered and rare species which survive only in the Changjiang, such as the Chinese alligator and Chinese dolphin (baiji), will also find their feeding and breeding habitats affected by the changes in the river's ecology. The habitat of the alligator has been reduced in recent times in Anhui and Zhejiang and it is on the verge of extinction. According to Professor Chen Biyu, an expert at the China Changjiang Alligator Breeding Centre in Anhui, the alligator is being killed off by Chinese farmers, the overuse of chemical fertilisers and land reclamation projects.⁴⁷ It is estimated that less than 500 exist.

Disease

The increase in water-borne diseases following the construction of large dams has been well-documented.^{48,49} Two main diseases will increase along the Changjiang following the creation of the reservoir behind the dam: namely, schistosomiasis and malaria. Since the founding of modern China, many efforts have been made to control schistosomiasis, which is firmly established in a large area around the

Changjiang. Some 16 million people in Hubei and Hunan are affected by the disease, which is making a comeback. In one village in Hubei, 75 per cent of schoolchildren have the disease.⁵⁰ The creation of a large body of static water stretching for some 600 km or so will almost inevitably bring an upsurge in the incidence of the disease. In recent years, the incidence of malaria has increased in the area around the Danjiangkou Reservoir (in the Changjiang Basin).⁵¹

Pollution

The hydroelectricity produced by the Three Gorges dam will be used to develop new and diverse industries along the Changjiang, boosting both the government's 'modernisation' push and pollution levels, which have already reached critical proportions. As the Chinese Government begins to enforce stricter environmental controls in the big cities, some of the more polluting factories have started to move out to villages. In addition, the reduced water flow downstream from the dam will weaken the flushing capacity of the river, whilst, upstream of the dam, the reservoir will act as a barrier to swift pollution dispersion.

The large cities along the banks of the Changjiang, such as Chongqing, Wuhan, Nanjing and Shanghai are of central importance for Chinese industry. Chongqing and Shanghai are centres for the chemical industry; Nanjing is one of China's electronic capitals. Wuhan has industries ranging from metallurgy and textiles to chemicals and electronics. These same industries, expected to expand during the modernisation process, are the source of most of the pollution along the Changjiang.

Today, the picture is grim. Shanghai itself is severely affected by pollution in the Huangpu Jiang and Suzhou Creek, the main source of which is industrial waste as most houses do not possess flush lavatories. Drinking water is taken straight out of the Huangpu Jiang. In some rivers, phenol, arsenic and mercury concentrations have already exceeded set safety standards.⁵² Guo Zhizhong, Professor at Hehai University, describes Nanjing's Qinhuai Jiang, lauded in classical poetry for its beauty, as a 'filthy sewer', and blames the 400,000 tons of waste flowing into it daily.⁵³ Marine pollution is so severe in certain areas that there has been a sharp drop in the number of valuable and

economically useful marine products, such as prawn, scallop and jellyfish. Significant damage, too, has been inflicted on the

"The Chiangjiang will be grossly polluted by the year 2000 if present waste disposal problems along its banks are not solved"

migration routes of anadromous fish in large rivers.⁵⁴

Conditions can only be expected to worsen as riverside factories are encouraged, river transport being a key factor in choosing new plant sites. Eight of the fourteen large chemical installations imported from abroad in recent years were built along the Changjiang.⁵⁵

The Changjiang will be grossly polluted by the year 2000 if present waste disposal problems along its banks are not quickly resolved. More than 20 large and medium-sized cities are located on its banks. A recent survey indicated that cities along the Changjiang tributaries now dump 16 million tons of liquid waste into the rivers each day. Even if there is no further escalation in pollution, the river will drain off 30 billion tons of liquid wastes per year by 2000. It is reported that 86 per cent of China's rivers are already unfit for drinking or fish breeding.⁵⁶

The likelihood of appropriate environmental controls being instituted to control industrial growth along the Changjiang is slim. Although the State Planning Commission announced in May 1987 that it would allocate 12.5 billion yuan to prevent water pollution in the next few years,⁵⁷ the problem of pollution is unlikely to be controlled easily. Since the end of the 1970s, following economic reforms, thousands of rural enterprises have mushroomed across China, creating considerable pollution.

According to a survey conducted by the Jiangsu Provincial Environmental Protection Bureau, in 1984 most of the waste from rural industrial enterprises in the province was discharged without treatment. In addition, rapid population growth in rural towns and insufficient public disposal facilities have increased the amounts of wastewater and sewage. This problem is not restricted to Jiangsu, the root cause being poor environmental controls and planning in rural towns, which has encouraged a migration of polluting industries from big cities to rural areas. The advent of electricity in smaller towns as a result of Three Gorges, together with a lack of enforcement of envi-

ronmental laws, will inevitably exacerbate both water pollution and other forms of pollution.⁵⁸

Earthquakes, Landslides and Bombs

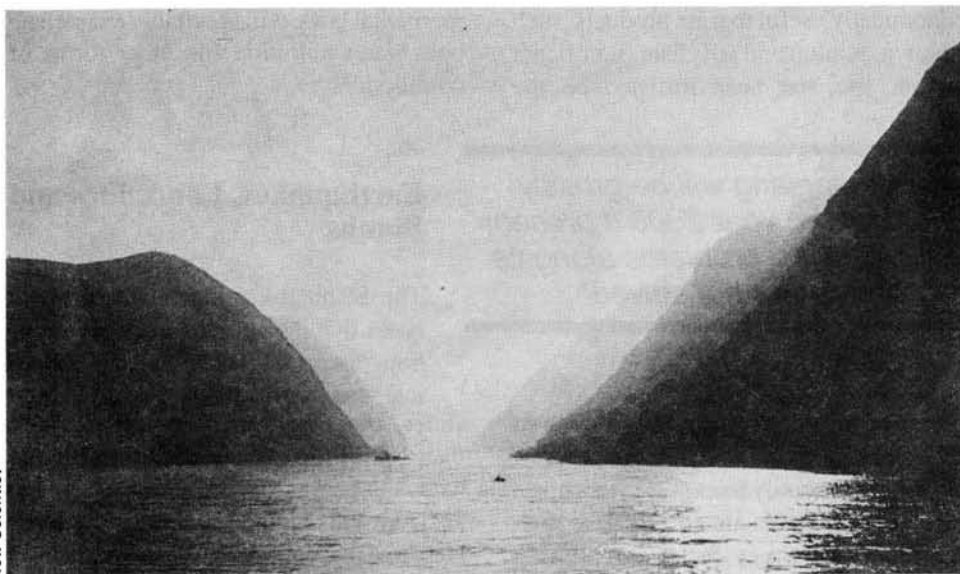
The Sichuan Geological Department notes that the geological structure of both banks of the Changjiang is fragile, resulting in many rock falls and slides, some 30 of which have carried more than 10 million cubic metres of earth, the most dangerous having occurred at Lianziyan and Xintan. Many have speculated that the Xintan slide occurred following the filling of the reservoir of the enormous Gezhouba dam. The increased number of landslides and rockfalls incurred by the Three Gorges dam will present a great risk to transportation along the river. Furthermore, such rockfalls can create tidal waves which could breach the dam.⁵⁹

According to studies by the Wuhan Earthquake Research Department, there are at least 80 large to medium-sized hydroelectric power stations which have induced earthquakes in the past. Prior to dam construction, some of these areas only experienced small scale earthquakes or none at all. With regard to the Three Gorges dam, there are three fault lines in the area. These lines intersect in the region of Lianziyan and Xintan—a region where an earthquake of 5.1 on the Richter scale occurred in recent times.

Another major source of danger is the likelihood that the dam would be a target of attack during a war, thus devastating a densely populated area of China.

Loss of Aesthetic and Cultural Resources

The Three Gorges would dam one of China's greatest beauty spots and a famous tourist attraction. Steep canyons with swirling mists, and scores of historical and archaeological sites that are thousands of years old will be inundated. Legends and poems regarding the Gorges are abundant. Most Chinese look upon the opportunity to visit the Three Gorges as one of the most significant events of their lives. As has happened with the Gezhouba dam, the trip through the Three Gorges dam locks will become the only thrill in travelling down the Changjiang. The CVPO suggest opening up the tributaries of the Changjiang as a tourist attraction, but this will simply be



The mighty Changjiang River, a habitat for numerous species, many of them endangered, and the source of livelihood for millions of people. Will the Chinese sacrifice this invaluable cultural and ecological heritage for a temporary source of power?

a compensatory measure for the Gorges themselves which will have been lost forever.

Wrong-Headed Development

China's ultimate objective is to 'catch up' with the developed countries, while maintaining a socialist system in which the benefits of prosperity are widely shared.⁶⁰ Officially, the Three Gorges project is therefore seen as a symbol for rapid and equitable growth in the twenty-first century. Electricity generation, together with flood control in the Changjiang basin, will, it is claimed, pave the way to greater industrialisation and increasing production for export markets via imported technology, thus enabling China to reach her ambitious target of quadrupling the country's Gross National Product (GNP) by the year 2000.

What effect will this type of development strategy have for the welfare of China's people and her environment? Increasing the GNP of a country can no longer be seriously equated with increased welfare. When orthodox GNP-oriented nations like the USA or Japan are showing signs of impending collapse, knowing that they cannot maintain their pie-in-the-sky levels of affluence without ensuring the opening of new markets, such as China, for selling their technology, it seems hopelessly out-of-touch of China to be treading the same sterile path.

The Three Gorges may provide China with plentiful energy, possibly even allowing her to catch up with the developed world *economically*, but in doing so she can only increase the rate of environmental exploitation through increased consumerism, a strategy which in the long-term is

not development at all.

Indeed, it is not only the direct economic, social and environmental impacts of the dam on the Changjiang basin (in themselves enormous) which are a source of danger for the people of China, but also *the very fact that the Three Gorges project is the lynch-pin of the environmentally unsound policies which China's leaders are now pursuing through their present modernisation goals.*

Alternatives

Alternatives exist for generating the same amount of electricity as the Three Gorges without the same level of social, economic and environmental destruction. Yet, the Environmental Impact Assessment carried out by the CVPO has not seriously considered the alternatives to the Three Gorges dam for the Changjiang basin. An enormous amount of research has been carried out by research institutes, universities, and the Changjiang Valley Planning Office on the technical feasibility and impacts of the Three Gorges dam for the last fifty years. If about half of those resources had been placed on assessing alternatives, many solutions would already be in hand for generating electricity at a lower monetary, social and environmental cost.

One plan could be to build a series of 10 to 20 mini hydro-stations, generating the same total installed capacity of 13,000 MW in the upper reaches of the tributaries of the Changjiang in Sichuan, Huhei and Hunan where a large proportion of the hydropower potential is located. These would require a lower amount of capital and would generate electricity sooner than the Three Gorges project. They could also

be built successively in groups to meet increasing power demand.

The problem of flooding can only be tackled through control of soil erosion by afforestation schemes and better farming practices. Financial and political support needs to be generated for the afforestation schemes that are required. This work must be enhanced by greater efforts to enforce forestry laws to curb the already rampant illegal logging taking place in Sichuan and elsewhere.

Furthermore, if agricultural and aquatic production is to continue at sustainable rates, then much work will need to be carried out to ensure that the present productivity of the Changjiang basin can continue to support local needs and is not eroded by the year 2000.

There are also alternatives to the model of development presently being pursued in China. The satisfaction of needs-oriented goals, achieved through environmentally-sound projects and frugal resource consumption, provides a new development route to which China should commit herself, thus giving an example for other Third World countries to follow. By caring for the environment, such development would increase the welfare of a greater number of people than would the pursuit of old-fashioned consumption-oriented goals.

Conclusion

The value of an environmental impact assessment of the Three Gorges for decision-making is very low. A project which will essentially demolish the face of life on the Changjiang as it exists today to produce a post-Three Gorges future is no future at all for the Chinese people. Mitigation measures and altered design features are not going to alleviate any of the severe social, economic and environmental costs which will be incurred following the damming of the mighty Changjiang — costs, moreover, which will continue to accrue to future generations.

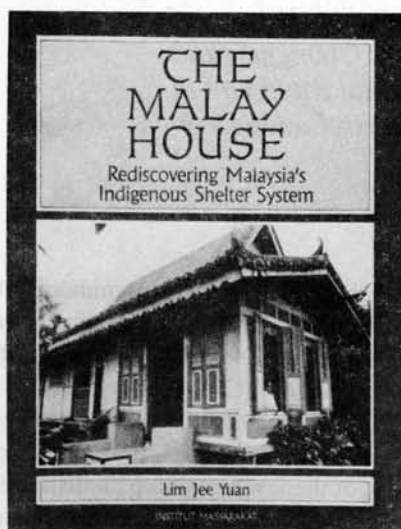
"*Shivu zongg shi yi fen wei er*": "There are two sides to everything". Why should China squander her future by building a project which will annihilate a whole river basin, when other options are available, ones which will provide greater real benefits in terms of satisfying the basic needs of the people and improving their welfare?

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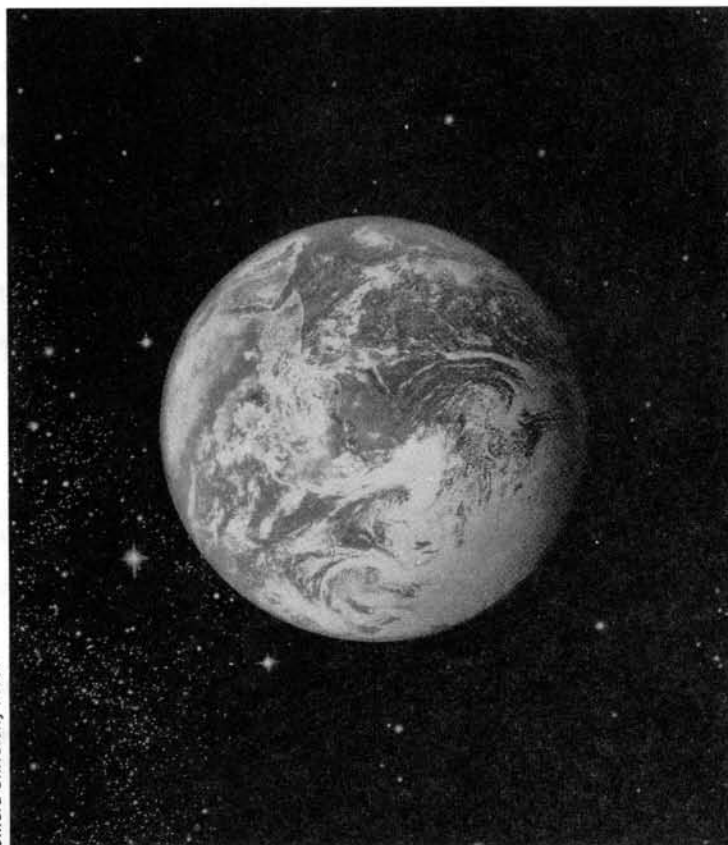
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*Gaia, as portrayed on the front cover of Jim Lovelock's book, **Gaia: A New Look at Life on Earth**. The Gaia hypothesis constitutes one of the most formidable challenges yet to the reductionistic ecology of the academic establishment.*

Gaia: Some Implications for Theoretical Ecology

by Edward Goldsmith

If we accept the Gaia Hypothesis, then modern reductionist and mechanistic ecology, as taught in our universities, can no longer be defended. However, rather than simply returning to the "holistic" ecology of Clements and Shelford, a more sophisticated ecology must be developed to take account of the work of such holistic thinkers as C.H. Waddington, Paul Weiss, Ludwig Von Bertalanffy and others.

Ecology, as an academic discipline, was developed towards the end of the last century. It came into being largely when a few biologists came to realise that the biological organisms and populations which they studied were not arranged at random but were, on the contrary, organised to form 'communities' or 'associations' whose structure and function could not be understood by examining their parts in isolation from each other. Both Frederick Clements and Victor Shelford, two of the most distinguished of the early ecologists in the USA, defined ecology as the "science of communities".¹

In the 1930s, the Oxford ecologist Arthur Tansley coined the

term 'ecosystem',² which he defined as a community taken together with its abiotic environment, much as Jim Lovelock sees 'Gaia' as the biosphere taken together with its abiotic environment. It is probable that if Clements or Shelford were alive today they would see ecology as the "science of ecosystems". Eugene Odum, one of the most prestigious ecologists alive today (and also one of the few remaining "holistic" ecologists) defines ecology as "the structure and function of nature".³ Since he is one of the few modern ecologists to have taken the Gaia thesis seriously, I recently asked him if he would agree to seeing ecology defined as "the structure and function of Gaia"⁴ — the overall ecosystem into which nature is organized. He fully agreed that this was a very acceptable definition.

Ecology, seen in this light, would be indistinguishable from Jim Lovelock's 'geophysiology'. It would of necessity be interdisciplinary. This was clear to the early ecologists who saw

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ecology as an all embracing super-science. Barrington Moore, for instance, the first President of the American Ecological Society, saw ecology as "the science of synthesis", and as being "superimposed on the other sciences". "Will we be content", he asked his colleagues, in his address to the St. Louis branch of the society in 1919, "to remain zoologists, botanists, and foresters, with little understanding of one another's problems, or will we endeavour to become ecologists in the broad sense of the term? The part we play in science depends upon our reply. Gentlemen, the future is in our hands."⁵

Ideally, of course, ecology taken in that holistic sense of the term, would be non-disciplinary, rather than inter-disciplinary, since the disciplines into which knowledge has been divided have developed in such total isolation that they are difficult to reconcile with each other, still more difficult to merge into an ecological superscience. What is certain is that ecology, if it is really to explain the structure and function of Gaia, should take into account a whole body of material that was not available to the early ecologists and that has been ignored by modern ones. This would include the Gaia thesis itself; the work of Lynn Margulis on symbiosis, which even the latest ecological literature on cooperation or mutualism in ecology does not mention; and the equally relevant and highly holistic writings of A.N. Whitehead, C.H. Waddington, J.H. Woodger and other members of the Theoretical Biology Club that flourished in the 1940s.

J. H. Woodger, for instance, clearly saw that nature was one. He saw, too, that its functioning could not be understood in terms of a set of separate compartmentalised disciplines, and clearly stated that what was needed was "a most general science, not immersed in a particular subject matter, but dealing with the relationship between various special sciences and trying to synthesize their most general results."⁶

The similarity between this view and that expressed by Barrington Moore is very striking. Indeed Woodger's *Biological Principles*, now totally overlooked by ecologists, is an important ecological work which we cannot afford to ignore. The writings of other holistic thinkers such as the Cambridge ethologist W.H. Thorpe, the Swiss psychologist and biologist Jean Piaget and the US cytologist and embryologist Paul Weiss, are also of the greatest ecological value.

Equally relevant is the general systems theory of Ludwig von Bertalanffy of which a variant was developed independently at about the same time by Ross Ashby. General systems, which must not be confounded with systems ecology, an essentially mechanistic and reductionistic discipline, provides an indispensable tool for the development of a unified science — what one might call "real ecology" — but is equally ignored by modern ecologists. I shall refer to this again later.

The Perversion of Ecology

However, real ecology is not the order of the day. If modern ecologists take no account of Jim Lovelock's Gaia thesis, of Lynn Margulis' work on symbiosis, or the writings of Whitehead, Woodger, Waddington, Piaget or of Von Bertalanffy's general systems theory, it is because ecology is no longer a "science of communities" nor a "science of ecosystems", let alone a science concerned with "the structure and function of Gaia." As Donald Worster shows in his most illuminating book *Nature's Economy*,⁷ Odum is today on his own. Worster documents the extraordinary transformation that ecology has undergone in the last 40 years to make it conform more

"The Gaia Thesis is holistic — holistic in the extreme. . . For Lovelock, 'the entire range of living matter on earth, from whales to viruses, and from oaks to algae, could be regarded as a single living entity, capable of manipulating the earth's atmosphere to suit its overall needs.'"

closely to the paradigm of reductionistic and mechanistic science — and thus to conform with the paradigm of modernism, which serves to rationalise, and hence legitimise, our aberrant and necessarily short-lived modern industrial society. Significantly, a closely parallel transformation has taken place in comparative psychology, genetics, evolutionary theory, anthropology and sociology.

Other students of the history of ecological ideas have also noted this transformation. Daniel Simberloff, for instance, tells us:

"Ecology has undergone, about half a century later than genetics and evolution, a transformation so strikingly similar in both outline and detail that one can scarcely doubt its debt to the same materialistic and probabilistic revolution. An initial emphasis on a similarity of isolated communities replaced by concern about their differences: the examination of groups of populations largely superseded by the study of individual populations; belief in deterministic succession shifting with the widespread introduction of statistics into ecology, to realization that temporal community development is probabilistic: and a continuing struggle to focus on material, observable entities rather than ideal constructs".⁸

As a result of this transformation, virtually all the established principles of the old ecology have been abandoned. Thus the whole is no longer seen as being more than the sum of its parts and is therefore studied by examining the parts themselves in isolation from each other: competition has replaced co-operation as the ordering principle in nature: diversity no longer favours stability: ecological succession no longer leads to a stable climax: and the mere mention of the term "Balance of Nature" elicits from our academic ecologists a condescending smirk, if not a belly laugh.

Ecology has in fact been perverted — perverted in the interests of making it acceptable to the scientific establishment and to the politicians and industrialists who sponsor it. In a way, this is understandable. Were it otherwise, as Worster admits, "ecologists might have disappeared as an independent class of researchers and would not occupy today such an influential position among the sciences." That said, however, it is by no means clear that ecologists do in fact exert such influence. Indeed, it is unlikely that those ecologists who view the biosphere in purely reductionistic and mechanistic terms can understand the implications of the devastation being wrought by the modern industrial system, and hence that they can understand what action is required to bring this devastation to an end. This partly at least explains the negligible role played in Britain by the British Ecological Society in awakening scientists, politicians and the general public to the present world ecological crisis which threatens the very survival of man on this planet.

The answer to the question "What are the implications of the Gaia thesis for ecology?" must thereby depend on which ecology we refer to. Clearly the Gaia thesis cannot in any way be

reconciled with the ecology that is taught in our universities today. If the thesis were to be accepted, and today's academic ecologists were to face its implications, then conventional ecology would have to be transformed into a more sophisticated version of the old ecology of Clements, Shelford and Barrington Moore, which today's ecologists have been at pains, over the last fifty years, to discredit. For that reason, I agree with Lynn Margulis and Dorion Sagan that "the Gaia hypothesis is likely to provide the foundations for a new ecology."⁹

The Pioneer and the Climax World Views

The reductionist and mechanistic ecology of today and the holistic ecology that the Gaia thesis will help us create reflect two diametrically opposed world views. For the purposes of this paper, I shall refer to the former as "the pioneer world-view" and to the latter as "the climax world-view". Let me explain why. A pioneer ecosystem, that is to say an ecosystem in the earliest stages of development, or one that has been ravaged by some discontinuity such as a volcanic eruption or an industrial development scheme, displays a whole constellation of closely related features. In a sense, such an ecosystem is the least 'living' of ecosystems or, more precisely, the one in which the basic features of living things are least apparent, for the obvious reason that they have not yet had time to develop. Such an ecosystem is among other things highly productive, which of course endears it to our modern production-oriented society which can cream off the apparently surplus biomass, process it, and put it up for sale on the international market. The reason why it is so highly productive, of course, is because as soon as it is brought into being, so the healing processes of nature are brought into operation and the ecosystem changes rapidly via the different stages of ecological succession until it achieves that state which resembles, as closely as possible, the original climax.

The climax or adult ecosystem, on the other hand, is very unproductive. This must be so both because the climax is the most stable state possible in the local biotic, abiotic and climatic circumstances, and because the achievement of such a stable state appears to be the basic goal of living things. Once achieved, change is kept to a minimum.

The pioneer stage has other essential features that are all closely associated with each other, so much so that to display one of those features means displaying the others too. For instance, there is little *diversity* and little *organisation* in such an ecosystem, and, as a result, its constituent parts appear to be arranged in a disorderly or *random* manner.

This being so pioneering ecosystems appear *individualistic* and their behaviour seems to be explicable by studying them *reductionistically* on their own. They are also *competitive* since they are subject neither to the constraints which might be applied on them by the larger whole, of which they are part, nor to self-imposed internal constraints. Instead, only external constraints (competition, predation, 'management' etc) operate. Such controls are crude and inefficient; as a result, the life of these ecosystems is punctuated by large and often unpredictable discontinuities which they cannot accommodate without undergoing serious structural changes (population collapses, for instance). In other words they are highly *unstable*.

Randomness, individualism, competition, crude external controls and instability are indeed the inevitable features of a pioneer ecosystem; they are the features too of a world in which the basic features of living things are still embryonic. They are also the

features of the degraded society of which we are part and of the degraded environment in which we live today, both states being the inevitable result of the process of industrial development which we are misguidedly taught to identify with 'progress'. They are, in fact, the features of what Eugene Odum refers to as a "disclimax".¹⁰

The features of a climax ecosystem, on the other hand, are totally different, indeed diametrically opposed. A climax ecosystem is orderly and its behaviour goal-directed or *teleological*. Individuals are integrated into larger wholes at different *levels of organisation* — the family, the small community and the larger society, levels which themselves are part of the hierarchy of the biosphere. For such wholes or systems to exist implies that their parts co-operate with each other. They also possess highly sophisticated *internal control mechanisms* which enable them to reduce environmental discontinuities, either by bringing about the appropriate changes to their environment (changes, which among other things, must serve to insulate them from the rigours of their external environment) or, alternatively, by increasing their ability to deal with such discontinuities. Both such strategies serve to assure the preservation of their basic structure in the face of change and hence, correspondingly, to increase their *stability*. Such systems are thereby *homeostatic*, and their fate is no longer dependent on the crude interplay of external forces.

Order, teleology, wholeness, co-operation, stability, and internalised control are the inevitable features of a climax ecosystem as they are of all complex living things. They are also the features of a climax society — that is, a society culturally designed to flourish as part of a climax ecosystem. The only society that fits this description is a tribal society.

If Jim Lovelock's Gaia thesis has caused a major stir in scientific circles, it is largely because it implies a major shift from the pioneer world-view to the climax world-view. In this paper, I would like to show just how it has affected some of the main features of the former world-view as it is reflected in modern ecology. I would also like to carry the argument a stage further to see how the Gaia thesis itself would be affected by what ecology should be — a "Gaian ecology", we might call it — one that takes the climax rather than the pioneer state to be the norm.

Holism

Science is still reductionistic or analytical. Underlying it is the metaphysical assumption that the smaller the particles the more concrete and real they must be. W H Thorpe defines reductionism as:

"the attribution of reality exclusively to the smallest constituents of the world and the tendency to interpret higher levels of organisation in terms of lower levels."¹¹

Atoms are considered particularly real today; however, with the great vogue enjoyed by molecular biology, molecules have also acquired 'realness'. Francis Crick still insists, for instance, that they are the only reality. In saying this, he and other reductionists are committing what Whitehead called "the fallacy of misplaced concreteness", that of abstracting a part and ascribing to it the sort of reality that belongs to the whole.¹²

Science also assumes that for knowledge to be 'exact' and 'mature', it must be formulated in quantitative terms. This can be done where the subject matter is physics, hence the tendency to seek to understand biology, ecology and even sociology in physical terms. However, as Pantin notes, physics has been able



The chief characteristics of a pioneering ecosystem like the heath (left) are "randomness, individualism, competition, crude external controls and instability." By contrast, those of a climax ecosystem (right) are "order, teleology, wholeness, co-operation, stability and internalised controls."

"to become exact and mature just because so much of the whole of natural phenomena is excluded from this study."¹³

The physicist, by reason of his training, cannot avoid leaving out "so much of the whole of natural phenomena", but then, as Paul Weiss argues, "there is no reason for us to downgrade nature to meet his inadequacy."¹⁴

One of the failings of the reductionist world view is that it sees the world as dead, machine-like, passive and crude. Indeed, as Von Bertalanffy notes, it makes no differentiation "between physical and chemical processes taking place in a living organism and those in a corpse; both follow the same laws of physics and chemistry."¹⁵ He goes on to note: "Concepts like those of organisation, wholeness, directiveness, teleology, control, self-regulation, differentiation and the like are alien to conventional physics". Yet they are "indispensable for dealing with living organisms or social groups."

The Gaia thesis is holistic — holistic in the extreme. Jim Lovelock notes how "most of us were taught that the composition of our planet could adequately be described by the laws of physics and chemistry."¹⁶ He refers to this as "a good solid Victorian view", but it is wrong. Gaia can only be understood in terms of the structure and function of living things. This is one of the most important messages of the Gaia thesis. Lovelock's argument is still more holistic when he tells us:

"The entire range of living matter on earth, from whales to viruses and from oaks to algae, could be regarded as constituting a single living entity, capable of manipulating the earth's atmosphere to suit its overall needs and endowed with faculties and powers far beyond those of its constituent parts."¹⁷

This clearly means that the behaviour of Gaia cannot be understood by examining its parts in isolation from each other, which must follow if Gaia is an organisation and therefore more than the sum of its parts. Lovelock even compares Gaia to a biological organism, in that, like an organism, it is a cybernetic system geared to the maintenance of its stability or homeostasis. This thesis would have been acceptable to the early ecologists who regarded an ecological community as very similar to an organism. Thus A.S. Forbes stated in 1896 that "a group or association of animals is like an organism."¹⁸ C.C. Adams, in the

first American book on animal ecology, published in 1913, insisted that:

"the interactions among the members of an association are to be compared to the similar relations existing between the different cells, organs or activities of a single individual."¹⁹

Thienemann went further. He saw the living things that made up a lake community, for instance, as "a unity so closed in itself that it must be called an organism of the highest order."²⁰

Frederick Clements in his book, *Plant Succession*, published in 1916, tells us that:

"The unit of vegetation, the climax formation is an organic entity. As an organism, the formation arises, grows, matures and dies. Its response to the habitat is shown in processes or functions and in structures which are the record as well as the result of these functions."²¹

In fact, this view of the ecological community as a 'supra-organism' became so well established that Simberloff refers to it as "Ecology's first paradigm."²²

As Bodenheimer noted at the time, the highly integrated supra-organismic concept of the community was stressed in nearly every textbook of ecology and "backed by established authority". Indeed, it was generally regarded "if not as a fact, then at least as a scientific hypothesis not less firmly founded than the theory of transformation" — that is, of evolution. He went on: "It is above all the concept that distinguishes ecology from biology proper."²³

With the transformation of ecology, which I have already referred to, this view was slowly abandoned in favour of one that better conformed with the reductionist paradigm of science and, hence, with the paradigm of modernism which it serves to rationalize. The resulting reductionistic approach to ecology — which sounds like a contradiction in terms — is normally traced to the writings of H.A. Gleason, whose famous article "The Individualistic Concept of the Plant Association", was first published in 1926 and presented and discussed at the International Botanical Congress that year.

Significantly, Gleason used the usual reductionist argument I have described above. He regarded the association or community as an abstract entity that only existed in the eyes of the beholder, for only the individual was real. The same argument, one might

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add, is still used by Neo-Darwinists today to justify their preoccupation with selection at the level of the individual, and their refusal to see evolution as a process occurring at the level of the 'unreal' ecosystem, let alone of a still more 'unreal' Gaia.

Initially, Gleason's thesis was very badly received. In the words of McIntosh, a noted historian of ecological thought, Gleason was "anathema to ecologists."²⁴ Gleason himself admitted that for ten years after the publication of his article, he was "an ecological outlaw."²⁵ His thesis simply did not fit in with the ecological paradigm of the times. However, as the latter was transformed so as to make it conform with the paradigm of science, so Gleason's ideas became increasingly acceptable.

In the 1930s, Arthur Tansley, to whom I have already referred, and who had originally adopted a firm holistic position, abandoned it in favour of a highly reductionist one. He denied the basic holistic principle that the whole is more than the sum of its parts and hence that it is not amenable to study by the reductionist method of science. "These 'wholes' ", he wrote, "are in analysis nothing but the synthesized actions of the components in associations."²⁶ A mature science, in his view, "must isolate the basic units of nature" and must "split up the story" into its individual parts. "It must approach nature as a composite of strictly physical entities organised into a mechanical system. The scientist who knows all the properties of all the parts studied separately can accurately predict their combined results."²⁷

If this were so, then the very term 'community' would be superfluous, and he sought to eliminate it from the scientific vocabulary. He denied too that there was anything in common between human associations (which he presumably regarded as legitimate communities) and those to be found among non-human plants and animals. The latter were not "linked by psychic bonds",²⁸ and, hence, for a reason that is not altogether clear, were not true communities.

Today, reductionist ecology is firmly established. Collier and his colleagues go so far as to insist that the individualistic concept "constitutes one of the most influential and widely accepted views at the present time."²⁹ McIntosh refers to reductionist ecology as "a viable and expanding tenet of current ecological thought"³⁰, while, Colinvaux, in a well known textbook of ecology, describes the holistic view of the community as a "heresy".³¹

Other modern ecologists go still further and actually claim that their work has provided incontestable proof of the validity of Gleason's philosophy. Curtis, for instance, tells us that "the entire evidence of (his own) plant ecology study in Wisconsin can be taken as conclusive proof of Gleason's individualistic hypothesis of community organisation . . ."³², while Whittaker regards his "gradient analysis" as providing similar evidence.³³

This sort of nonsense will become more and more difficult to sustain as Lynn Margulis's work on symbiosis becomes increasingly accepted, and as the new holistic ecology develops. I say "new" because the holistic ecology of the past had major shortcomings. Among other things, it never explained the relationship between the whole and the parts, let alone that between the parts and the whole. It never in fact really explained how living things were organised.

The Organisation of Gaia

One reason is that organisation cannot be explained in reductionist terms, since to admit that there is such a thing implies that systems are more than the sum of their component parts. Organi-

sation is also difficult to quantify. There have indeed been efforts to do so — by Dancoff and Quastler, for instance — but the type of organisation they are measuring, calculated in terms of Shannon and Weaver's reductionist and mechanistic concept of information, bears no relationship whatsoever to the biospheric organisation with which we are concerned.

To understand this organisation, we must start off by regarding the biosphere as made up of natural systems, operating at different levels of organisation. Natural systems must not be confounded with the systems studied by engineers. They are above all living systems which display all the features of living things already referred to. It is true that many of the definitions of natural systems are vague and could be made to include the engineer's systems, but this was not the intention of Von Bertalanffy, still less of Paul Weiss who defined a system "as a complex unit in space and in time whose sub-units co-operate to preserve its integrity and its structure and its behaviour and tend to restore them after a non-destructive disturbance."³⁴ Weiss' definition is a valuable one since it accentuates the essential aspects of living things such as their complexity, the co-operation between their parts, their tendency towards overall stability, and their ability to restore their basic features in the face of a disturbance — in other words, their capacity for homeostasis.

Lovelock defines Gaia, the all encompassing natural system, in very similar terms as:

"... a complex entity involving the earth's biosphere, atmosphere, oceans, and soil; the total constituting a feedback or cybernetic system which seeks an optimal physical and chemical environment for life on this planet."³⁵

There is every reason to suppose that such natural systems as molecules, cells, organisms, stable (tribal) communities and ecosystems can be described in similar terms. The behaviour of all such systems, in fact, can be shown, at a certain level of generality, to display the same fundamental features, which would suggest that they are all subject to the same basic constraints and are thereby governed by the same laws. If this is so, then it is clear how General Systems Theory provides a means of unifying science.

Hierarchy

Natural systems, however, are not arranged in a random way. They form a hierarchy. This means that each system is at once part of a larger system and at the same time made up of smaller ones. Paul Weiss notes how this is true of the cell, the main object of his studies. The cell must be seen:

"In a double light: partly as an active worker and partly as a passive subordinate to powers which lie entirely outside of its own competence and control, i.e. supra-cellular powers."³⁶

Arthur Koestler tried to show how this principle applied to all natural systems or 'holons' as he called them. He took the double-faced Roman God Janus, one of whose faces looks outwards and the other inwards, as a symbol of the holon, with its two roles within the hierarchy of the biosphere. Unfortunately, the whole subject of hierarchy is one that has been largely ignored by ecologists and scientists in general. To my knowledge, only two conferences have been held on the subject (one organised by Lancelot Law Whyte and the other by Howard Pattee. — and neither was very enlightening, the participants tending to use the term hierarchy very loosely to mean very different things.

Once again Eugene Odum seems to be about the only ecologist today to display an interest in hierarchy. He sees ecology as

largely concerned with the upper end of the hierarchy of the biosphere, that is "the system levels beyond that of the organism."³⁷

To understand the structure and function of Gaia means studying the hierarchy as a whole, which in turn means understanding the two roles of Janus, its relationship to the larger systems of which it is a part and its relationship to the smaller systems that in turn compose it. The former relationship is taboo among ecologists today as it is among mainstream scientists in general.

Indeed, if, as most scientists seem to, we were to accept the perfectly preposterous thesis of the selfish gene, then we would also have to accept that living things show no concern whatsoever with the survival of the larger systems of which they are part — no more in fact than do the inhabitants of the modern disintegrated non-society of today. Indeed, those who do show such an interest are described as displaying 'altruism', which apparently only occurs when, on the basis of a 'cost-benefit' analysis, they see co-operation as more likely to favour the proliferation of their genes than the usual much, more 'rational', competition and aggression. This may indeed be so in a disintegrated or neo-pioneer society and, in a pioneer ecosystem; it is not so, however, in a climax society, nor in a climax ecosystem whose members can only behave in that way which satisfies the requirements of the hierarchy of the larger systems of which they are part. As Von Bertalanffy writes:

"... an enormous preponderance of vital processes and mechanisms have a whole-maintaining character; were this not so, the organism could not exist at all...."³⁸

Ungerer, according to Von Bertalanffy, was so impressed with the "whole-maintaining function" of life processes that he replaced the biological "consideration of purpose" with that of the "consideration of wholeness",³⁹ a notion that is considerably reinforced by the Gaia thesis.

The main feature of Janus's relationship with its parts must be one of *control*. Whitman notes how the organism controls the action of the cells, during development:

"Comparative embryology reminds us at every turn that the organism dominates cell formation, using for the same purpose one, several or many cells, massing its material and directing its movements and shaping its organs, as if cells did not exist."⁴⁰

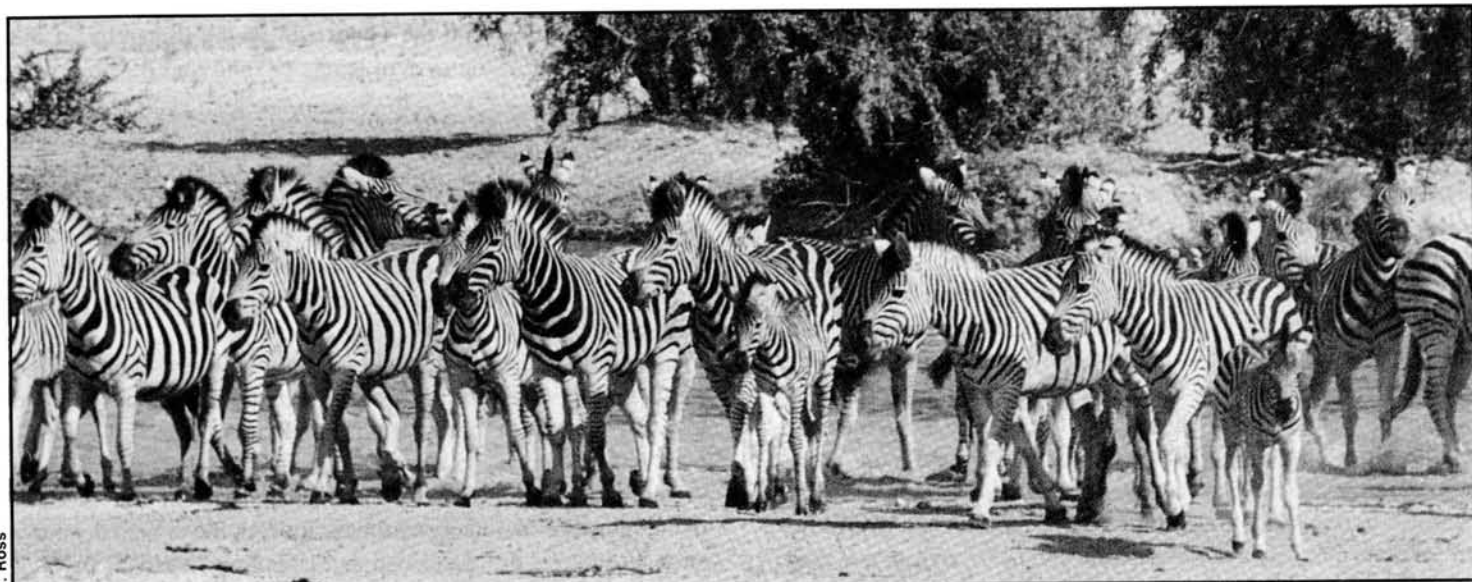
Paul Weiss points out how one cannot understand the behaviour of cells unless they are seen as the parts of a larger system which has the power to "integrate" and "direct" their behaviour.⁴¹ This principle is built into the concept of 'order', which is generally seen as the influence of the whole over the parts, and hence of the latter's degree of differentiation and interdependence and corresponding limitation of choice.

Pattee regards hierarchical control as "the essential and distinguishing characteristic of life." It must be a feature of all hierarchies and hence of all natural systems.⁴²

Weiss points to the various mechanisms that multicellular organisms develop to co-ordinate and control the activities of their component cells. He refers to:

"... the nervous system, the hormone system, the homeostatic maintenance of the composition of the body fluids; for in principle, each one of these subsystems operates within its own scope by the same rule of integrative dominance that the higher system exercises over its components."⁴³

Functionally, similar methods of hierarchical control are operative at the level of any ecosystem, though Odum is possibly the only one of today's ecologists to have pointed this out. In a sense, the "wholeness maintaining" behaviour of the parts and the control exerted over the parts by the whole — in other words,



K. Ross

The mutualistic relationships between species has largely been ignored by academic ecologists — at least until the last decade. But increasingly studies show many relationships previously thought to be predatory to be mutualistic. Even plants are no longer seen as passive in the face of grazing animals. Research reveals a whole host of strategies which they adopt to compensate against their losses.

the two different roles of Janus — are but different ways of looking at the same phenomenon. Indeed, one can formulate a law that must apply to all natural systems within the hierarchy of the biosphere, to the effect that behaviour that 'serves' the interests of the whole must at the same time 'serve' the interests of the differentiated parts. If this were not so then there could be no viable whole. I refer to this as the "Law of Hierarchical Mutualism". Let us look at this thesis more closely.

Hierarchical Mutualism

That the behaviour of the parts must serve the interests of the whole is clear from another consideration. Jim Lovelock sees Gaia as creating the environment that it requires to maintain its stability. If we accept General Systems Theory, then one must accept that natural systems, at other levels of organisation, are doing likewise. This means that living systems in general depend for their proper functioning and in particular for the maintenance of their stability on the preservation of their specific external environment.

The term 'environment' has never been properly defined. It is used by ecologists in the vaguest possible way to mean little more than "all that is out there". This is also true of Neo-Darwinists, even though they attribute to the environment the capacity for natural selection, a process which is both highly discriminatory and highly teleological.

In reality, "what is out there", from the point of a natural system within the hierarchy of the biosphere, is nothing more than the larger system of which it is a differentiated part, without which it has no *raison d'être* and cannot survive. For this reason, the 'whole-maintaining' behaviour on the part of any natural system — that is, the behaviour that satisfies the requirements of the larger system — must also be that which satisfies the requirements of the differentiated subsystem. (I say "differentiated", as this would not be true of random parts or parts that are not integrated into the hierarchy of the biosphere). It is in this language, I feel, that one must translate the literature on the subject of morphogenetic fields, a concept introduced in the 1920s (independently, I believe) by Weiss and Gurwitsch. Jim Lovelock seems to have little sympathy for this concept. It is nevertheless an essential one, since it accentuates the depend-

ence of natural systems on their respective, and highly specific, internal and external environments all the way up the hierarchy of the biosphere.

Mutualism

If Gaia is a single natural system capable of maintaining its homeostasis, then its parts must co-operate with each other. Lovelock makes this point very clearly. In other words, the most fundamental relationship between the constituents of the biosphere must be one of mutualism. This was also the view of the early academic ecologists. Indeed, at the turn of the century literally hundreds of papers were published in ecological journals and texts on the subject of mutualism.

Roscoe Pound, an American naturalist, for instance, described, in a celebrated article, all the various forms of mutualism that were known to occur in ecosystems, including pollination and the fixation of nitrogen by bacteria living on the root-nodules of plants. Mutualism in ecosystems was even compared to that occurring in other natural systems such as biological organisms — something which no academic ecologist would dare propose today.

The Chicago school of ecology which flourished in the 1940s also saw mutualism as the principal relationship among living things. One of its leading figures, Warder C. Allee, regarded "an automatic mutual interdependence" as a "fundamental trait of living matter."⁴⁴ Then came the great ecological transformation already alluded to, and competition became the order of the day, to be viewed by ecologists and theoretical biologists alike as no less than the fundamental ordering principle in nature — as it still is today.

What is extraordinary is the lack of evidence for this thesis. As Peter Price notes in *The New Ecology*, "the body of theory is vast"; however, "little has been tested objectively."⁴⁵

Connell is particularly outspoken on the subject. Having reviewed the literature, he was only able to find a single study involving serious experimental work designed to determine if competition played a significant role in the interaction between species.

It is not an exaggeration to say, as does Price, that:

"competition theory lives in a dreamworld where everything

can be explained, but the validity of these explanations has not been adequately established in the real world."⁴⁶

Incredible as it may seem, it is only today that the dogma of competition is being critically examined. To quote Price again: ".....only after fifty years of building an edifice to competition is serious doubt being cast on the evidence for its foundations."⁴⁷

Worse still, the term "competition" has never even been properly defined. Merrell, in his *Ecological Genetics*, provides a veritable catalogue of the different ways in which the term is used. There is no point in listing them here, but his summing up is worth quoting:

"Some definitions apply only to animals, others to all organisms — plants as well as animals; some definitions refer only to interspecific competition, others to both intraspecific and interspecific competition; for competition to occur, resources must be in short supply in some definitions but not in others; sometimes the definition is so broad that it does not exclude predator-prey relations, but in others the same trophic level is specified. Given these differences of opinion, it may be hazardous (not to mention presumptuous) to attempt to reach some workable definition of competition."⁴⁸

Nor are the various applications of the "competitive principle" to ecology any better defined. The "competitive exclusion principle" for instance, as Merrell also shows, has been formulated by different ecologists in literally dozens of different ways.

In the meantime, so long as competition was the order of the day, co-operation and hence mutualism ceased to be of any interest to ecologists. Vandermere and Boucher, for instance, point out:

"Although some of the most spectacular interspecific interactions in nature are obviously mutualistic, relatively little research, empirical or theoretical, has been aimed at understanding this basic and perhaps prevalent form of interaction."⁴⁹

So too, Risch and Boucher illustrate the extent to which mutualism has been ignored by modern ecologists:

"A survey of 12 ecology texts published within the last five years clearly substantiates the claim that practically the entire discussion of organismic interactions has centred on predation and competition. Of a total of 718 pages devoted to interspecific interactions in these texts, 321 pages concern predator-prey interactions, 362 pages concern interspecific competitive interactions, and only 35 pages discuss any kind of mutualistic relationship. In addition to the disproportionate amount of space devoted to the different interactions, predation and competition are presented as important organising principles, while examples of mutualism (such as . . . cleaning symbioses) are presented as interesting but eccentric exceptions to the general rule."⁵⁰

In the early 1970s, however, there was a sudden resurgence of interest in mutualism. It seemed to manifest itself independently in the work of ecologists at different universities, who were often unaware of each others work. Well known ecologists, who had down-played the importance of mutualism, suddenly changed their minds about it. Thus Robert May, in 1973, stated that the importance of mutualism "in populations in general is small".⁵¹ However, "in only a few years", to quote Boucher, "May's appreciation of mutualism changed considerably". He suddenly announced that mutualism was now seen as "a conspicuous and ecologically important factor in most tropical communities."⁵² Indeed, in recent years, May has become one of the leaders in encouraging work on mutualism which he sees as "likely to be one of the growth industries of the 1980s."⁵³

Today's ecologists, for instance, have started looking at the role played by micro-organisms in the metabolism of complex organisms. Boucher, James and Keller have noted that gut flora

are involved in breaking down cellulose and related substances in mutualism with many vertebrates, as well as with termites and other arthropods. Urea is broken down and its nitrogen recycled by rumen bacteria and by the fungal components of some lichens. Toxic secondary plant compounds are also degraded in caeca and rumens by microbial symbionts.

Ecologists have also noted the increasing numbers of parasitic or predatory relationships which, on closer examination, turn out to be mutualistic. Thus McNaughton has pointed out that the normal view of the relationship between grazers and the grass they graze is false:

"Ecologists have tended to view plants as relatively passive participants in short-term interactions at the plant-herbivore interface, suffering tissue reduction from herbivory, and responding in evolutionary time through the evolution of novel anti-herbivore chemicals and structures."⁵⁴

It now seems clear that plants are capable of reacting in a much more dynamic manner to grazing and indeed are capable of "compensatory growth and assimilate reallocation." All in all, McNaughton found nine different ways in which the relationship between grazing animals and the grass on which they graze can be regarded as mutualistic.

Does this then mean, Boucher asks, that mutualism is "destined to be part of a new synthesis, in which Newtonian ecology is replaced by a more organicist, integrated, value-laden view of the natural world?" He is not too optimistic on this score. The reason is that "our present theories of mutualism are still basically mechanistic, mathematical, fitness-maximising and individualistic."⁵⁵

Unfortunately this is only too true. D.H. Janzen considers that "Mutualisms are the most omnipresent of any organism-to-organism interaction."⁵⁶ However he insists that "natural sys-

THE EARTH REPORT

MONITORING THE BATTLE FOR OUR ENVIRONMENT

GENERAL EDITORS: EDWARD GOLDSMITH AND NICHOLAS HILDYARD

Dispassionately written, factual and concise, this book is far more horrifying than any supernatural shocker, documenting as it does the all-too-real, relentless destruction of the earth's natural environment. The issues it raises are of immediate, urgent concern, not only to politicians, campaigners and students but every citizen of the planet.

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tems larger than the individual cannot be mutualistic.”⁵⁷ The reason is that:

“A mutualism is an interaction between individual organisms in which the realized or potential genetic fitness of each participant is raised by the actions of the other. The participants are called mutualists. Since a species has no trait that is analogous to the genetic fitness of an individual, mutualism cannot be defined with reference to species.”⁵⁸

If a species cannot be involved in a mutualistic relationship, nor can inanimate forces, nor even seeds:

“By definition, inanimate dispersal of seeds is not a mutualism. Wind and water have no fitness. Explosive capsules are plants that move themselves. Burrs stuck on horses legs do not benefit the horse. Hard red Erythrina seeds swallowed by a fruit pigeon and defecated entire do not benefit the pigeon. The squirrel does not benefit from the acorn that it buries and never recovers. An ant-acacia whose fruits are eaten by a bird that carefully spits out each seed below the parent ant-acacia does not benefit.”⁵⁹

Boucher considers it inevitable that ecologists should see mutualism in this narrow reductionistic way:

“While arguing that nature is an integrated whole and that everything is connected to everything else, we continued researching with theories that said that communities are no more than sets of individual organisms. The problem, in other words, is one of cognitive dissonance — the difficulty of working with two sets of ecological ideas, based on different fundamental assumptions and ultimately in conflict.”⁶⁰

What is in fact required is a paradigm shift. Mutualism must be seen in the light of a climax rather than a pioneer world-view. The Gaia thesis can do a great deal to help bring about such a transformation.

Stability

One of the basic features of the biosphere is its extraordinary stability. This is implied by Stephen J. Gould and other proponents of the theory of punctuated equilibrium who point to the fact that many forms of life have not changed for hundreds of millions of years. This point is also made by Jim Lovelock who notes the great stability of Gaia over the last few thousand million years. Though Darwin may have been the prophet of evolution, and hence of change, he was also impressed by the stability of the living world. Thus, he tacitly admitted in a letter to Lyell that he was not wholly happy with the term ‘natural selection’. “If I had to commence *de novo*”, he wrote, “I would have used ‘natural preservation’.”⁶¹

Preservation must be important, since without it, there can be no structure which displays any sort of permanence. If an organism or community or species or ecosystem has an identity at all, it is because of its persistence. Indeed, a development process whose end-product is not preserved at least for a period of time seems to be self-defeating.

As Piaget puts it: “Une construction sans conservation n’est plus un développement organique mais un changement quelconque.”⁶²

Indeed, within the biosphere, change seems to occur not so much because it is desirable *per se* — indeed it would seem that nature tries desperately to avoid it — but because, in certain conditions, it is necessary as a means of reducing the need for other more destructive changes.

If this is so, then we should accept that stability is the overall goal of life. This was the view of Claude Bernard who wrote:

“All the vital mechanisms, varied as they are, have only one object, that of preserving constant the conditions of life in the internal environment.”⁶³

Though the concept of stability is of concern to modern ecologists, its treatment is rather muddled. Hollings, whose writings are occasionally referred to by Jim Lovelock, regards a stable ecosystem as one that returns to an equilibrium state after

a temporary disturbance and, what is more, “with the least fluctuations.”⁶⁴

He includes in this category living things that have not undergone change for a very long time. These, he does not regard as persistent. He then contrasts stable ecosystems with resilient systems which are characterised by large fluctuations. Those alone, he sees as persistent.

Hollings’ work has been taken up by Eric Jantsch and Ilya Prigogine, whose theoretical writings, as I have tried to show in my article “Superscience, its Mythology and Legitimation”,⁶⁵ serve, above all, to provide the mythology required for rationalising high-technology, and in particular genetic engineering. It involves singing the praises of individualism, competition, aggression, and instability, and hence of such discontinuities or fluctuations as the wars, epidemics, famines, and climate changes which must necessarily characterise our atomised, high-technology, neo-pioneer society. At the same time, co-operation and stability are deprecated — necessarily so, since in such a society they are conspicuous by their absence.

However, Hollings’ position does not stand up to serious scrutiny. To begin with, no living system returns to an equilibrium state after a disturbance, but rather it moves to a new position that is as close as possible to the original one. The reason is that unlike the behaviour of machines, the behaviour of living things is irreversible. Each experience must affect a living thing in some way, and such effects cannot be eradicated. The fact is that living things change, though some do so more than others, and indeed must do so in the interests of preventing bigger and more destructive changes. For this reason, a stable system is not an immobile one — such a system could not possibly be stable in the face of a changing environment — but one that is capable of maintaining its basic structure and function in the face of change.

In other words, nothing in the real world corresponds to Hollings’ stable ecosystem. What is more, the closest approximation to such an ecosystem — say a tropical rain forest — cannot, by the wildest stretch of the imagination be regarded as “non-persisting”. On the contrary, ecosystems that have lasted without major modifications for more than a hundred million years are obviously highly persistent. They may indeed be facing annihilation today, but then they could hardly have “predicted” the occurrence, let alone the scale, of modern logging activities. Natural systems are neither omniscient nor omnipotent — and cannot be expected to deal adaptively with phenomena that have never occurred during their hundred million years of experience.

It is certainly true that a climax ecosystem has committed itself to an environment of a specific type, which means that it can only survive if the main features of that environment are maintained. This must make the system vulnerable to very radical changes that might affect the main features of its internal or external environments. But then, it is justified in ‘expecting’ (if I can use such anthropomorphic terms) that they will be so maintained.

Well-known ecologists who downplayed the importance of mutualism suddenly changed their minds about it

This must follow from the fact that climax systems — such as Gaia, as Jim Lovelock has noted — exist in an environment whose main features they have themselves created, and which are precisely those that minimize the incidence and seriousness of potentially disruptive changes, and which otherwise maintain those conditions required to safeguard their stability.

Thus rainforests can 'expect' the occurrence of the rainfall they have come to require for the simple reason that *they themselves have generated much of it* via evapotranspiration, so much so that they are in this respect practically closed systems; the Amazonian rainforests, for instance, appear capable of generating up to 75 per cent of the rainfall they receive.

Rainforests can also confidently predict that the nutrients required for their sustenance will be available, *for they themselves have generated these nutrients*. Indeed, tropical forests, as everyone knows, grow on very poor soils, but the litter they generate is recycled so quickly, and the trees have developed such effective means of extracting the nutrients from it, that no shortage of nutrients is ever likely to occur.

Many ecosystems that are characterised by large fluctuations or discontinuities, such as grasslands, are pioneer ecosystems which will, if undisturbed by man, eventually develop into climax ecosystems. Others, such as the Californian chaparral, appear themselves to be climaxes existing in biotic, abiotic and climatic conditions which do not favour further development. What seems clear, however, is that all such systems are striving to achieve what, in the conditions in which they exist, is the maximum achievable stability. Their goal remains the preservation of their basic structure and function in the face of change, and they succeed in achieving it to the best of their capacities. One must thereby agree with Waddington that Hollings' distinction between 'stability' and 'resilience' is based on "a confusion between two different types of stability."⁶⁶

This fits in better with Eugene Odum's own distinction between 'resistance stability' (which he defines as "the ability of an ecosystem to resist perturbations and maintain its structure and function intact")⁶⁷, and 'resilience stability' (which he defines as a system's ability to recover when it is disrupted by a perturbation)⁶⁸.

As an example of the former, he takes a forest of Californian Redwoods, whose thick bark enables them to withstand fire, but which take hundreds of years to recover if destroyed. 'Resilience stability', on the other hand, Odum exemplifies by the Californian Chaparral vegetation which burns easily but which recovers quickly.

Significantly, Odum does not suggest that the Redwood forest is not persistent or that the chaparral is not stable. Both assure their survival in the face of the range of changes which, in terms of their experience, they are justified to 'expect', though the former can do so at considerable less cost to its basic structure and function than the latter.

Unfortunately, little work seems to have been done by ecologists to test the thesis that ecosystems can maintain their own stability or homeostasis: however, what work has been done tends to confirm the thesis. The best known experiments in this field are those conducted by Simberloff and Wilson in 1969. These researchers removed all the fauna from several small mangrove islets and then closely watched the way they were recolonised by terrestrial arthropods. Though, in the end, the islets were populated by very different species from the original ones, the total number of species was very much the same as originally.

The same data were re-examined three years later by Heatwole



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"One of the basic features of the biosphere is its extraordinary stability. Indeed, within the biosphere, change seems to occur not so much because it is desirable *per se*, indeed it would seem that nature tries desperately to avoid it, but because in certain conditions, it is necessary as a means of reducing the need for other more destructive changes."

and Levins. Their interest was to classify the different species in terms of trophic organisation, noting the number of species in each of the trophic categories (herbivores, scavengers, detritus feeders, predators etc.). The results were highly significant. They showed that the trophic structure of the communities on the different islets displayed a remarkable stability even though the species composing each of the trophic levels had undergone a considerable change. This experiment clearly illustrates the principle of systemic homeostasis and stability, for the system had undergone change, but its basic structure had been preserved.

Significantly, mainstream ecologists have refused to accept this interpretation. For example, Putman and Wratten, the authors of a recent textbook on ecology, insist that the data do not point to the "recovery of a disturbed system" but rather to the "establishment of a new community after total defaunation."⁶⁹ Simberloff insists the same result could, in any case, have been achieved stochastically — in other words, that it is consistent with the postulate of randomness, a tenet which is critical to the paradigm of modernism. Horn tries to explain the ecological healing process, or successional development towards a stable

climax, in terms of the statistical properties of Markov chains, which suggests that, rather than being a device for achieving or restoring homeostasis, it is but a statistical phenomenon.

We are faced here with but another rather pathetic attempt to preserve the credibility of the paradigm of reductionist ecology or "the pioneer world-view" in the face of yet further evidence of its inadequacy. This demonstrates once more the need for a new Gaia-inspired holistic ecology.

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Italy's Green Party: On the Road to Success

by Andrew Rosenbaum

Since it was formed in 1984, Italy's Green Party has chalked up one environmental victory after another. Having helped bring the country's nuclear industry to a virtual close, it is now looking to clean up Italy's chemical industry.

Italy's 'Lista Verde' or Green party does not like to think of itself as a political party. "We hate to talk politics," said one of the Green parliamentary deputies. Yet 1987 was a year of political victories for Italy's Green party at both the national and local levels. In a referendum held on November 8th and 9th, an 80 per cent majority voted against further spending on nuclear power, and against Italy's continuing its participation in the construction of the Superphenix reactor. In the national election of June 14th and 15th 1987, the party sent 13 deputies and two senators to parliament. And by applying the referendum tactic to local problems, the 'Verdi' have been able to bring about a nationwide revision of the heavily polluting chemical industry.

A History of Neglect

The Italian Government's slowness in applying European Community directives regarding automobile emissions, waste disposal, and air and water pollution has led to a decay that is visible to the majority of citizens. In the words of CENSIS, the Centre for the Study of Social Investment:

"While the latent radioactivity resulting from the Chernobyl accident is frightening, the reactions to unbreathable air in the Italian cities — Rome at the head with 2.2 inhabitants per car — are direct; smog is perceptible, impregnates clothing, dirties the monuments, corrodes the stone. . . ."

Holiday-makers who wish to swim in the sea are often faced with "No Bathing" signs: fertilizers washed out from inland agriculture have caused disastrous eutrophication in the Adriatic, and inadequate sewage treatment and chemical dumping have blighted large portions of the Italian coast.

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In the last few years, the mass media have given wide publicity to environmental issues, which now intrude daily into family life. At least eight popular television shows cover environmental problems, and the national weekly *L'Espresso* devotes a regular column to ecology. The effect is evident. A poll taken by CENSIS in 1986 showed that 83 per cent of Italians were sensitive to the need for environmental action, irrespective of its effect on the economy.

A New Consciousness and a New Politics

This new environmental consciousness is expressed in the profusion of environmental associations which have sprung up during the eighties. Along with the World Wildlife Fund, which has seen its membership grow rapidly, and the Friends of the Earth, the 1980s have witnessed the birth of many new groups, from ecological co-operatives to anti-nuclear leagues organized to oppose a local project. The largest new organization is the "Environmental League", the most politically-minded and left-leaning of the new groups, which proposes a broad critique of the current industrial development. But there are also nature study groups, health food groups, societies for alternative medicine and others. Sociologist Luigi Manconi counts 304 environmental groups in Lombardy alone; there are 100,000 to 200,000 members in diverse groups throughout Italy.

In 1984 these various small organizations joined with the three, best-known, and largest groups to form the "Federazione della Lista Verde", the campaign committee which lists candidates on the ballot. The party was to have no other administration, no hierarchy and no bureaucracy. Decisions were to be made by the General Assembly of all members.

It was to remain a loose federation, an

'archipelago', as it is called, of associations, whose aims as stated in the Federation statutes were to "use non-violent civilian methods to develop policies and institutions for environmental protection, defending the peace and preserving the rights of every living being."

This lack of a concrete organization has proved an advantage. Italy's parliament has more than a dozen small parties, the largest of which, the Christian Democrats, can claim only 32 per cent of the vote. Compromise is required on a wide scale for any decision to be made, and many Italians are frustrated with the traditional political parties which they view as being all the same. As historian Giorgio Bocca points out:

"In this democracy of discontinuous and querulous opposition in which not even a small party has had the courage to take up fundamental questions like that of defending the environment, the Greens took up the cause and have received all the credit."

This helps to explain why the party took 2.6 per cent of the vote in the local administrative elections of 1987.

Shutting Down Nuclear Power

Yet the victory in the elections is not the most important of the Greens' accomplishments. They have succeeded in effectively halting Italy's nuclear power.

Italy still imports 80 per cent of all its primary energy requirements, about 60 per cent of which is in the form of oil. Reducing this reliance was one of the objectives of the ten-year National Energy Plan when the plan was updated in 1985. The Plan made proposals to stimulate energy-saving schemes and the rational use of power, and promoted the creation of new energy sources, including the use of nuclear power.

To overcome popular opposition to

plant construction, the ENEL (Ente Nazionale per L'Energia Elettrica, the national electric company) agreed to pay a financial incentive to any local district that would host a nuclear station.

The first large nuclear power station to be completed was a Boiling Water Reactor (BWR) at Caorso (near Piacenza in Emilia-Romagna). It came into operation in 1983, but has not been operational since 1985 when it failed a security check. Although Italy planned to build nine other nuclear stations, construction was started on only three: a gas-graphite reactor at Latine (on the coast near Rome); a Pressurised Water Reactor (PWR) at Trino Vercellese (in the Piedmont), and a BWR at Montalto di Castro (near Viterbo in northern Lazio). Nuclear power was ultimately expected to provide less than 5 per cent of total energy consumption. Italy also had a 33 per cent stake in the experimental Superphenix fast reactor at Creys Malville in France, in which France and Germany also held 33 per cent each.

The Italian anti-nuclear movement first came to prominence in 1977 when 20,000 people marched on the construction site of the Montalto di Castro plant. All the major environmental organisations campaigned against the three nuclear stations, and the fledgling movement was aided by popular opposition in those districts where ENEL tempted the local administration with incentives. ENEL was ultimately unable to complete any of the proposed projects.

The final blow to Italy's nuclear programme was struck by the Chernobyl accident, which affected Italy more seriously than it did other southern European countries. Green vegetables were contaminated by the direct fall-out of Iodine 131 and milk was contaminated when cows ate contaminated grass. Chernobyl caused inestimable damage to the image of nuclear power in Italy. In May 1986, an opinion poll found that 71 per cent of Italians wanted no more nuclear stations built, and in the same month 100,000 people marched through Rome calling for an end to their construction.

In national referenda, held on November 8th and 9th 1987, more than 80 per cent of the voters agreed with the positions espoused by the Greens. In particular, they voted against the participation of ENEL in any foreign nuclear programmes, which would include the Superphenix reactor in France. They also voted to abrogate a law allowing the central government to overrule local officials in the siting of nuclear power plants. In addition, they rejected the law which allowed the government to pay

subsidies to district authorities which agreed to host nuclear plants.

The Gorria government has implemented the referenda by closing down the plant at Trino Vercellese, and dismantling the station at Latina. At Caorso, the government has decided to reopen the plant only when international security standards can be met. The reactor at Montalto di Castro is to be converted to take other forms of fuel. After a lively debate between those who favour running the plant on methane, and those who favour using a variety of fuels, the plant is to be made "polycombustible".

As a result of the referenda, the government has been forced to shelve its National Energy Plan, which had given a major role to nuclear power. One consequence could be to increase the country's reliance on imported oil.

Advocates of nuclear power, like Industry Minister Battaglia, insist, that "Italy should retain at least one station, so as to retain a foothold in this technology". Opponents, like physicist Gianni Mattioli, a Green parliamentary deputy, point out that "the old BWR Mark III of Montalto, the last hope of the nuclear industry in Italy, is already well out of date". The controversy will surface again after the present moratorium comes to an end, but the effect of the referenda on the Italian nuclear industry has been devastating. Most recently, the Piedmontese Fabbriazioni Nucleari, S.p.A., a company which enriches uranium for use in nuclear reactors, laid off a third of its workers and warned that it would close down if a conversion plan was not formulated.

"The electoral success moved the cause of ecology a notch up in status", maintains Ermeto Realacci, president of the Environmental League, "and it is thanks to the work of the 'Lista Verde' in parliament that we got the referenda passed."

Using the Referendum Tactic

The Greens continue to work to oppose what they call "the advocates of exponential growth." In October 1987, Italian environmentalists forced Montedison S.p.A., Italy's largest chemical company and the third largest private company, to close down an \$100 million pesticide plant. They succeeded in forcing a popular referendum in the Tuscan town of Massa Carrara where the plant is located, in which 77 per cent of the town's residents voted to close the plant. While the vote had no legal status — it was purely consulta-

tive — the town's mayor decided not to renew Montedison's licence to produce the pesticides Rogor and L-56. Without the licence, Montedison maintained, it could not make a profit on the plant's operations, and its 400 workers would be out of a job. When a Florence tribunal sided with the company, and the plant went back into production, the Greens decided to appeal, and the matter is now pending.

Now the Greens are threatening no less than 14 popular referenda in areas throughout the country. They want to close the centre of Florence to traffic; at Rosignano, near Livorno, they want to close the Solvay chemical plant; at Pero near Milan, they want to close another sulphur-producing chemical plant. Despite the fact that the referenda have no force in law, they illustrate the gap between public opinion and administrative policy, and that leaves politicians in an uncomfortable position.

Environment Minister Giorgio Ruffolo has been obliged to act to obviate the need for these embarrassing referenda. On November 27, 1987, he announced a "national inquiry into the environmental compatibility of chemical plants." He has already taken ACNA, S.p.A., an agrochemical firm, to court. That company was to have been the subject of the Greens' next referendum.

Ruffolo has proposed a 1988-1990 *Plan for the Environment* as part of the 1988 budget bill. This plan will have a crucial effect in determining all future Italian environmental policy, but the Greens are not satisfied with it. In its place, they have proposed an alternative plan: if they succeed in mustering the same kind of support as they did for the anti-nuclear and local referenda, they will have a chance to put their stamp on policy in areas where they have not yet been able to influence directly.

Other political parties are trying to steal the ecological limelight. All the major parties, including the Communists, did a volte-face on nuclear power shortly before the national referenda. Confindustria, the Italian employers' association, held a two-day conference on the environment in which they propounded a Ten Point Plan for Ecological Change. Whether an alliance of the traditional political parties and industry will take over the role of the Italian Green party, as is the case with Germany's 'Grunen', or whether the Greens retain their role is a question that will be resolved in the coming year.



Hellier

Fully-grown clumps of *Rhizophora*, the twin-flowered mangrove, line the banks of many quiet creeks in the tropics. This tannin producing species may be on its way to extinction in India.

The Mangrove Wastelands

by Chris Hellier

Worldwide, mangrove forests are being destroyed at an alarming rate. Yet mangroves play a vital ecological role, supporting a wide range of species and preventing erosion. In addition, they provide a livelihood for millions of people.

"It is the red mangrove that rules hereabouts: a greedy usurper that occupies the marshy no-man's-land between dry land and water, a wide and flat space shunned by other plant life. This grasping tyrant seizes the unwanted, and consolidates its position so as to become unassailable, surrounded by salt water at high tide and mud at low tide, when it is irrigated by ooze from sluggish backwaters. The mangrove spreads widely, its roots looping, branching, grappling, embracing, revelling in the sludge; from its branches it drops aerial roots into the static convulsions below. And overall is a dense roof of glossy leafage which effectively excludes sunlight from the stinking, impenetrable chaos beneath. One can do nothing with mangroves but avoid them."

Judging by the above quote from an Australian explorer in the mid-nineteenth century, colonial man appears to have developed a low opinion of tropical mangrove forests. But instead of simply avoiding them, as the explorer suggests, they have increasingly been drained or developed. Even as recently as 1973, an Australian member of parliament referred to a biologically outstanding mangrove forest in Queensland as "a mangrove wasteland, just ripe for development."

Throughout the tropics, mangroves have been destroyed or degraded as a result of various forms of over-exploitation. But unlike tropical rain forests, mangroves have received little attention from conservationists, scientists or resource managers. The perception of mangroves as wastelands was a common, indeed the dominant, view until about ten years ago. Since then the growing awareness of the importance of mangroves for fisheries, forestry and other sustainable uses has led to a number of conservation initiatives — notably research projects under the patronage of UNESCO — to help protect these fragile ecosystems.

The Mangrove Ecosystem

Mangroves consist of intertidal salt-tolerant flora, dominated by sclerophyllous broad-leaved trees with pneumatophores or stilt roots. They are one of the most important features of tropical coastlines, occurring in relatively sheltered lagoons, estuaries and quiet back-waters. Though different mangrove areas have many common features, mangroves display a great diversity of ecological structure and system dynamics from one area to another. They range from vast areas covering thousands of square kilometres with high species diversity, to isolated trees clinging to coral reefs; and from mangroves which have been managed by man for centuries to the undisturbed virgin forests of Papua New Guinea.

In general there is little data available on the area of mangrove forests destroyed or degraded in recent years. Indeed, no overall estimates of the global or regional loss of mangrove forests and species ex-

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Degraded Pitchavaram mangrove in India, a country which lost half its mangroves between 1963 and 1977. The current position is unknown

ists. However, available estimates of mangrove loss for a number of countries are alarming. For instance, between 1963 and 1977, the area of mangrove forest in India was reduced by almost half, from 682,000 to 356,500 hectares. The current position is unknown. In the Philippines mangroves covered around 400,000 to 500,000 hectares in 1918. The latest figures show that the total area had dwindled to about one third by 1985 — to between 150,000 and 200,000 hectares: most of this loss has occurred since the 1960s. In Thailand, the country's mangrove resources were reduced by almost a quarter between 1961 and 1979, from 368,000 hectares to less than 290,000 hectares.

The main causes of recent degradation vary from country to country. They include: clear felling and the collection of firewood: land reclamation: chemical and domestic pollution: mining: urban and industrial development: freshwater diversion: siltation: and tourism.

In the Philippines, vast areas of mangrove forest have been converted to fish ponds. According to the Philippines Bureau of Fisheries and Aquatic Resources, aquaculture development has accounted for the loss of over 200,000 hectares of mangrove since the 1920s. The rate of destruction has accelerated dramatically since the early 1950s — from an annual 88,681 hectares to 244,401 hectares in 1981. At this rate mangroves could disappear from the Philippines by the mid-1990s.

Elsewhere, the story is much the same. When Singapore became a British colony in 1819, mangrove forests covered an estimated 7,500 hectares, some 13 per cent of the island. By 1969, the mangrove

area had been reduced to just over 6 per cent of the island. Today, land reclamation and urban and industrial development have reduced the mangrove cover to a few small areas of degraded forest, amounting to about 500 hectares. In the Sunderbans, the mangrove forests which straddle the Indo-Bangladesh border, 1,300-1,500 square kilometres have been reclaimed for rice production. In Ecuador, 16 per cent of the total mangrove area was converted to shrimp farming between the mid-1960s and early 1990s. And, in the higher income countries, such as America, Australia and New Zealand, it is the property developers, looking for choice sites for up-market homes, that have destroyed or degraded mangrove areas. Overall, the mangroves of central America and South and South East Asia are under the greatest pressure, mainly from the conversion to aquaculture and agriculture.

A Valuable Resource

Far from being wastelands to be dispensed with at a whim in the name of 'development', mangroves are a valuable, productive resource and a crucial coastal stabilizer. In many areas, mangroves act as an important buffer or barrier against typhoons, cyclones and hurricanes and prevent coastal erosion. For instance, in the Bay of Bengal, cyclones are a frequent threat to human life. Here the Sunderbans mangrove forests provide some degree of protection to the local people, the loss of life and property being less in inland areas behind the forested delta than in similar areas without mangroves.

Mangroves are also important as

breeding, nursery and feeding grounds for harvestable fish, shrimp, shell-fish and other marine organisms. In Florida as much as 80 per cent of marine species of commercial importance or recreational value depend on mangrove ecosystems for some stage of the life cycle. About half the commercial fish caught in Fiji use mangrove waters for at least one stage in their life: moreover, according to a recent study, 83% of those fish form an important part of the Fijian diet, together with molluscs and crustaceans.

In addition, mangroves have a large range of varied economic uses. In many areas, people have traditionally lived in equilibrium with mangroves, without upsetting the ecological balance, while using them as a source of charcoal, posts and poles, tannin, paper, dyes and chemicals, thatch, firewood, cosmetics and soap, honey and incense. Dozens of other minor uses have also been listed. Mangrove systems thus make a significant contribution to the livelihood of local peoples who have also been able to earn money exporting mangrove products.

One of the most common, widely distributed and useful mangrove trees found in Asia and Oceania, and in West Africa, where it was introduced in 1906, is the *nipa palm*. It is generally found in the interior of the mangrove but does not grow in places which directly face the sea or extend into freshwater areas. The nipa leaves have traditionally been used for making shingles, which are then used for roof thatching and wall partitions. In some countries, the leaves are plaited and made into umbrellas, raincoats, hats and baskets. The petioles are used as fish-net floats, while the leaf midribs are soaked in water and twisted into ropes. In Thailand, Indonesia and Peninsular Malaysia, young leaves are made into cigarette wrappers. The nipa's sap can be made into a sugar source if fermentation is delayed but, more usually, the juice is rapidly fermented into an alcoholic liquor known as 'toddy' in India or 'tub' in the Philippines. Young nipa seeds are eaten as sugar coated sweets, whilst the hardened endosperm of mature fruits make useful buttons.

An Assured Future?

Awareness of the ecological, economic and recreational value of mangrove ecosystems has grown considerably over the last decade or so and prompted several initiatives to protect them. Most mangroves, however, are still poorly managed

though about 20 countries have designated reserves to protect mangrove areas or particular species.

One major inter-regional initiative on mangrove research was started in 1983, when the UNDP/UNESCO Regional Mangrove Project was set up in the Asia and Pacific regions. The project "was a response to a strongly felt need for a better scientific knowledge of mangroves and for the establishment of guidelines for site specific appropriate management."

Sixteen countries participated or were associated with the project. However, in their final report, the UNESCO researchers accepted that continued conversion of mangrove areas is inevitable, although some "should be maintained in their pristine conditions to avoid pushing the whole system down the road to degradation, and to ensure restocking of captive fisheries." They stress that intact mangrove areas should not be converted to other uses but that degraded areas, where once mangroves thrived, can be converted to agriculture, particularly rice cultivation. Why no consideration is given to the replanting of the degraded areas with mangrove species is unclear.

One of the project's major aims was to encourage and provide advice to member countries to formulate 'National Mangrove Management Plans'. As yet, few of the countries have prepared such plans but the project's final report gives some indication of the extent to which different countries are committed to the protection and conservation of their mangrove areas. Indonesia, for example, has made a start with the establishment in 1984 of a 200-metre wide 'green belt' along the coastline. During the 1980s, work has intensified on the rehabilitation of degraded mangrove forests in Java and Sumatra; about 20,000 hectares of degraded mangrove have been rehabilitated in West Java. Two mangrove islands have been designated as nature reserves and one biosphere reserve includes a substantial area of mangroves. Yet, at the same time, the extensive conversion of mangroves to brackish water fishponds, under the 'tambak' system, is continuing to be promoted. In the current *Five-Year Development Programme (1984-1989)*, the government is sponsoring the conversion of 100,000 hectares of mangrove land into fishponds, particularly for prawn farming, in an effort to earn foreign exchange.

Some scientists have suggested that Indonesia, with its vast mangrove areas covering over four million hectares, could convert up to 10 per cent of the mangroves



Mangrove forests have provided a living to fishermen for centuries. In the Philippines, the remaining mangroves may now have reached a critical limit beyond which they can no longer support coastal fisheries.

to tambak aquaculture without any significant impact on the mangrove ecosystem. Others are not so certain and believe that this level of conversion would harm the fisheries within and adjacent to the converted areas. Indeed, Nurzali Naamin of Indonesia's Research Institute for Marine Fisheries has concluded that converting the mangrove ecosystem to tambak 'will usually result in a net loss of foreign exchange earnings, protein production and obviously employment.'

Most of the other countries participating in the UNESCO/UNDP project now appear, at least on paper, to be taking positive steps to conserve and properly manage mangrove areas. However, the Philippines, in particular, has failed to take a positive line. Of the 146,139 hectares of mangroves recorded in 1978 — down from about 450,000 hectares in 1920 — 78,593 hectares, or 53 per cent, have been designated as conservation and preservation areas which "will be used for scientific research and educational endeavours to satisfy the ecologists"! The balance is allocated for conversion to fishponds or other uses. There thus appears to be little appreciation of the economic resource value of mangroves, of their importance in nutrient exchange, and their role in maintaining coastal fisheries. This policy of continued fishpond expansion also goes against the advice of the Ministry of Natural Resources' Mangrove Committee, which in 1977 recommended that "the remaining mangroves may now have reached the critical limit to support breeding and nutrient needs of coastal fisheries . . . fish pond

Far from being "wastelands" ripe for "development", mangroves are a valuable and productive resource.

development can avoid utilization of mangrove-covered swamplands (as) expansion can be confined to swamplands without mangrove cover."

It seems that in some countries the concept of mangroves being wastelands, to be dispensed with at will, is taking a long time to die.

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Rio Mazan —A People's Forest

by Adrian Barnett

Recently, some 3,300 hectares of cloud forest were purchased by the people of Cuenca in Ecuador to save them from destruction by logging companies. Their example provides a success story to emulate.

Peace Parks in Nicaragua, debt swaps in Ecuador, Costa Rica and Bolivia, industrial sponsorship of a national park in Belize: all part of a recent spate of conservation initiatives in South and Central America that involve international organizations and national governments. Such efforts are obviously vital components in the campaign to save the world's remaining tropical forests. However, the widespread publicity that surrounds these welcome victories tends to overshadow the conservation work of local groups within these recipient countries. At worst, this may give the impression that the average 'Pedro in the Plaza' neither knows nor cares about his environment; at best that he is concerned but powerless.

However, nothing could be further from the truth. Throughout South America, there exists a network of committed and well-organized conservation organizations. Many are involved with conservation initiatives that exist outside the formal structure of established national parks and protected areas. Such parallel schemes can therefore protect areas that are of local importance but which fall outside the brief of the government's conservation agencies. They also form a focus for community conservation awareness and provide unequalled opportunities for environmental education.

One such scheme operates in the Cajas Mountains, 3,200 metres up in the Andes of southern Ecuador. Here the people of the town of Cuenca have privately purchased 3,300 hectares of cloud forest and natural grassland covering the headwaters of the Mazan River.

The Effects of Deforestation

This initiative, the first of its kind in Ecuador, was organized to protect both watersheds and wildlife. Watershed protection became necessary as a result of widespread timber extraction in the area. In the past, Cuenca's economy was largely wood-fired with many of its 100,000 inhabitants dependant, directly or indirectly, on the extraction and processing of such valuable timber trees as *Podocarpus* and *Ocotea* from the mist-shrouded slopes that ring the town. But, in the absence of effective controls, forests were finally banished to remote valleys, while for kilometres around Cuenca impoverished scrub and barren moonscape replaced the exuberance of virgin forest.

By the mid-1970s, a more terrible harvest was being reaped as the silt load of the rivers became progressively heavier. The deforestation of slopes greater than 45 degrees, combined with high rainfall, resulted in annual soil losses in excess of 60 tons per hectare per year, stripping areas completely in two to three years. Problems of irrigation were rapidly followed by dangers to health, as ETAPA, the municipal water company, struggled to provide Cuenca with potable water. The buzz and clunk of chainsaws and axes had been replaced by the silt-coated silence of ETAPA's clogged machinery.

Then, in 1976, it was announced that the Rio Mazan valley had been sold for logging. This area, only nominally protected by its legal designation as a forest of hydrographic importance, represented one of the few forests still safeguarding Cuenca's water supply. ETAPA protested that without the aid of Mazan's giant green sponge it would no longer be able to maintain Cuenca's water quality. Public dis-

quiet changed to fury when the government official responsible for legalizing the sale popped up as a director of the company that was to log the valley. Responding to public pressure the Ministry of Agriculture (MAG) redesignated the area as a Protective Forest. A popular movement led by Tierra Viva, a local environmental organization, began to press for the public purchase of the land.

Buying a Forest

But the problem of purchase for protection proved as thorny as some of the forest's plants — not only would the original seven owners have to be paid off, but the logging company was also demanding compensation for loss of revenue. At times it appeared that the fight to save this primary forest would be lost in the jungle of the Ecuadorian legal system. Eventually, after four years of negotiations, legal battles and fund-raising, the forest was bought by the people of Cuenca for 100,000 US dollars. Thus, the Rio Mazan valley became the first forest reserve in Ecuador to be bought by, and for, a local community.

The forest was known to be rich in wildlife and the people of Cuenca soon began pressing the authorities to be allowed to visit the forest. ETAPA had been made warden of the reserve but, lacking adequate biological surveys and with no facilities to cope with a flood of visitors, it was understandably worried that the local people would destroy the very area they had been at such pains to protect. Help arrived in the shape of a team of British biologists already engaged in conservation work nearby. After preliminary reconnaissance work in 1983 and 1984, a 30-strong team of British and Ecuadorian

Adrian Barnett works with the Rio Mazan Project. The project is a registered charity and can be contacted through: The Secretary, 24 Campdale Road, London, N.7 0EB

scientists began to survey the valley in the summer of 1986, returning for a second season in 1987.

Biological Wealth

The results of their work (which included biological and geological surveys, habitat mapping, environmental impact analysis, ethnobotanical studies and the provision of a management plan) showed how timely the conservation initiative had been, for the valley's biological wealth surprised even those schooled in the Cornucopian standards of the tropics. In only 260 hectares of the reserve (an area no bigger than London's Richmond Park) there are more species of orchid than in the whole of the British Isles, and 69 other families of flowering plant. Mycologically, the area appears endlessly fruitful: 90 per cent of the fungi collected are new to Ecuadorian scientists. Not surprisingly several are new to science.

To date, 121 species of bird have been recorded. This includes four candidates for the IUCN's new Red Data Book (RDB) for tropical birds; the Andean Condor (*Vultur gryphus*), the Grey-breasted Mountain Toucan (*Andigena hypoglauca*), the Golden-plumed Parakeet (*Leptosittaca branickii*) and the Violet-throated Metaltail (*Metallura baroni*). A flock of 40 parakeets was the first to be seen in the province for over 40 years. Prior to this study, the Metaltail, a minute hummingbird, had been recorded less than a dozen times since its original discovery in 1890. Puma were also observed, preying on an RDB-listed deer, the Northern Pudu (*Pudu mephistopheles*).

Environmental Education

Alongside habitat protection and watershed conservation, environmental education is seen as one of the vital priorities for the site. At present, environmental education is somewhat underdeveloped in Ecuador; a recent survey by the Ministry of Agriculture of the twelve protected areas under government control showed that only three have any interpretive displays, only two have nature trails, and several have no formal facilities at all. At Mazan, the research station now has several displays in Spanish, which provide information on the general ecology of cloud forests and show some of the ecological interactions occurring at Mazan. These complement a newly-constructed nature trail.

Vaughan Fleming



A Grey-breasted toucan, one of the many endangered species which can be found in the Rio Mazan Reserve. To date, some 121 species of bird have been recorded.

ETAPA is now building a purpose-built visitor centre to house the new displays, audio-visual materials and dioramas that this year's field team will design and make. There are also plans for a smaller exhibition in Cuenca itself.

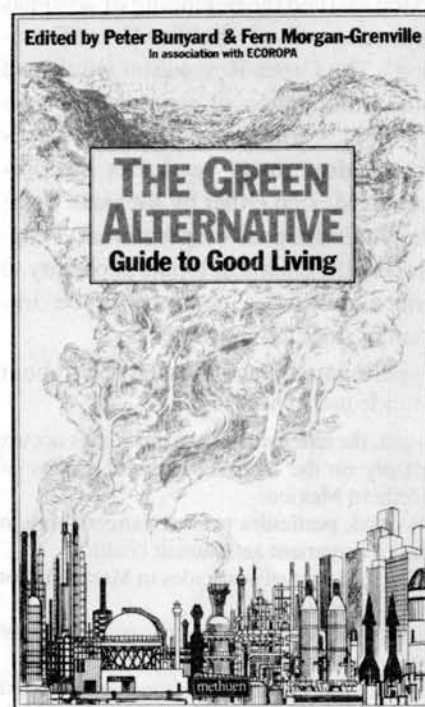
Following the success of the work at Mazan, the scientists have been invited to assist the Unidad de Manejo de la Cuenca del Rio Paute (MACPA) in its soil conservation programme for the Rio Paute basin. In this, the British and Ecuadorian team will survey all forests in the region, some 5,186 square kilometres, identifying the scale and causes of environmental degradation, assisting with management plans and developing educational materials on the value of natural forests for soil and water conservation. Successes at Mazan will play a big part in this. The first ten-month field season of this five year programme is scheduled to begin in November 1988.

While the British part of the team has nightmares over the logistics of this enterprise, Ecuadorian scientists continue to research into Mazan's ecology. Butterfly habitat requirements and forestry studies are just two of the projects presently being undertaken.

A Story to Inspire Others

The success of the Rio Mazan reserve is a tribute to the determination and vision of the people of Cuenca and the dedication of the British and Ecuadorian biologists, all of whom are unpaid volunteers. It is hoped that it will inspire similar initiatives elsewhere: such effects are sorely needed. In the first study season at Mazan the field team clocked-up over five man-years of

fieldwork — and now know a little of the workings of its fern-strewn interior. But, at global rates of forest destruction, an area the size of Mazan is lost every five minutes.



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Pesticide Use in Mexico: Decades of Abuse

by Lane Simonian

Mexico was one of the first countries to adopt the Green Revolution in agriculture. Although the new technology increased yields, it did so at tremendous cost to both society and the environment. Pesticides in particular have caused severe pollution, increasing pest problems and numerous poisonings.

In 1941, the Mexican government solicited the Rockefeller Foundation's assistance in developing programmes to increase agricultural yields¹. The Rockefeller Foundation's intervention in Mexico marked the beginning of what has since become known as 'The Green Revolution'. The Green Revolution was based on the introduction of a number of new technologies, including chemical pesticides. Today, many pesticides are produced in Mexico either by Mexican firms or by multinational corporations². Pesticides and the chemical inputs necessary to produce pesticides continue to be imported by Mexico, however.

Five important facts must be noted about pesticide use in Mexico:

- First, the extensive use of pesticides occurs mainly on the large agricultural estates of northern Mexico;
- Second, pesticides present dangers both to the environment and human health;
- Third, the use of pesticides in Mexico is not strictly regulated;
- Fourth few restrictions exist on the export of pesticides to Mexico;
- And, fifth, the United States has imported fruits and vegetables from Mexico which violate FDA (Food and Drug Administration) pesticide residue standards. Both Mexicans and Americans have thus been harmed by the unrestricted sale and use of pesticides.

Agriculture in the North

One of the most important factors in the development of commercial agriculture in northern Mexico, in which pesticides later played an integral part, was the absence of

a sedentary Indian population. In the 19th century, the enslavement of the nomadic Yaqui Indians opened up land for agricultural production in the northern state of Sonora. During the *Porfiriato* (1876-1911), attractive prices and improved irrigation systems were used to encourage domestic and foreign entrepreneurs to settle the land 'vacated' by the Yaquis. The construction of railroads was also a stimulus to development as agricultural enterprises in Sonora became linked not only to other parts of Mexico but also to the growing markets of the American southwest. Commercial agriculture was firmly established in Sonora by the time of the Mexican Revolution.³

Many Porfirian landowners managed to survive the Revolution by establishing alliances with revolutionary generals, who after the revolution became a major land-owning group in their own right. Redistribution of land in the north was not undertaken until the government of Lázaro Cárdenas came to power in 1934, ruling until 1940. Through Cárdenas' Land Reform Programme of 1937, some peasants gained land in the north. However, much of the land redistributed in the north eventually went to Mexican businessmen and bureaucrats. In addition, some *Porfirian* landowners retained control over the land.

The Green Revolution

It has been these 'progressive' commercial farmers of the north who have been targeted by successive Mexican governments since Cárdenas as being receptive to modernisation. Not surprisingly, it was in

the north that the new agricultural technology of the Green Revolution was first introduced⁴.

As Keith Griffin notes:

"The Green Revolution is from a technological point of view largely a biological and chemical revolution, but from a socio-economic point of view it is largely a commercial revolution."⁵

The Green Revolution is a chemical and biological revolution because it is based on the use of hybrids (genetically-bred plants), chemical fertilizers, and pesticides. It is a commercial revolution because the use of the new technology has furthered the expansion of export agriculture often at the expense of traditional agriculture.

Mexico was one of the first countries to adopt the technology of the Green Revolution. After initial assistance and advice from the Rockefeller Foundation, Mexico in the late 1940s and 1950s established several bureaux within the Ministry of Agriculture to promote the use of hybrids, fertilizers, and pesticides among commercial farmers⁶. Both the United States and Mexican government were predisposed towards 'modernizing' Mexican agriculture, claiming that the Green Revolution would mean increased agricultural production and, thus, both cheaper food for the cities and increased foreign exchange as a result of greater food exports⁷. For the United States, the Green Revolution would mean a new market for American technology, together with cheap winter fruits and vegetables (from Mexico) for the American West. While the professed aim of the Green Revolution was to alleviate rural poverty, this was neither the real goal nor the ultimate outcome of the Green Revolution. In fact, in Mexico, because of

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increased mechanization and the displacement of traditional farmers, the Green Revolution actually exacerbated rural poverty⁸.

Initially, the commercial farmers of northern Mexico did not share the Mexican government's enthusiasm for the Green Revolution. Because it appeared that expanding the area under production was more profitable than farming the land more intensively, most farmers were hesitant to use the new technology⁹. It was not until the high-yielding potential of the new plant varieties was demonstrated that some northern farmers began seriously to consider adopting the technology of the Green Revolution. Even then, the government had to subsidize heavily the use of pesticides, fertilizers, and plant hybrids in order to encourage their use¹⁰.

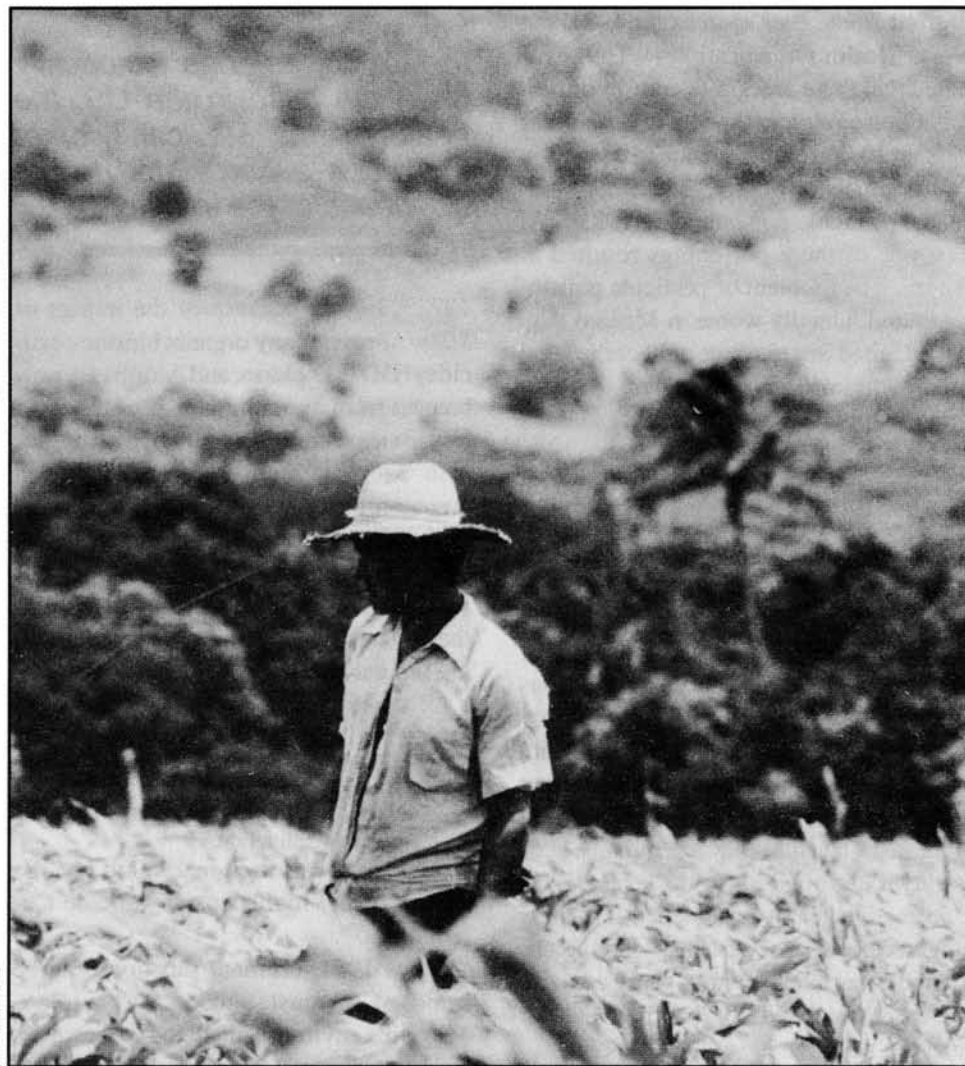
Pesticides became an essential part of the new agricultural system due to the vulnerability of monocultures to pest damage. Wheat, a major crop of the Green Revolution, has exposed grains which can easily be attacked by pests. Plant specific pests, such as the English grain aphid, thus suddenly became a major problem in Mexican agriculture¹¹, dense stands of single crops presenting few barriers to pest expansion.

The Value of Traditional Farming

By contrast, Mexico's subsistence farmers have traditionally used biological controls to minimize pest damage — and with great success. Intercropping (the planting of several different crops together) provides natural barriers to pests. Through intercropping, the damage done by plant-specific pests is limited. In addition, corn, which was first cultivated in Mexico, is enclosed in a sheath which protects it from pest damage. Whereas the hybrids of the Green Revolution were developed to produce greater yields, subsistence crops have traditionally been selected for their adaptability to climate and their resistance to pests¹².

Mexican peasants were aware of the risks involved in adopting the technology of the Green Revolution. In particular, the new plant varieties were poorly suited to the Mexican environment and thus more likely to fail than traditional crops. This knowledge led some peasants to reject the Green Revolution.

Others, however, wanted to acquire the new seeds, machinery, fertilizers, and pesticides, but lacked the financial re-



Plantation agriculture has taken over from traditional farming in the north of Mexico. Few of the pesticides used are properly labelled — and even if they were few workers could read them. Pesticide poisonings are thus common, although no official statistics are published. On the big estates, workers are often discouraged from reporting poisonings by the threat of unemployment.

sources to do so. Government credits were not readily forthcoming either¹³ — since Mexico's ruling party, the PRI (Partido Revolucionario Institucional) considered it too expensive to modernise the traditional sector. On the other hand, to have allowed commercial agriculturalists to buy *ejidos* (the peasantry's communal lands) would have been seen as a betrayal of the revolution. For the PRI, the Mexican peasantry was thus both a concession to the past and a burden to the future.

Ecological Costs of Pesticide Use

The use of pesticides in northern Mexico has resulted in greater agricultural production but in less equity. The use of pesticides has also entailed environmental costs. The run-off of pesticides and other chemicals into Mexican streams, rivers, and bays has resulted in fish kills¹⁴. In addition, Mexico has suffered from many problems commonly associated with pesticide use: the moisture and fertility of the soil has been reduced; the natural resistance of plants

has been impaired; and non-target organisms have been killed¹⁵. Genetic resistance among pests is increasing which means that either stronger doses of pesticides must be applied or new pesticides developed¹⁶.

Pesticide Poisonings

In addition to harming the natural environment, pesticides also threaten human health. No official statistics are kept on the number of pesticide poisonings in Mexico. As one reporter commented, "Nobody cares"¹⁷. There are strong reasons for such indifference: publishing statistics on pesticide poisonings would not only discourage tourism¹⁸ in Mexico but might also trigger tougher FDA inspections of Mexican food exports to the United States¹⁹. Understandably, Mexican land-owners also oppose any investigations into the problem of pesticide poisoning.

Official information on pesticide-related illness in Mexico is, thus, scarce. However, the extent of the problem can be

inferred from other sources. In 1984, the World Health Organisation (WHO) estimated that there are 375,000 cases of pesticide poisonings in the world every year and that 10,000 of these result in death²⁰. In California, there were 1,179 cases of job-related pesticide poisonings in 1985²¹. At least one of these poisonings resulted in death²². The problem of pesticide poisoning is undoubtedly worse in Mexico than in the United States, since neither the legal nor the administrative machinery for regulating pesticides is as developed as it is in the United States.

Newspaper reports — mostly based on interviews with employees at local health clinics — provide the best available information on pesticide related illnesses in Mexico. One of the major problems reported has been the misapplication of pesticides. Many safety instructions printed on pesticide canisters are in English. Even when safety instructions are printed in Spanish, many workers cannot understand them either because they are illiterate or because they are Indians, such as the Mixtec migrants from Oaxaca. Even if protective gear is provided, it is usually removed because of the heat. Poor hygiene is another problem. Empty spray containers are often used for bathing and for carrying water²³.

Migrant workers frequently complain of headaches and flu-like symptoms. Local clinics report high incidences of respiratory and neurological problems among field workers. Many cases of pesticide poisoning are probably misdiagnosed or go unreported. On some occasions, landowners have pressured clinic workers not to diagnose a patient's illness as being due to pesticide exposure. Because of the threat of being fired, field workers are afraid to report their symptoms to doctors. Whatever the exact number, though, pesticide poisoning is a major problem in Mexico.

Inadequate Controls

Awareness of the environmental health threats posed by pesticides has arisen slowly. Efforts to regulate pesticide use have taken even longer²⁵. In the United States, for example, pesticides have been widely used since World War II, but it was not until 1962, with the publication of Rachel Carson's *Silent Spring*, that the public became aware of the environmental health threats posed by pesticides such as DDT. However, a comprehensive law regulating pesticides was not passed until

In Mexico, as has historically been the case in the US, the health of the Mexican worker has been subordinated to the health of the tomato.

1972²⁶. In part because of the impact of *Silent Spring*, many organochlorine pesticides (DDT, Dieldrin, and Aldrin) are now banned from agricultural use²⁷. However, less toxic pesticides continue to be used²⁸.

In Mexico, there has been an even greater time lag between the development of pesticides, the awareness of the dangers that they pose, and the development of strict laws to regulate them. Article 24 of the 1971 environmental law provides that the federal executive

"shall limit, regulate, or when necessary prohibit the use of all substances such as insecticides, herbicides, fertilizers, defoliants, radioactive materials, etc. when its improper use may cause contamination."²⁹

Article 24 was used in 1980 to ban the import of the highly toxic pesticide Celathion-50³⁰.

Since 1981, criminal sanctions can be imposed against those who violate Mexico's environmental laws³¹. However, the Mexican government's chief environmental concern has been to curb air and water pollution in the urban areas and not to regulate pesticides. Responsibility for enforcing pesticide regulations still remains with the Ministry of Agriculture. Given that the Ministry's principal goal is to expand agricultural production, tough enforcement of pesticide regulations is not to be expected³².

Most decisions regarding the environment in Mexico are still based on economic considerations. As Laurie Becklund and Ronald Taylor note:

"In Mexico, as has historically been the case in the United States, the health of the Mexican worker has been subordinated to the health of the tomato."³³

Mexico has extensively used a number of highly toxic pesticides. For example, in 1978, Mexico used over 4,400 tons of parathion, an insecticide which can cause nerve damage; 127 tons of Endrin, an insecticide which is a suspected carcinogen; 110 tons of PCP, a fungicide which can cause nerve, liver, and kidney damage; and 27 tons of paraquat, a herbicide which can cause respiratory collapse. In addition, Mexico produces and uses pesticides which, though less toxic, can still result in birth defects, respiratory problems, nerve

and organ damage, and cancer — especially if they are overused. (More detailed information on the pesticides applied in Mexican agriculture and their suspected and known health effects is presented in Table 1)³⁴.

Occasionally, the Mexican government has used biological means of pest control. In the mid-1970s, sterile mating techniques were used in conjunction with pesticides to limit the spread of the Mediterranean fruit fly from Central America³⁵. The Mexican government has also experimented with integrated pest management techniques (combining biological pest control with other methods of pest control) on cotton and on other crops³⁶. Training and research into integrated pest management techniques have also been expanded in Mexico³⁷. At present, however, alternative pest control methods such as crop rotation, intercropping, and biological pest control (sterilization and the use of natural predators) are not widely used.

Importing Banned Pesticides

The international failure to control pesticides has also been a problem. Multinational petrochemical companies have reacted to stricter pesticide regulations in the industrialized world by selling their products in the Third World. Mexico has often imported pesticides which were banned in the countries which produced and exported them. Some multinational corporations such as Dupont and Bayer produce pesticides in Mexico itself³⁸.

The United States government is another party which has promoted the use of pesticides in Mexico. The United States Agency for International Development (USAID) has assisted Mexico in pest and drug control programmes, most notably the spraying of the herbicide paraquat on marijuana plants.

Prior to the Carter Administration, U.S. government agencies did not have to consider the environmental consequences of their actions in the Third World. Under the Carter Administration, steps were taken to regulate the export and use of pesticides in the Third World. In 1979, Jimmy Carter signed Executive Order 12114, which required agencies such as AID to file environmental impact statements before they could commence on projects in foreign countries⁴¹. Five days before leaving office, Carter signed Executive Order 12264, which required the United States to inform Third World countries if an exported pesticide had been banned in the

United States. The Order also required official approval from Third World governments before a pesticide could be exported⁴².

These two executive orders might have provided the basis for stricter regulations. However, under Ronald Reagan, the Environmental Protection Agency has taken a less activist stance on environmental matters. Reagan's ideological orientation towards deregulation and his lack of interest in environmental matters is reflected in the fact that the administration has no policy towards the export of pesticides. In 1985, the United States was the only member of the United Nations to oppose a resolution supporting the continuation of a service which listed restricted and banned pesticides⁴³. Previously, the Reagan Administration had rescinded Executive Order 12264 which required the United States to notify Third World countries of pesticides banned in the United States⁴⁴. Currently, there are no U.S. government regulations which limit the export of pesticides to the Third World.

The Circle of Poison

The export and use of pesticides is only one of the environmental controversies to have caused a dispute between Mexico and the United States. Most of the other disputes also involve pollutants originating in one country which are then "deposited" in the other. Examples include: the dumping of sewage from Tijuana into the Chula Vista area; the emission of sulphur dioxide from Mexican chimneys, resulting in acid rain in the southwest United States; the seepage of nuclear and toxic wastes from storage sites in New Mexico into Mexican groundwater; and the run-off of fertilizers and pesticides from southwest farms into Mexican drinking water. Each one of these environmental problems burden one country more than the other.

By contrast, the export and use of pesticides (in Mexico) has harmed both countries. Pesticides exported from the United States have been sprayed on Mexican crops which are then imported back into the United States. In 1981, 15 per cent of the sampled beans and 13 per cent of the sampled peppers imported from Mexico violated FDA pesticide residue standards⁴⁷. Moreover, the General Accounting Office (GAO) has been highly critical of FDA testing procedures⁴⁸. In 1977, only 17 per cent of those products regulated by the FDA were tested for pesticide residues. The FDA does not test for

Pesticides Used in Mexican Agriculture

The herbicide 2 4-D is used on cereals, propanil on rice, trifluralin on cotton, and atrazine on sorghum. The fungicides captan and quentozone are used in seed dressings while the inorganic fungicides are applied to a variety of fruits and vegetables. Most insecticides are used on a whole spectrum of crops.

Pesticide/ Insecticide, Organochlorines	Tons Used (Actual Estimated 1978)	Suspected Environmental Health Effects
DDT	4930	Nerve Damage
BHC	2060	Nerve Damage
Toxaphene	2290	Cancer, Reproductive System Effects
Endosulfan	136	Nerve Damage
Endrin	127	Cancer, MutatLbns, Prenatal Damage, Reproductive System Effects
Heptachlor	255	Cancer
Organophosphates		
M-Parathion	2970	Cancer, Nerve Damage, Prenatal Damage
E-Parathion	1515	Cancer, Nerve Damage, Prenatal Damage
Malathion	170	Prenatal Damage
Dimethoate	340	Cancer, Mutation, Prenatal Damage
Disulfoton	21	Prenatal Damage, Damage to Spleen
Monocrotophos	425	Highly toxic, but rapidly excreted
Chlorpyrifos	30	No listing of suspected effects
Trichlorfon	106	Cancer, Mutations, Nerve Damage, Paralysis, Prenatal Damage
Organophosphates		
DDVP	80	No listing of suspected effects
Azinphos	255	Cancer
Methamidophos	255	No listing of suspected effects
Diazinon	76	No listing of suspected effects
Carbamates		
Carbaryl	1275	Behavioral effects, Cancer, Heart Defects, Mutations, Kidney Damage
Methomyl	297	Liver and Spleen Damage
Carbofuran	68	Mutations
Pyrethroids	20	Respiratory Failure
Other Insecticides	809	
Herbicide		
Phenolics		
DNPB	30	Cancer
Nitrofen	42	Prenatal Damage
Phenoxies		
2 4-D	1200	Cancer, Mutations, Death-due to Ventricular Fibrillations or Cardiac Failure
Carbamates		
EPTC	25	No listing of suspected effects
Herbicide		
Diuron	225	Cancer, Mutations, Prenatal Damage, Red Blood Cell Destruction, Damage to Spleen
Flumeturon	17	Cancer, Mutations
Linuron	34	Bone Marrow Change, Mutations, Prenatal Damage
Diazines		
Bentazone	25	Kidney Damage
Trazines		
Atrazine	340	Cardiac Dilations, Convulsions, Growth Retardation, Liver Haemorrhaging
Ametryne	319	Mutations, Paralysis, Kidney Damage, Spleen Haemorrhaging
Amides		
Propanil	250	Mutations
Quat. Amm.		
Paraquat	85	Abdominal Pain, Convulsions, Myocarditi, Nerve Damage, Respiratory Collapse, Spleen Haemorrhaging
Tolodines		
Trifluralin	340	Cancer, Mutations, Prenatal Damage
Others		
Dalapon	51	Mutations, Kidney Damage, Weight Loss
Dicamba	21	Prenatal Damage
MSMA	85	Mutations, Prenatal Damage
Other Herbicides	380	
Fungicide		
Inorganics		
Copper Sulphate	935	Cancer, Cirrhosis of Liver, Mutations, Prenatal Damage, Pulmonary Fibrosis, Reproductive System Effects
Other Copper Compounds	640	No listing of suspected effects
Sulphur Dust	1020	No listing of suspected effects
Chlorinated Phenols		
PCP	110	Cancer, Hypertension, Prenatal and Postnatal Damage; Nerve, Liver, and Kidney Damage
Chlorothalonil	21	Kidney Damage, Prenatal and Postnatal Damage
Quintozone	423	Cancer
Dithiocarbamates		
Mancozeb	705	No listing of suspected effects
Propineb	85	Cancer
Zineb	85	Prenatal Damage, Reproductive System Effects
Fungicide		
Phthalimides		
Captan	111	Cancer, Mutations, Prenatal Damage
Follet	13	Cancer, Mutations, Prenatal Damage
Amine Derived		
Benomyl	2	Liver Damage, Mutations
Others		
Triadimefon	19	No listing of suspected effects
Other Fungicides	59	

Source Material: W.H. Hallenback and K.M. Cunningham-Burns, Pesticides and Human Health, Christopher Maltby, Report on the Use of Pesticides in Latin America, and Marshall Sittig, Handbook on Toxic and Hazardous Chemicals and Carcinogens.



Pesticide run-off is a major cause of pollution in Mexico. Not only must the country contend with its own pesticides, but it also receives prodigious quantities from the US, via shared rivers.

pesticide residues on pineapples, grapes, and onions imported from Mexico, even though the total tonnage of these products is greater than the total tonnage of beans, squash, and peppers which the FDA does test⁴⁹. In 1981, in one-third of the cases in which samples were found to violate pesticide residue standards the main shipments had already reached market⁵⁰. Only 90 out of 268 common pesticides can be detected through FDA multi-residue analysis tests⁵¹. The application of pesticides, thus, affects not only the Mexican field workers but also American consumers. It is ironic that despite strict safety regulations in the United States its citizens are still being exposed to levels of pesticide residues deemed unsafe by the FDA. The circle of poisons continues to go round and round⁵².

Signs of Hope?

Pesticides are viewed as indispensable to Mexican agriculture. Nevertheless, some members of the Mexican government appear to be concerned about current levels of pesticide use in Mexico. There are some positive signs that environmental problems in Mexico are now regarded more seriously than they were in the past. Environmental research institutes have been established. Academics have written several books and articles on environmental problems in Mexico. Moreover, however weak, an environmental movement does exist in Mexico (see *The Ecologist*, Vol. 17, Nos.1 and 6). The most optimistic conclusion is that environmental health threats, such as air pollution in Mexico City and pesticide use in north-

ern Mexico, will lead to effective local challenges to a highly centralized system. Precedents do exist elsewhere⁵³.

Acknowledgement: I would like to thank the following individuals for providing me with information: Howard Applegate, Professor Civil Engineering at the University of Texas-El Paso; Ivan J. Thomson, Professor of Nematology and Plant Pathology at the University of California-Riverside; the Environmental Protection Agency; and the United Farm Workers.

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The Ecology of Drought and Water Scarcity

by Jayanto Bandyopadhyay

India, like many other tropical countries, now suffers annual droughts of increasing severity. The droughts have generally been blamed on the failure of the monsoon rains. Yet, whilst the last 3-4 years have certainly seen reduced rainfall in India, the problem of water scarcity cannot be blamed on this alone. Ecological degradation and cash crop agriculture are also to blame. In effect, the country's droughts are largely man-made.

Having long taken its water resources for granted, India is now confronted by acute water shortages. To date, the country's water resource management strategy has been guided by the philosophy that "Water is strictly a fixed resource and cannot really be destroyed on any significant scale".¹ As a result, India has successfully destroyed the bulk of its water resources — namely, its streams and rivers, its fields and tanks, and its wells and ponds. For water is only a renewable resource if we respect the ecological processes that maintain and give stability to the water cycle. This India has signally failed to do.

State after state is now trapped into an irreversible and worsening crisis of drought, desertification and consequent water scarcity, threatening plant, animal and human life. In the 1960s, Uttar Pradesh had 17,000 villages without water; in 1972, the number had doubled to 35,000 and, by 1985, the crisis had spread to 70,000 villages. In Madhya Pradesh, 36,420 villages had no water in 1980. This figure had risen to 50,000 in 1982, and 64,565 in 1985. In Gujarat, the number of villages without water shot up from 3,844 in 1979 to 12,250 in 1986. In Maharashtra, the number of villages facing water scarcity have increased from 17,112 in 1979 to 23,000 in 1984.² The problem is the more acute given that, by the year 2025, 92 per cent of the current maximum utilisable freshwater available annually in India (some 104 million hectare metres) are expected to be fully exploited.

The ambiguous term 'drought' has been used rather freely in attempt to explain away the problem of water scarcity. And drought, in turn, has been related exclusively to the failure in rainfall. Although the annual volume of rainfall has certainly varied over the years, however, the magnitude of local water shortages is far greater than can be explained by fluctuations in rainfall. Further, water scarcity and drought is no longer restricted to arid regions with scanty rainfall. High rainfall areas, like Kerala and Goa, are also experiencing acute water scarcity and have been demanding drought relief. Quite clearly the popular correlation between drought and the failure or variation

in rainfall is inadequate and simplistic.

Four Types of Drought

Water scarcity and drought exist whenever and wherever the links in the water cycle are broken or destabilised. A closer look at the processes involved suggest that a distinction must be made between four very different types of drought:

- Meteorological drought linked to actual rainfall failures.
- Surface-water drought linked to hydrological de-stabilisation of river catchments leading to flash floods and reduced flow or drying up of rivers.
- Soil-water drought linked to reduced water holding capacity of soils due to reduced organic content, as well as high water demanding new crops.
- Groundwater drought linked to ecologically unsustainable over-exploitation of groundwater through pumping beyond limits of recharge.

The Water Cycle

It would be wrong to see rainwater, surface water, soil water and groundwater as ecologically unconnected. These systems are inseparable and are linked to each other through the water cycle, and through processes of infiltration, percolation, evapotranspiration and so on. Under conditions of seasonal rainfall, streams and rivers have perennial flows derived from groundwater sources, whereas groundwater in river basins is recharged by surface water available in streams, lakes and rivers.

Meteorological Drought

In countries which receive an annual monsoon, as in India, the

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The introduction of 'Green Revolution' crops, such as high yielding varieties of rice, has placed an enormous strain on India's water resources; traditional crops have been deprived of water in order to irrigate cash crops.

determination of what exactly constitutes 'meteorological drought' is a complex issue. Drought as a meteorological phenomenon is officially described as a deviation from normal rainfall. A 40 per cent departure is described as 'moderate drought', while above 50 per cent is considered 'serious drought'. Rangasami points out that with a pattern of rainfall like the Indian monsoon, this norm is very difficult to fix. Furthermore, in regions such as Gujarat, Rajasthan or Andhra Pradesh, where rainfall varies greatly from year to year, it is easy to show 'drought' in any year in all districts.³

Firstly, tropical climates cannot be viewed through a temperate bias. Whilst Cherapunji receives an average of 12,000 mm or more of rain a year (which would take about two decades to fall in London), temperate London, unlike tropical Cherapunji, will never experience acute water stress due to the more uniform spread of precipitation and much lower rates of evaporation.⁴

Secondly, tropical vegetation is adapted to seasonal droughts and the life-cycle of native or naturalised wild and cultivated plants matches the availability of rainfall. The long dry period after 2-3 months of rainfall does not therefore bring about a 'drought' under conditions of ecological stability.

Thirdly, under certain conditions, the natural vegetation of the tropics itself produces rainfall. Meher-Homji, for example, has shown, on the basis of vegetation and rainfall studies at 29 stations over nearly a century, that, as a rule, the larger the area of deforestation, the greater the number of criteria showing diminishing rainfall and rainy days.⁵ At a conference organised by the United Nations University held in Brazil, Salati presented his work on the relationship of tropical forests to the hydrological cycle. He estimated that as much as 75 per cent of the annual rainfall in the Amazon basin returns direct to the atmosphere through evapotranspiration. The forest thus feeds the atmosphere with water which is returned as rain. Salati points out that the destruction of the natural forests of the Amazon will decrease rainfall — and, instead of being used for water evaporation, incident solar energy will be used to heat the air, contributing to the expansion of deserts.⁶

Surface-Water Drought

Nothing can better symbolise the creation of water scarcity — despite abundant rainfall — than Cherapunji today. With the

destruction of the native Oak forests, the 12,000 mm of rain which falls every year instantly runs off the Meghalaya plateau, accentuating flood conditions in the Sylhet district of Bangladesh. With the catchment area denuded, the monsoon cannot effectively recharge the local streams. As the rains stop, the streams run dry and Cherapunji, once the wettest place on earth, joins the list of regions without water.

The creation of surface-water drought through the degradation of catchment areas results from a failure to maintain the ecological processes which allow rainfall to percolate into the underground aquifers and thus to replenish local streams and rivers throughout the year. In the tropics, the clear-felling of natural forests in river catchments instantly increases the incidence of flash floods, through enhanced surface run-off, and subsequently, because the water is no longer conserved in the soil, leads to drought.^{7,8,9} Such clear-felling has been official forest policy in India for many years. In a report to the Government of India prepared by FAO under its extended technical assistance programme, one of the main prescriptions for enhancing wood production was to improve the accessibility of hill forests in order to permit better exploitation of their timber.¹⁰ The increased exploitation of catchment forests, and their conversion into plantations of commercial species like Pine or Eucalyptus, has been a major cause of floods and droughts in India.¹¹ As a consequence of the mismanagement of river catchments, the amount of land now classified as 'flood-prone' has increased from 20 million hectares (ha) in 1971 to 40 million ha in 1980. By 1984, the figure had reached 60 million ha.¹²

The drying up of streams and rivers and the resultant surface water drought is a direct outcome of the degradation of upland watersheds and the destruction of their capacity to store water. Changes in the type of vegetation are an important factor, as our work on the ecological impact of large-scale monoculture plantations of Eucalyptus in India has shown.¹³ Eucalyptus plantations create surface water drought in three ways:

- Unlike the natural forests, the canopy of Eucalyptus plantations intercepts little rainfall which consequently hits the forest floor directly and is lost as run-off, causing floods.

- Instant surface run-off is also increased because Eucalyptus contributes little biomass for conversion to humus, the latter being important for enhancing soil moisture and groundwater recharge.

•Finally, the high evapotranspiration rates of Eucalyptus — even under conditions of low water availability — also contributes to decreased water yields and surface water droughts.

The replacement of the natural shola forests and grasslands of the Nilgiris by Eucalyptus plantations has led to a significant decrease in water yield over a 10-year period.¹⁴ Similarly, comparative catchment studies in Madagascar between natural mountain forests, secondary forests and Eucalyptus plantations have shown that flood run-off was, on an average, more than 20 per cent higher in the eucalyptus plantations, whilst their contribution to 'base flow' throughout the year was the lowest. With the plantation of Eucalyptus, only 4-19 per cent of the rainfall entered local streams, while the natural and secondary forests contributed about 50 per cent to the base flow.¹⁵ The Eucalyptus plantations were thus directly to blame for both the enhancement of instant run-off and flash floods and the creation of surface water drought, while the natural forests contributed significantly to flood control by buffering instant run-off and increasing lean season flows.

The planting of Chir Pine in the Himalaya and Tropical Pine in Central India have similarly contributed to surface water drought. In the 1950s, long before the Chipko movement took up the cause, Mira Behn, the English disciple of Mahatma Gandhi, raised the alarm about surface water resources by highlighting the damage being done to the Himalayas by the replacement of Oak by Chir Pine.¹⁶

There are other important factors which have contributed to the destabilisation of river catchments in India, and indeed elsewhere in the tropics. Thus, the hydrological stability of India's upland watersheds has been significantly undermined by mining and road construction, overgrazing and the spread of non-terraced agriculture. Mining and road construction have damaged mountain slopes by covering large surface areas with debris, leading to greatly increased run-off and an alarming rate of sedimentation, the combined impact of which has been to cause surface water drought even in high rainfall regions. Limestone quarrying in catchment areas of the Himalayas, especially in the Doon Valley, has turned most perennial rivers into seasonal ones that now carry more than 2000 mms of rainfall as flood waters.¹⁷ Most of these perennial streams were recharged by rainfall conserved as groundwater in the perched limestone aquifers of the Musoorie hills.

The situation is similar wherever there is large-scale mining in areas where rainfall is heavy. In South India, iron ore mining in the Tungabhadra watersheds of the Western Ghats is creating similar surface water droughts, by reducing the perennial flow of streams and rivers and increasing their silt load. In the case of hill roads, Narayana and Rambabu calculated that each 10 metre stretch of Himalayan road contributes 2 tons of debris per year to be deposited in the river-beds, reservoirs and flood plains downstream.

Rivers, Dams and Surface Water Drought

Dams and river valley projects have been promoted as both a solution to the problem of flooding and, by providing irrigation water, to the problem of drought. By 1979, the Government of India had invested 100,556 million Rupees on building 1554 large dams. Table 1 gives the distribution of these large dams by state. Maharashtra, Gujarat and Madhya Pradesh, which have

the largest number of dams, are also prominent among the worst drought affected states.

Dams have signally failed to provide an insurance against drought primarily because they do not provide a mechanism for maintaining the water cycle by providing the necessary control over water flows. Moreover, dams are increasingly a *cause* of the very floods they are intended to control. Only recently, on August 31st 1987, several areas of Burdwan and Meninpur districts of West Bengal were flooded by water released from the Damodar Valley Corporation's dam, where the reservoir had been kept as full as possible in order to maximise the dam's hydroelectric potential and was unable therefore to absorb a sudden rush of floodwaters. In Hooghly district, three people (including a child) were washed away.¹⁸ On August 27th 1987, while Gujarat was suffering a severe drought, flood warnings were issued in nearly 50 villages downstream from Kadana dam in view of the release of water from the dam following a heavy rainfall in the catchment areas. A similar alert was also given to a large number of villages downstream from the Vanakbori Dam.¹⁹ In 1978, releases from the Nanak Sagar, Kaulagarh and Begul Sandh dams flooded vast areas in the Rohilkhand areas of Uttar Pradesh. In the same year when the water level of Bhakra dam reached 1684 ft (thus exceeding the maximum capacity of its reservoir), water was released to save the dam, rendering 65,000 people homeless in the Punjab. On September 19th 1980, a serious flood was created in Orissa as a result of heavy discharge of water to save the Hirakund dam on the river Mahanadi.²⁰ The Sharavati flood disaster of July 1980, which affected 27,000 people in Karnataka, resulted from efforts to protect the Linganamaki project.²¹

The crisis of surface water drought results from the collapse of the water conservation and storage potential of river catchments. Since dams cannot rectify such ecological disruption, they have failed as flood control mechanisms. Nor, as we shall see, have the dams built to supply irrigation water succeeded in their stated aim of preventing drought.

Soil Water Drought and Irrigation

Soil moisture is essential for the maintenance of plant growth.

Table 1. Statewise distribution of dams in India.

State	No. of dams
Andhra Pradesh	74
Bihar	31
Gujarat	276
Himachal Pradesh	3
Jammu and Kashmir	7
Karnataka	63
Kerala	44
Madhya Pradesh	131
Maharashtra	631
Meghalaya	6
Orissa	39
Punjab	2
Rajasthan	67
Tamil Nadu	77
Uttar Pradesh	84
West Bengal	17
Goa, Daman and Diu	2

Source: Register of large dams in India, CBIP, New Delhi, 1979.

Except under conditions of land aridisation and desertification, which reduce the effective moisture content of soils and decrease its biological productivity, soil water drought is a relative phenomenon. Conditions which could kill paddy for lack of water could also lead to crop failure due to excess water in the case of crops like bajra or jowar, which have much lower water requirements. Table 2 gives the water requirement of some irrigated crops as well as their food productivity per unit volume of water.²² Crops with low water requirement (such as millets, pulses and oilseeds) have traditionally been grown in arid and semi-arid areas under rainfed conditions. Crops like paddy have been grown in humid zones.

The incidence of soil water drought is not just related to crops grown but also to the soil structure. Different kinds of soil retain different amounts of water. The input of organic matter increases the water-retaining capacity of soils. Manure and various other organic fertilisers increase infiltration and reduce evaporation by 15-20 per cent. They thus help increase water retention in the soil by 2-5 times.²³ 'Black' soils, which occur south of the Vindhya mountains and the Malwa plateau, have a very high water-retaining capacity and under dry cultivation are the most fertile. Cotton has been traditionally cultivated in these soils, along with jowar, bajra and wheat. Among pulses, bengal gram is distinctive of black soils in the post rainy season. The retentive nature of black soils allows the dry cultivation of several crops, such as chillies, garlic, onion etc., which are grown only under irrigation in other soils.

Irrigation has a long history in India, but the traditional system of canals, anicuts, tanks and wells was limited in extent and in its storage capacity. The British, however, changed the entire nature of the indigenous irrigation system, transforming seasonal canals to perennial ones. Among the major projects undertaken was the construction in 1836 of the then largest canal in the world, the Ganga Canal near Haridwar. The move towards larger and larger irrigation systems was continued after independence in 1947 (see Table 3).

But the most significant change has been in the role which irrigation now plays in agriculture. As C. Dakshinamurti notes:

"The traditional irrigation system is mainly designed for protective irrigation and not adapted to the modern intensive agriculture based on high-yielding crop varieties and multiple cropping techniques, with increased fertiliser use requiring frequent irrigations."²⁴

The intensive water demands of Green Revolution agriculture have led to the extremely wasteful use of water, with the efficiency of some distribution systems being as low as 25 per cent. Moreover, intensive irrigation has had a severe ecological impact, leading to waterlogging and salinity on the one hand and the unpredictable occurrence of soil moisture drought on the other.

A number of processes have increased the vulnerability of modern agriculture to drought. Firstly, the financial subsidies given to water intensive irrigation agriculture have led to the neglect and underdevelopment of dryland farming. In the case of Deccan, the process of soil degradation in the drylands as a result of the extension of irrigation has been vividly described by Mann:

"Yet another agricultural result has followed in these Deccan canals areas in the draining of the manurial resources of the surrounding dry country into the watered region. The growing of sugarcane demands a very high degree of manuring and every source for manures must be tapped, apart from the oilcake and artificial manures which are brought by the sugarcane growers. For quite a large region round the Nira Canal area cattle manure and other similar materials have

Table 2 Water Requirement and productivity of Irrigated Crops

Crop	Water in mm	Productivity kg/ha/mm
Rice	950	1.72
Ragi	250	4.65
Jowar	250	4.47
Sugarcane	1250	-
Wheat	400	-
Maize	200	-

Table 3. Expansion of Irrigation in India since Independence.

Period	Outlays/Expenditure (in crores of rupees)			Potential Created (million hectares)		Cumulative Potential (million hectares)
	Major and Medium	Minor	Total	Major and Medium	Minor	
Pre-plan	-	-	-	9.7	12.9	22.6
First Plan	380	76	456	12.20	14.06	26.26
Second Plan	380	142	522	14.30	14.79	29.09
Third Plan	581	328	909	16.60	17.01	33.61
Annual Plans (1966-69)	434	326	760	18.10	19.00	37.10
Fourth Plan (1969-74)	1237	513	1750	20.70	23.50	44.20
Fifth Plan (1974-78)	2442	631	3073	24.82	27.30	52.12
Annual Plans (1978-80)	2072	497	2569	26.60	30.00	56.60
Sixth Plan (1980-81)	1225	284	1509	27.55	31.40	58.95

been drawn into the watered zone with the result that the dry crops there have been to that extent starved of the manures which they might have had."²⁵

The second drought inducing impact of irrigation is the diversion of water from traditional *protective* irrigation systems. The collapse of indigenous dryland agriculture has been further aggravated by the allocation of irrigation water for growing cash crops. Thus, whilst the staple crops in the drought stricken areas of Maharashtra, Karnataka or Andhra Pradesh are denied water, the sugarcane fields and grape vines are irrigated with scarce groundwater. A soil water drought has thus been created *not* by an absolute scarcity of water but by the preferential diversion of a limited water supply. Drought in Maharashtra's sugarcane region, for example, has been largely created by the diversion of water for sugarcane production.²⁶

The vulnerability of modern agriculture to drought is further increased because modern cropping systems reduce the amount of mulch and dung that returns to the soil as organic fertiliser. Chemical fertilisers and intensive water inputs lead to the rapid growth of crops, which, in indigenous crop varieties, leads to the problem of 'lodging'. Dwarf varieties which have been created to avoid 'lodging' thus reduce the availability of straw. In paddy, this reduction is about one third and in Sorghum about two thirds. The reduced production of straw in turn leads to a reduction in the availability of organic matter and thus in the soil's capacity to retain water. Large amounts of organic matter have traditionally been added to the soil in the Deccan, increasing the retention of moisture by 10-20 per cent and reducing run-off by 2 to 5 times. This no longer happens, with an inevitable increase in soil water drought.

A fourth process by which modern intensive agriculture increases vulnerability to drought is through the lower resistance

of hybrid varieties to pests. An example from Dharwad district in Karnataka illustrates the problem.²⁷ Before the 1970s, the only great drought in the area had occurred in the 1930s, a period remembered as the 'Great Famine'. Since the 1970s, the rains have not failed, as is clear from Figure 1, but the area nonetheless suffers from chronic drought. Prior to 1965-1966, the cropping pattern in the region consisted of jowar, cotton, groundnut, bajra as main crops, with a diversity of other crops, either mixed or in rotation. Thus, the Jowar crop was mixed with pulses like madlike, avare, niger, toor dal and green gram in the proportion of 1:10 or 1:5. The mixed crop system provided an insurance against drought. A further insurance against unexpected failure of crops due to low rainfall was the cultivation of a very hardy foodcrop called 'Same'. In the early 1960s, HYV sorghum was introduced under irrigated conditions and it proved highly vulnerable to pest attacks. Pesticides were used as part of the Green Revolution package, but they merely transferred the pests to neighbouring fields and created new pests to plague the originally pest-free indigenous strains of sorghum.

The farmers were effectively forced to stop cultivating traditional varieties. For example, in Kurugund village in Dharwad, the area under traditional varieties in 1965-1966 was 839.12 acres. In 1970-1971, the area was 973.84 acres. By 1975-1976, it was just 4 acres. From 1980-1981, no area was sown with traditional jowar. From 1970-1971, the area under HYV jowar gradually increased. In 1970-1971, it was 99.06 acres; in 1975-76, it was 401.74; and in 1980-1981, it was 835 acres.

Mixed cropping is forbidden and the HYV sorghum monoculture is more vulnerable to damage by pests and rainfall variation. Pesticide use has killed the hoppers and beetles which kept weeds under control. Thus weeds like striga have become a major menace for HYV crops. The combination of vulnerabilities of the Green Revolution package have created more frequent crop failures even under conditions of normal rainfall.

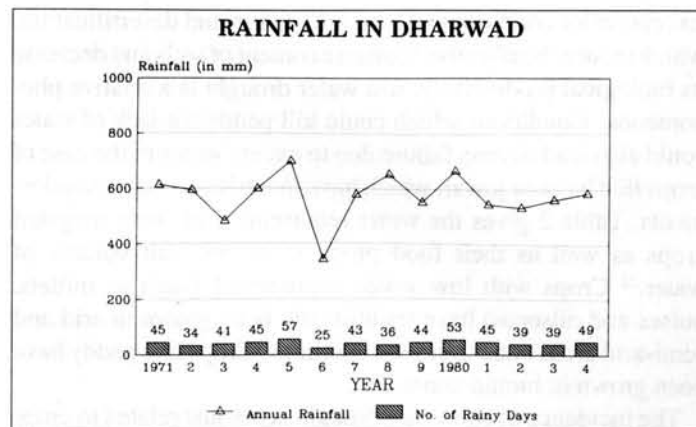
Significantly, the farmers are now turning their backs on Green Revolution agriculture. For example in Murugund village, the area under HYV jowar (832.24 acres in 1982-1983) dropped to 461.36 acres in 1984-85 and in 1985-86 it was 460.15 acres.

Clearly, the crop failures suffered in Dharwad are not rooted in meteorological drought, but in the vulnerability of Green Revolution agricultural to drought. Varieties that were drought resistant and which in normal rainfall years produced crops that could be stored as an insurance against low rainfall years have been displaced.

The success of sustainable agriculture has depended on conserving soil moisture in order to optimise crop production. The non-sustainability of agriculture is similarly linked to the neglect of such drought insurance mechanisms as mixed cropping, organic manuring and so on. This has initiated large-scale and long-term desertification trends. An analysis of land-use changes in other regions also makes it clear that ecologically destructive agricultural development is a major reason behind desertification. Buch reports:

"In places like Jhabua the so-called Green Revolution is threatening to convert even fairly good lands into desert. It is paradoxical that whilst the ecosystem of Jhabua almost totally precludes the possibility of desertification, human intervention has in fact created a desert."²⁸

In districts like Jhabua, which are among those covered by the Drought Prone Area Programme (DPAP) the incidence of drought has increased because the DPAP was guided by short-term economic returns: issues of long-term ecological rehabilitation and water conservation in these areas never got any serious



attention. The status paper of DPAP, for example, recommends a shift from millets to paddy — despite the total inappropriateness and non-sustainability of paddy cultivation in drought prone areas. The DPAP is thus making areas more vulnerable to droughts instead of making them more resilient.²⁹ In drought prone regions, ecologically sound, equally productive and less intensive methods of land and water management could be evolved without the extension of intensive irrigation. The national productivity of irrigated lands is, on average, a mere 1.4 tons/ha. By contrast, a recent experiment of Sorghum production involving *in situ* moisture conservation under a rainfall of 435 mm gave an average yield of 2.167 tons/ha. The highest yield achieved was 5.32 tonnes/ha.

Ground Water Drought

Intensive irrigation demands are also being made on India's limited groundwater reserves. Tables 4 and 5 give the planned use of groundwater for irrigation in India over the two decades from 1968-1988.³⁰

The rapid increase in the use of groundwater has been greatly encouraged by government subsidies on electric pumps.³¹ According to Dakshinamurti and his colleagues:

"It is seen that from 1950 to 1980 the development of groundwater was about 2.5 per cent on a linear basis, based on the area irrigated from groundwater resources during the year 1950-1951. The growth rates from 1960-1961 to 1964-1965 was 3.7 per cent. It suddenly rose up to 19 per cent from 1964-1965 to 1968-1969. This sudden and high increase in growth rate has been due to the advent of high yielding crop varieties, mobilisation of institutional resources for financing the programme, and stepping up of rural electrification".³²

Most groundwaters in India are drawn from shallow aquifers. To encourage irrigation in arid and semi-arid areas, the authorities have been liberal in promoting pumps — but the close hydrological links between surface water sources, wells and shallow aquifer borewells has been given scant consideration. The use of pumps is thus creating drought conditions for thousands of marginal and peasant farmers who now find their groundwaters depleted. In the hard rock areas of Maharashtra, Karnataka and Andhra Pradesh, the problem of groundwater depletion is so acute that the further extension of groundwater exploitation has been banned. However, in the absence of legislation, the ban lacks real force and the over-exploitation of groundwaters continues. Nonetheless, the Water Resources Development Ministry refuses to accept that groundwater drought is a problem.

In arid regions, where rainfall itself is low, little water percolates into the ground to recharge groundwaters. Yet, local rainfall

is ultimately the only source of groundwater recharge, especially in non-alluvial regions.³³ Sustainable limits for groundwater exploitation are therefore very low in regions like Deccan which have little rainfall and low percolation rates. When the rate of withdrawal of groundwater exceeds the rate of recharge of water through percolation, groundwaters are quickly depleted. Continuing over-exploitation of groundwater then drains such surface water resources as tanks and wells, making them dry for longer periods of the year.

When withdrawal exceeds recharge, ground water mining takes place, and a ground water drought is created even when no meteorological drought exists. However, ignoring this basic ecological fact, the authorities have been actively expanding irrigation schemes in arid regions as a strategy for 'preventing' drought. Indeed, the current drought is being used as an opportunity to expand the tubewell network. In Rayalseema region, for example, new borewells and pumpsets are being installed at an unprecedented rate, as an 'insurance' against drought. Inevitably, this over-exploitation has aggravated the drought, and has led to the drying up of wells and tanks as well as deep tubewells. A study on Rayalseema by Olson concludes:

"Irrigation has left us with the popular perception that this drought is more severe and more permanent than any past drought. Climatic change is a myth brought on by the novelty of exponential growth in water usage. ... the falling water table is evidence of overuse of water, not of climatic change."³⁴

Figure 2 shows that there is no appreciable meteorological drought in Rayalseema in terms of total annual rainfall over the forty years from 1946 to 1985.

Demands are now being made to bring irrigation water to Rayalseema from the Sri Sailam dam on the Krishna river through the Telugu-Ganga Canal, and further plans are under discussion to bring water from the Godavari river to augment the Krishna river supplies.³⁵ As demands for water are made on increasingly distant regions, desertification, which starts as a patchy phenomenon, thus spreads everywhere as a result of non-sustainable water policies in agriculture generating water scarcity. Water, a renewable resource has thus been transformed into a non-renewable resource.

In Maharashtra, the depletion of ground water is directly linked to the expansion of powered tubewells to irrigate sugarcane. While sugarcane is cultivated on only 2-3 per cent of Maharashtra's irrigated land, it consumes at least eight times more water than other irrigated crops. This has necessitated the intensive use of groundwater leading to the drying up of both shallow and deep wells. The sugar factories have been actively supporting the digging and deepening of borewells. As a result public wells and shallow wells belonging to small farmers have run dry. During the period of the Sixth Five Year Plan, 15,302 out of 17,112 villages with water problems were provided with water, leaving only 1,810 as 'problem' villages. The rapid depletion of ground water resources has, however, increased the number of problem villages with no source of drinking water to a staggering 23,000 villages.

Despite clear evidence that the overexploitation of water resources for sugarcane cultivation is the primary cause of both the growing scarcity of drinking water and the repeated failure of food crops in Maharashtra, which has seen no respite from drought since 1972, the cultivation and production of sugarcane has expanded. In the area around one sugar factory alone, sugarcane cultivation with groundwater irrigation increased from 3,248 hectares in 1961-1962 to 17,612 hectares in 1981-1982.

Incomes have risen as a result of shifting from rainfed coarse grain production to an irrigated cash crop. But the costs have

Table 4. Projected development of ground water for irrigation in India.

Year	Plan	Gross irrigated area million hectares	Volume of water million hectaremetres
1968-69	Annual	12.90	8.15
1973-74	Fourth	17.80	11.25
1978-79	Fifth	22.70	14.35
1983-84	Sixth	27.50	17.37
1988-89	Seventh	32.40	20.45

Report of the Task Force on Ground Water Resources (1972)

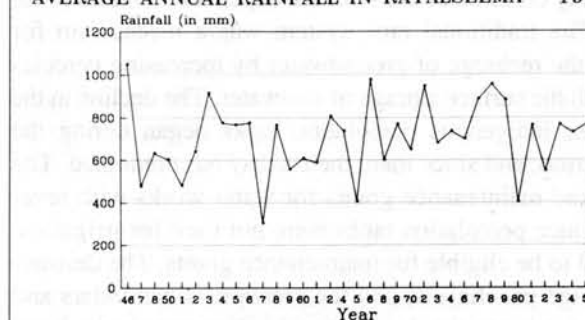
Table 5. State-wise projections for future development of gross areas irrigated from ground water schemes.

(Figures in thousand hectares)

Sl. No.	State	Gross irrigated area	Projections for future development of gross irrigated area			
		1968-69	1973-74	1978-79	1983-84	1988-89
1.	Andhra Pradesh	622.02	890.34	1214.10	1618.80	2225.80
2.	Assam (including Nagaland, Mizoram and Arunachal Pradesh)	-	20.23	80.94	223.05	485.60
3.	Bihar	569.00	809.40	1133.16	1618.80	2225.80
4.	Gujarat	910.98	1173.63	1416.45	1578.33	1618.80
5.	Haryana	547.15	728.46	890.34	971.28	1011.70
6.	Himachal Pradesh	2.02	4.05	10.11	20.23	40.40
7.	Jammu & Kashmir	2.02	16.19	40.47	80.94	141.60
8.	Kerala	8.09	20.23	50.58	101.17	202.30
9.	Madhya Pradesh	467.83	728.46	1133.16	1618.80	2225.80
10.	Maharashtra	902.07	1214.10	1456.92	1578.33	1618.80
11.	Mysore	352.89	566.58	849.87	1173.63	1618.80
12.	Orissa	40.06	80.94	202.35	404.70	607.00
13.	Punjab	1949.03	2428.20	2671.02	2751.96	2832.90
14.	Rajasthan	1426.97	1618.80	1821.15	1942.56	2023.50
15.	Tamil Nadu	951.85	1335.51	1659.27	1780.68	1821.10
16.	Uttar Pradesh	4171.24	5807.40	7446.48	9085.51	10319.80
17.	West Bengal	16.18	283.30	485.64	809.40	1214.10
18.	Union Territories + remaining states	55.04	80.94	101.17	121.40	141.60
All India (Thousand hectares)		12994.44	17806.75	22663.18	27519.57	32375.90
(Million hectares)		12.99	17.80	22.66	27.52	32.30

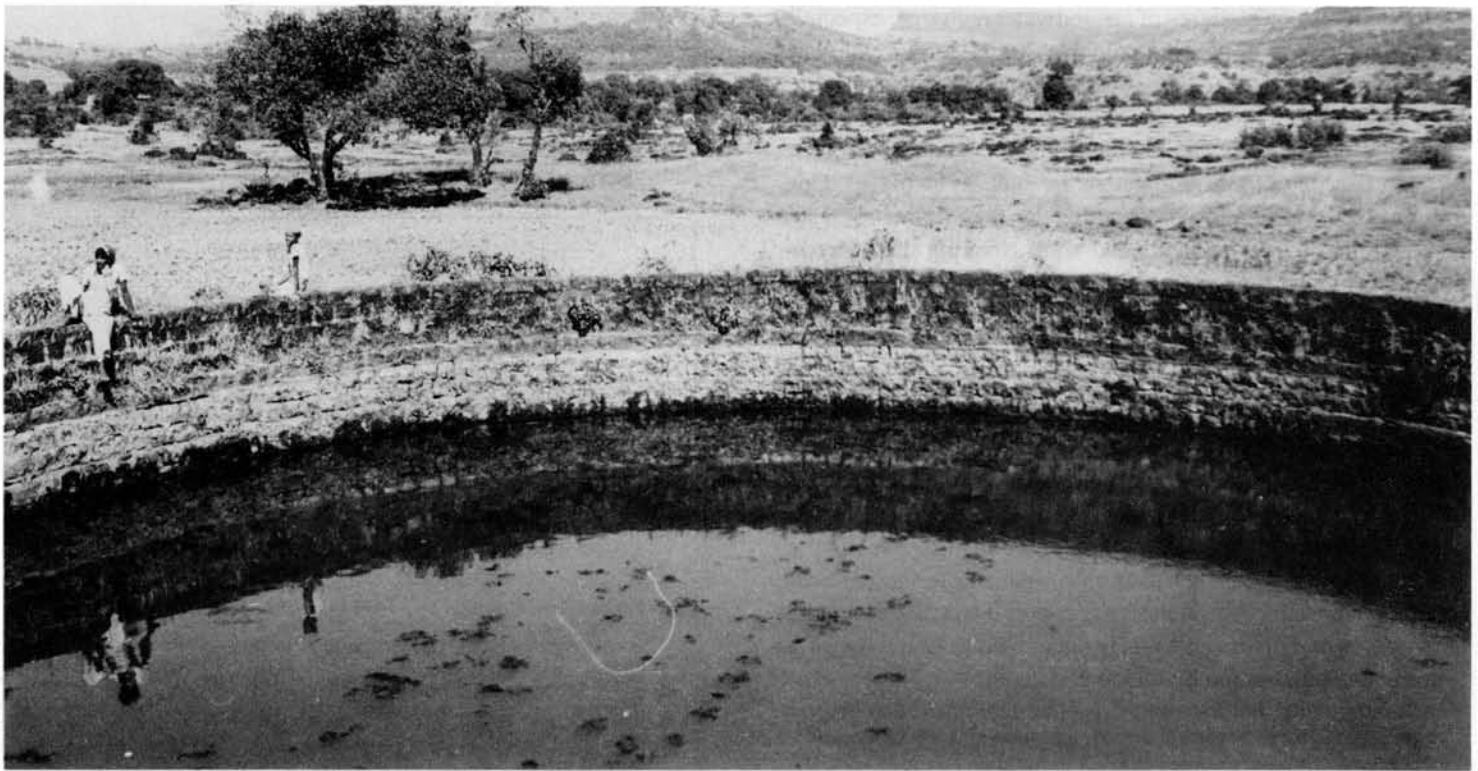
Report of the Task Force on Ground Water Resources (1972)

AVERAGE ANNUAL RAINFALL IN RAYALSEEMA 1946 - 85



been heavy. Manerajree village of Tasgaon Taluk is among those that have benefitted financially but lost materially by the expansion of pumped groundwater withdrawal for sugarcane cultivation. A new water scheme with a potential supply of 50,000 litres/day was commissioned in November 1981 at a cost of Rs. 693,000. The well lasted for one year: by November 1982, it had run dry. To restore water supplies, three bores were dug 60 metres from the well. In 1982, the three wells were yielding 50,000 litres/day: by November 1983, all the bores had dried up. In 1984, a bore well some 60 metres deep was dug, but even at this depth, water could not be found. Another bore of 200 metres provided some water but it also ran dry. At present, water is being brought by tanker from a distance of 15 km. More than 2000 privately-owned wells in this sugarcane country have also gone dry.

In the case of Karnataka, drought is also on the increase and, again, the causes are almost exclusively manmade. In the district of Kolar, which had a well-deserved reputation for water conservation through its system of village tanks, the uncontrolled expansion of Eucalyptus plantations, which have a high water



Traditional village tanks were not used for perennial irrigation, but as a precaution against drought. As a result of ground water 'mining' many tanks have now run dry.

demand, and the misuse of groundwater for irrigated cash crops like grapes, vegetables, and mulberry, have resulted in a total groundwater drought, leading in turn to the drying up of surface water sources.

As already mentioned, groundwater and surface water systems are intimately connected, and both are dependent on rainfall for recharge. The traditional tank system was a mechanism for increasing the recharge of groundwater by increasing percolation through the surface storage of rainwater. The decline in the use of these indigenous percolation tanks began during the colonial period, and since then, their decay has continued. The British linked maintenance grants for water works with revenues, and since percolation tanks were not used for irrigation, they ceased to be eligible for maintenance grants. The destruction of village panchayats, and the creation of zamindars and imamdars also led to the decay of tanks. Encouragingly, however, the current groundwater drought has created a readiness among village communities to re-establish collective control over water use and to restore the traditional tanks and ponds.³⁶

By contrast, present government policy is oriented more towards the privatisation of groundwater supplies and their uncontrolled exploitation. Communal water resources are thus being destroyed as access to water narrows down to those who can afford regularly to deepen their wells for the irrigation of cash crops. Through encouraging the over-exploitation of groundwater, the government is thus increasing inequalities in water access and water use.

Conclusion

Water 'development' projects, as conventionally conceived, have severely polarised rural society in India.³⁷ The examples of Maharashtra, Andhra Pradesh and Karnataka show how groundwater mining for commercial agriculture has created serious water scarcity, leading to drinking water shortages and scarcity of water for protective irrigation for subsistence agriculture.

Indeed, it is now abundantly clear that changes in those agricultural practices which have intensified the use of water and other resources, to which only the rich now have access, are a major cause of drought, the poor and the powerless being the worst victims.

The transformation of temporary meteorological drought into long-term groundwater and surface water drought as a result of ecologically destructive development programmes has serious political and economic ramifications, since the long-term costs are borne by the poor and the marginalised, while the short-term benefits go to the rich sections of the rural communities. As Gupta has pointed out:

"Planners must recognise that drought and its debilitating effect are triggered by the same set of macroeconomic policies which generate surplus."³⁸

The ecological use of water resources is thus not merely a matter of sustainability. It is also a matter of justice. Ecology and equity go hand in hand in water use.

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by Edward Goldsmith and Nicholas Hildyard

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Save the Forests Campaign

Some Comments

From: Lorenzo Natali

Vice President of the European Commission
19, Boulevard de Bercy,
75012 Paris.

I am replying on behalf of Mr Delors to your letter concerning the tropical forests and enclosing an Emergency Plan of Action prepared by *The Ecologist*.

I share the view that the ongoing destruction of tropical forests could have disastrous ecological and economic consequences, not only for the tropical countries themselves but also for the world as a whole. The Emergency Plan of Action contains a forceful description of the value of tropical forests and the likely results of their destruction. However, I would stress the fact that many complex issues are involved — debt, trade, population, agricultural development, land reform and sound environmental management more generally, as well as strictly forestry questions. Moreover, even in relation to the technical forestry aspects, conditions vary from place to place. I have accordingly asked the Commission services to study your proposals in more detail. Meanwhile, I will limit myself to some initial general reactions to your letter.

May I first of all emphasise that reafforestation and the conservation of remaining forest resources are recognised as key elements within the development policies of the Community. This is stated in the Third Lomé Convention which governs the Community's development assistance to the 66 African, Caribbean and Pacific states and was further elaborated in the Commission Communication to the Council and the European Parliament, *Conservation of Natural Resources - Countering Desertification in Africa*,¹ and in the EEC Fourth Environmental Action Programme (1987-1992).²

The Community's assistance to afforestation and forest conservation in developing countries has increased in recent years and now consists of over 40 major projects, or components of projects, with a total expenditure of over 25 million ECU per year. Much of this assistance takes the form of social forestry components within

integrated rural development programmes. Such programmes usually have multiple objectives (provision of fuelwood, poles, timber, fodder etc.; conservation of soil and water; forest conservation for the benefit of local people) and aim to involve local people in the protection, management and sustainable utilisation of forest resources. We are also supporting projects primarily aimed at conserving natural tropical forests. These include a major regional programme or tropical forest conservation in Central Africa, a natural forest rehabilitation project in Uganda and participation in the Korup tropical rainforest National Park in Cameroon.

All these projects are based on the belief that tropical forests can only be conserved through their rational management and sustainable utilisation so as to provide *inter alia* for the basic needs of the local populations. This means that as well as establishing protected, unexploited areas, much of the forest must be exploited in a rational, sustainable manner.

The community has also played an important role during the negotiation of the International Tropical Timber Agreement (ITTA) which is unique amongst commodity trade agreements in that one of its primary objectives is to: "encourage elaboration of national policies aimed at ensuring, in a sustained fashion, the utilisation and conservation of tropical forests and their genetic resources, as well as maintaining ecological balance in those particular regions".

The Commission believes that the International Tropical Timber Association (ITTO) has the potential to make an important contribution to ecologically sound and sustainable utilisation of tropical forests and is prepared to take a lead role within ITTO on this issue.

The Commission supports and participates in the Tropical Forestry Action Plan (TFAP) which incidentally was elaborated by FAO, the World Bank, the United Nations Development Programme and the World Resources Institute (WRI) and is based on the WRI document *Tropical Forests: A Call for Action*. Thus I cannot share the vehemence of your criticisms of the TFAP which appear to derive from a misunderstanding of its true nature. The

TFAP is a serious attempt to tackle the situation facing tropical forests and to provide a framework for generating the political, financial and institutional support necessary. Fifty tropical countries and virtually all the major donor agencies are now participating in it. Inevitably, the TFAP has its faults — notably the initial failure to involve fully local government organisations and indigenous peoples — but many of these faults are recognised and steps are being taken to rectify them. Thus I believe that it would be better to work with the TFAP to improve and strengthen it rather than to seek an alternative plan.

The suggestion to call for a Special Session of General Assembly of the United Nations to discuss the problem of tropical deforestation in order to raise public and political awareness of the situation and initiate action is an interesting one on which I will reflect further. Certainly the destruction of tropical forests and its consequences on the environment worldwide and on the economy of developing countries is one of the major problems confronting the world and initiatives to tackle the problem are necessary.

.....

From : Dr. Peter Kramer.

Director of Conservation,
World Wide Fund for Nature,
Gland,
Switzerland.

WWF shares *The Ecologist's* concern about the destruction of tropical forests. We have made tropical forest conservation a top priority for both field projects and policy activities. We consider that *The Ecologist* has played a very important role over the years in drawing the public's attention to this problem, and providing a forum for people from tropical forest countries to express their views.

WWF does not, however, fully share *The Ecologist's* appreciation of the *Tropical Forestry Action Plan* (TFAP). In particu-

1. COM (86) 16 Final
2. COM (86) 485 Final

lar, we do not think that the plan blames the poor for deforestation by adopting the premise that poverty, overpopulation and ignorance are prime causes of forest destruction. We do not believe that the World Resources Institute (WRI), the UN Food and Agriculture Organisation (FAO), the UN Development Programme (UNDP) and the World Bank are blaming the poor for being poor. However, the original TFAP does have a number of important defects:

1. It does not sufficiently take into account the role of projects funded by overseas development assistance in non-forestry sectors (mining, transportation, dams) in forest destruction.

2. Even in the forestry sector, the projects appear to be "more of the same" and many forestry projects funded by overseas development assistance have been ill-conceived and have resulted in the conversion of natural forests to plantations, increased rates of logging etc.

3. The plan does not concern itself sufficiently with the rights and needs of indigenous peoples.

4. The plan was prepared in a top-down manner with almost no involvement of local NGOs.

The institutions involved in the TFAP have recognised the validity of some of these criticisms. They have invited some international NGOs (WRI, IUCN, IIED and WWF) to attend the six-monthly donor advisors group meetings of the TFAP, and consideration is being given to inviting the Environmental Liaison Centre to join the group to act as a channel with local NGOs.

WWF considers that there have been changes in the perceptions of the institutions involved in the TFAP, as a result of these criticisms:

1. The Tropical Forestry Action Plan is not really regarded now as a plan at all but a *concept* or *process*. Plans for the forestry sectors of individual countries are developed on the request of the host government (and in close collaboration with it) through visits to the country by missions of forestry experts, co-ordinated by a lead agency. In principle, the national body responsible for co-ordinating the TFAP mission and subsequent activities should *not* be the Ministry of Forestry, but the Ministry of Finance or Planning to avoid the "foresters talking to foresters" problem, and to build broad support within the country for both the TFAP process and the importance of the forestry sec-

tor. This decision is up to the host government, however, and only in one TFAP exercise so far (Colombia) has Ministry of Planning taken a lead role.

2. Overseas development assistance institutions are increasingly recognising that the value of forests cannot be measured in terms of short-term financial criteria. It is also recognised (at least partially) that many previous forestry projects have not been successful and have resulted in losses to local people. The conservation NGO's present at the six-monthly meetings (IUCN, IIED, WRI, WWF) are calling for a new type of forestry project based on sustainable use of the resource, and are listened to sympathetically. It is unclear to what extent the TFAP will lead to financing the new type of project however. NGO input into the country missions is needed to help achieve this goal.

3. New guidelines on ecosystems conservation and indigenous peoples rights have recently been adopted.

WWF's policy is thus to continue to attend the TFAP advisors group meetings with the objectives of continually reminding participants of conservation concerns, and informing local NGO's and WWF representatives of TFAP processes starting in their countries in order for them to be in a position to influence the development of the country plans.

We believe that it is these country plans, and their implementation which should be judged rather than the original TFAP documents.

The WWF International Board reviewed *The Ecologist's* 'Plan for Action' with particular interest. Dr Gerard Budowski, who is a member of the Board, was able to comment on it in some detail because of his long experience in tropical forestry. The Board's view of the components of the plan may be summarised thus:

1. Debts for Forests:

WWF supports the use of appropriately designed debt-swaps to support the conservation activities of local NGOs. In addition to the example mentioned in your editorial, WWF has supported a debt swap with Fundação Natura in Ecuador. Debt swaps should however be carefully planned in co-ordination with local participants to avoid the perception of 'neo-colonisation'.

2. Redeveloping the Biosphere:

WWF agrees with the need for reforestation activities, but considers that this is an activity better carried out under TFAP, rather than by the creation of a Civilian Conservation Corps.

3. The Phasing Out of Destructive Development Schemes:

This is an important activity to which WWF is devoting increasing attention. Careful monitoring of all projects which affect tropical forests is needed, as well as a halt to particularly damaging ones. WWF does not consider however that it is realistic to expect countries (such as Brazil and Zaire) which have extensive forests to "phase out all development areas". Some conversion of forests to other land-users is inevitable in these areas — but this conversion should be carefully planned and executed.

4. Reforming Development Strategies:

Clearly the "terms of trade" facing many tropical forest countries are unfavourable and lead to excessive pressure on their natural resources. However, a mechanism already exists for dealing with part of this problem: the International Tropical Timber Organisation (ITTO). We believe that this kind of institution should be encouraged and expanded.

WWF does not consider it realistic to limit Third World countries' imports to those manufactured goods "which they can pay for without selling off their forests". We believe that this must be decided by the countries themselves.

5. An Emergency Meeting of The United Nations:

WWF does not consider that this is a realistic option since the relevant UN agencies are already involved in the TFAP.

In conclusion we consider that it is better to try to shape the development of the TFAP rather than abandon it and begin a new initiative.

.....

From: Dr. Marcus Colchester,

Projects Director,
Survival International,
310, Edgware Road,
London W.2 1DY.

We read with great interest *The Ecologist's* characteristically forthright exposition of the crisis facing the world's tropical forests.

However, Survival International has serious misgivings about the implications for tribal peoples of the main solution that *The Ecologist* has proposed, namely that the exchange of the Third World's debt for the guaranteed protection of the world's remaining tropical forest.

In line with international law, Survival

International takes the position that tribal peoples have exclusive rights of ownership over the lands that they traditionally use and occupy.

Survival International therefore objects to the notion that these lands can only be secured against the damaging effects of development by debt conversions. On the contrary, Survival International advocates that these lands be used in a rational manner, as indeed they have been for millennia, by remaining the property of their traditional owners. No financial transactions should be necessary to ensure the recognition of tribal peoples' rights to their lands. Debt conversions which set such a precedent might seriously prejudice the territorial claims of other traditional owners.

'Debt for nature swaps' that have been undertaken so far, have exchanged Third World debt for Government guarantees to designate forest areas as National Parks. However, in many parts of the world, National Parks have created serious problems for tribal peoples. In the first place the designation of land areas as National Parks usually has the effect of extinguishing tribal peoples land rights. Secondly, National Parks legislation may also impose serious constraints on tribal peoples' economic activities by prohibiting hunting, fishing, collecting and the felling of forest trees for agriculture and house construction etc.

In sum, debt for nature swaps have many of the shortcomings of the development process they are designed to curb. They are being pushed forward for short-term gains, from the top down, without taking into account the rights, needs and demands of the peoples who have lived in these lands for hundreds and thousands of years.

The forests are not for sale.

.....

From: Alexander King

*President of The Club of Rome
168, Rue de Grenelle,
Paris 75007*

Thank you for your letter about the plan for your campaign in favour of the tropical forests. I agree that this is one of the major problems of the world and could have a very adverse effect not only on the environment but on many social and economic matters.

I am very glad therefore to return the form of support duly signed and wish the campaign every success.

From: Martin Khor

*Consumers' Association of Penang/Friends of the Earth Malaysia,
Penang,
Malaysia*

Thank you for your letter of 11 April together with the Forest Campaign plan. We are glad to inform you that the Consumers' Association of Penang and Sahabat Alam Malaysia will endorse this plan. We will be sending copies of this plan to our major contacts.

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From: Brent Blackwelder,

*Vice President,
Environmental Policy Institute,
Washington, D.C.,
USA*

The Environmental Policy Institute heartily endorses your Emergency Action Plan to save Tropical Forests.

The only addition I would make to the major headings of the plan is to add a push for maximum efficiency in energy end-use which is essential to address the greenhouse warming effects. Destructive energy supply projects are a big cause of deforestation and contribute to the greenhouse effect. Even hydropower dams do this because they cause deforestation which is a significant component of the carbon dioxide build-up. The developing world is repeating all the energy mistakes of the industrialised world.

.....

From: Barbara Unmüßig,

*Staff Member to Ludger Volmer MP.,
Die Grünen im Bundestag
5300, Bonn 1.*

Thank you very much for your letter to Petra Kelly who passed it to me concerning the Tropical Forest Action Plan and your position on that plan. I fully agree with your criticism on the WRI plan which I studied deeply over the last months. Vandana Shiva's booklet, *Forestry Crisis and Forestry Myths — a Critical Review of 'Tropical Forest: A Call for Action'*, edited by the World Rainforest Movement (Penang/Malaysia), has been very helpful. The TFAP plan will continue the commercialisation of the natural resources in the

Third World, as will other World Bank managed wild life and wild land plans.

The Green parliamentary group has also started a 'Saving the Forests' campaign and we have initiated parliamentary debates on the issue. Because of the IMF/World Bank campaign in West Germany and the different planned counter activities during the Annual Meeting of both institutions at the end of September in Berlin, there are a lot of possibilities to criticise the WRI Plan and publicise our own strategies. The major German environmental organisations are starting now to discuss the whole issue and I myself am very much engaged in that.

The Green parliamentary group supports your campaign except for your demand that the Third World's debts should be exchanged by international agreement for the guaranteed protection of the world's remaining tropical forests. The Green Party is in favour of a global debt cancellation without any conditionality.

.....

From: Professor P J Joseph

*Chairman Forestry Board,
Kerala,
India*

We are happy to learn that you are making a worldwide signature campaign in order to awaken the attention of the world towards the dire consequences of widespread deforestation and to get an emergency meeting of the UN convened in order to think of the ways and means of preventing the catastrophe that would be caused by the continuing and devastating deforestation.

We are happy to congratulate you on your noble venture and we extend our whole hearted cooperation and unstinted support for all your endeavours in this direction.

.....

From: John P Milton,

*Chairman,
Threshold,
Drawer CU,
Brizbee, AZ 85603
USA*

Congratulations for an extremely well conceived plan for action on Tropical Forests. Please count us in as full support-

ers of the campaign and we would be delighted to be included in any letters or other communications that you put out as co-sponsors of the plan for action.

The major difficulty that I can see with the implementation of the four phase programme is in insuring that any international agreement for the guaranteed protection of the world's remaining Tropical Forests is actually enforced. As you both well know, the enforcement of deforestation in many Third World countries is extremely difficult. Threshold is still deeply committed to furthering the cause of Tropical Forest preservation and to that end, we are creating a crisis fund, which will have the ability to move very quickly into areas of extreme need. We will be fund-raising for this over the coming year and if you have any ideas on contributors to that fund or specific issues that should be brought to the attention of others at this time, please let me know.

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From: Arnold Newman,

Vice President
International Society for the Preservation of
the Tropical Rainforest,
Sherman Oaks,
CA 91423, USA

Thank you for your recent letter and 'Tropical Forests: A Plan for Action'. Your campaign is an admirable one. As the author of *The Tropical Rain Forest: The Lungs of the Planet*, I am, of course familiar with the issues.

The bulk of your text for 'A Plan for Action' is quite sound. I find areas, however, limited in approach, in perhaps simplifying solutions. In final analysis, we would wish to avoid 'the plan' being attacked by its inevitable detractors on valid grounds.

A few special notes: Eucalyptus, while detrimental if misapplied, is a valuable and prolific source of wood when correctly implemented.

Third World countries, by necessity, will need to export crop and wood produce toward balance of trade. It would be wholly unacceptable to them to ask that they refrain from importing items you have labelled "totally superfluous." I believe a balance should be struck to arrive at a point closer to equilibrium.

You need to address the reality of national sovereignty in the Third World. They will not want to be dictated policy by First World. They have, in fact, bristled

recently in statements to the effect. For instance, Brazil's statement that tropical forests are not private museums for the amusement of developed nations, scientists, and tourists. We must be receptive to that attitude or the doors to our options will be shut in our face by the "custodians" of these forests.

The issues of sustained development which must include not only agro-forestry, fish aquaculture, sustained methods of timber extraction, such as strip cutting which regenerates climax species, but also plantation forestry to relieve the pressure for that produce from virgin forest. We cannot take the stand that timber export-import will cease because we all will it so. (We all do, of course.)

I especially like your suggestion of a Civilian Conservation Corps to bring the technologies we advocate into the Third World forest areas. This can present the World Bank with an opportunity to fund on the positive side of conservation. I should think they would be receptive to such a plan at this time.

I encourage you in your efforts. I easily see my organisation endorsing 'Tropical Forests: A Plan for Action' should future drafts reflect the above.

.....

From: Mateo J Magariños de Mello,

Asociacion Uruguaya de Derecho Ambiental,
Montevideo,
Uruguay.

I endorse your four point plan personally with all my heart and mind. The only thing that I do strongly believe a bit wrongly expressed is the concept of clause 2. I deeply believe that the commercial and economic sides of the problem must not be neglected; on the contrary, they must be emphasised. We should say something like:

"That a massive reforestation programme should be undertaken, combining two necessary aims: first: the afforestation of marginal lands, inappropriate for agriculture, with fast growth species of commercial value, and second: the reafforestation of devastated forested lands with trees selected primarily for their ecological value as the ones that have been destroyed."

To attack the commercial afforestation will not lead us to solve the problem. On the contrary. We must give to Caesar what belongs to Caesar, and to God what be-

longs to God. Otherwise we will inevitably fail. (Nevertheless, I must say that I have a strong tendency to *maximise* in environmental matters).

I have sent your paper to Cr. Enrique Iglesias, suggesting to him that the IDB take the leadership in convening the United Nations Conference. I will try also to engage my country in this.

.....

From: Roger Wilson

Natural Resources and Environment Department
Overseas Development Administration
London SW1E 5DH

Thank you for your letter to the Minister for Overseas Development enclosing a copy of the editorial from *The Ecologist*. I have been asked to reply on the Minister's behalf.

Those who share a concern about environmental degradation, amongst whom we count ourselves, agree on the awesome scale of the problems we face. Where they differ is on the solutions. There are many experts in development and the environment, including most of the Non-Government Organisations in Britain, who could not share, for example *The Ecologist's* view of the Tropical Forestry Action Plan nor its analysis of the prime causes of deforestation.

On a point of fact, it is not correct to say that no conservationists or ecologists were involved in the preparation of the Plan. The International Union for the Conservation of Nature and Natural Resources, for example, helped in its formulation and are actively involved in its implementation, along with other Non-Governmental Organisations.

Nor is it helpful in finding solutions to the problems to pretend that degradation can be attributed solely to the commercial activities of loggers, ranchers or those growing export crops. Some, but not all of these groups have played a part, but the sad reality is that most felling of tropical hardwoods is done by desperately poor people who are attempting only to satisfy their basic needs for fuelwood, fodder and land for agriculture. Similarly, while debt, international protectionism especially in the agricultural sector, national economic policies and land tenure systems can all contribute to the plight of the poor, we should not overlook the role of rapidly increasing population pressure and pov-

erty itself amongst the factors in environmental degradation in most developing countries.

To suggest, as *The Ecologist* editorial implies, that we should put a ringed fence around the tropical forests is neither a practical proposition nor an answer to the aspirations of millions of poor people around the world. They will have little sympathy with the proposal. For our part, we have a moral duty to respond to their need for help. In the process, development is bound to change the environment but it need not, and should not, destroy it. Our responsibility is to manage the process wisely and sustainably and to help those in developing countries to create the capacity to do likewise.

The Government is playing its role in this. Our aid for forestry has increased threefold in the last five years. On wider economic issues, the Chancellor of the Exchequer's Debt Initiative for Sub-Saharan Africa is designed to reduce the burden on the poorest African countries. The Government has also been in the forefront of those pressing for a more open trading system in the current Uruguay Round and in the European Community.

It is through such practical measures that progress will be made and it seems unlikely that more speechifying in an emergency meeting at the UN, which *The Ecologist* is proposing, would advance the cause very far.

You may be interested to see the enclosed copies of two recent speeches in which the Minister set out his views on these issues in more detail, as well as the enclosed booklet entitled *The Environment and the British Aid Programme*.

This letter was originally sent to Mr. Tim Rickman who forwarded it to The Ecologist.

.....
From: Dr S L Mansholt,
(Ex-President of the European Community),
Oosteinde,
The Netherlands

Of course I too am very concerned about the disastrous development of the ecological development of our planet. And continued deforestation is indeed one of the gravest emergencies that face mankind.

However, I have my doubts that the United Nations will be able to do much in favour of improving the prospects of action for an ecological approach of the need

for reforestation.

What does "international agreement" mean? Only when such an agreement is accompanied by the decision to make available the large sums needed for executing the agreement can it have a positive influence.

Nevertheless, I welcome your action to do everything to shake public opinion!

.....
From: Professor Warwick Fox

*Centre for Environmental Studies
University of Tasmania,
Australia.*

Thank you for your letter regarding *The Ecologist's* 'Tropical Forests—A Plan for Action'. I am, of course, very happy to support the plan and congratulate you on the energy you are putting into this critical issue.

.....
From: Professor Hazel Henderson

*St Augustine.,
Florida.*

My thanks to *The Ecologist* for once more taking the leadership in the vital protection of our biosphere. I fully support your "Save the Forests-Save the Planet" Action Plan. I will publicise this plan as much as I am able — and feel free to use my name in your supporters roster.

.....
From: Professor Keith Buchanan,

*Emeritus Professor,
Victoria University,
New Zealand*

and Mrs Anne Buchanan

We feel that one of the great strengths of your editorial is the way it underlines the defects of the conventional wisdom as embodied in, for example, the WRI plan, and emphasises strongly the extent to which many policies adopt the line of "Blaming the Victim". We strongly endorse your assessment of the urgency of the problem and the need for swift action if our earth is to be maintained as a viable

environment for all. The flora and fauna — including the human groups — of the humid tropics are obviously immediately menaced with extinction. However, as you point out so correctly, the further reckless depletion of the tropical forests threatens the longer term future of the whole of humanity.

By valuing profit over ecological sustainability, our economic policies are responsible for the fact that we are handing on to the next generation a sadly diminished inheritance. By valuing profit over human justice these same economic policies already cause an enormously diminished existence to many millions of our fellow beings.

We have three points on which we would like to comment:

First: the first sentence in part 2 of your *Plan for Action* (p.132 of Editorial) states that "environmental or biospheric degradation" are the main causes of poverty and famine in the third world. We would regard these as symptoms, as are poverty and famine, of short sighted and profit-oriented economic policies which 'developed' nations have foisted on the third world. At most one could call them 'immediate causes'.

Second: on p.129 you stress that the great bulk of forest destruction has coincided with "the massive acceleration of economic development within the third world." We think one must be careful to emphasise that this 'development' is, in fact, the economic *exploitation* of the third world to fuel the economic development of the *industrialised* world (as you in fact imply in part 4 on p.133).

Third: while the 'Debts for Nature' scheme may be the most practical way to tackle this problem, we do not think it should be advocated without the explicit statement that it in no way implies that the *peoples* of the third world have any political, economic or moral obligation to repay debts which were undertaken without their approval and without benefiting them; which are, in any case, far less than the profits and resources which have been extracted from their countries by the industrialised societies; and which have already been repaid over and over through the crippling interest they have had to pay because of the economic policies of the industrialised countries.

Ultimately, the problem arises from the rapid expansion of consumption in the developed societies since 1945 and the export to the Third World of patterns of consumption associated with what has

become a resource-greedy trash culture, in turn promoted to generate profits. The basic issue is thus whether we can have both a market oriented economy and ecological sustainability.

Having made these points, which we hope you will consider, we warmly endorse your efforts.

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From: Professor James Lovelock

Launceston,
Cornwall

Of course I will endorse your campaign for an extraordinary meeting of the UN on stopping deforestation. This was also the message of an address I gave at the recent Global Forum for Spiritual and Parliamentary leaders on Global Survival, at Oxford.

.....

From: Professor Daniel Hillel,

Science Advisor,
Environmental Science and Technology Division,
The World Bank,
1818, H Street, N.W.,
Washington, D.C. 20433,
USA.

I have read with interest Peter Bunyard's interesting article entitled 'The Significance of the Amazon Basin for Global Climatic Equilibrium', published in the July/November 1987 issue of *The Ecologist*. I am in accord with the main intent of the article, which is to protect the earth's rainforests from destruction and the severe consequences thereof. However, a number of points made in the article raise questions in my mind for which I would like to have answers.

Bunyard cites calculations by Ramade (1984) that worldwide deforestation injects between 5 and 10 billion tons of carbon into the atmosphere annually, of which 3 to 6 billion tons come from the destruction of tropical forests (not including the contribution of soil organic matter). Assuming a tropical forest biomass typically containing 20,000 tons of carbon per square kilometre (see, for example, the article by Toledo and Navas in the book *Land Clearing and Development in the Tropics*, edited by Lal et al, Balkema, 1986), the figures you give imply the total release of carbon from 150,000 to 300,000

square kilometres of cleared tropical forest annually. Do you have any actual data on the extent of forest clearing and the amounts of biomass carbon released to the atmosphere? An article by Detwiler and Hall in the January 1st, 1988 issue of *Science* estimates that cleared vegetation contributes 0.3 to 1.3 billion tons (i.e. 10 per cent to 22 per cent of the figures you cite without reservation).

The figure you cited on the additional contribution of 'forest humus' (2 billion more tons of carbon each year) is even more surprising. Assuming a total carbon content in the soil of 10,000 tons per square kilometre (a rather high figure for tropical soils) of which, say, 1,000 tons are decomposed and released to the atmosphere annually after forest clearing, I calculate that to generate 2 billion tons one would require 2 million square kilometres of forest clearing annually. That is an obvious exaggeration. The figures cited by Detwiler and Hall (1988) seem more plausible: 0.1 to 0.3 billion tons from soil organic matter, i.e. roughly 10 per cent of the figure Bunyard gave categorically.

More questionable yet is the implication that forest clearing necessarily reduces rainfall dramatically and that "regeneration of 'adequate' forest may take one thousand years or more". One must remember that the process of forest clearing does not result in a sterile pavement but, typically, in secondary vegetation, generally of the herbaceous or shrub type (followed, if allowed, by trees). Secondary vegetation evapotranspires only marginally less than a forest cover. The recent work by Shuttleworth (to be published in a forthcoming issue of the *Proceedings of the Royal Society of London*, 1988) estimates an evapotranspiration reduction of 10 per cent, possibly resulting in a rainfall decrease up to 20 per cent (from, say, 2,500 mm to perhaps 2,000 mm) — hardly as dramatic as Bunyard's article implies. The extensive areas subject to ocean-derived rainfall, incidentally, would hardly be affected at all.

The experiments that Bunyard described sketchily as having been performed by Judy Rankin are given no reference. Has the work been documented and is it obtainable?

Heat is indeed transferred from the tropics to the higher latitudes, mainly via ocean currents and atmospheric circulation (the latter conveying both sensible and latent heat). However, the Hadley Cell circulation Bunyard invokes does not imply the conveyance of moisture from the tropics to the temperate areas: on the con-

trary, it explains how the rising moist air in the tropics condenses and precipitates its moisture in the tropics, then descends as dry air onto the arid belts on either side. The Hadley Cell pattern is not hermetic, however, as periodic masses of air break through it in the form of rainstorms.

In conclusion: The consequences of uncontrolled forest clearing can indeed be severe, particularly with regard to the loss of biodiversity as well as to the potential effect on atmospheric processes. A convincing case backed up by scientific evidence that deforestation may cause significant climate change would, of course, be a very strong argument for more concerted world action to save what is left of the tropical forest. Our concern is that emotive and exaggerated claims about the contribution of deforestation to climate, which at a later stage are discredited, could act as a deterrent to more concerted international action. There are many well substantiated cases for forest conservation which justify international action.

Professor Hillel is Professor of Plant and Soil Sciences at the University of Massachusetts.

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Peter Bunyard Replies:

Professor Hillel suggests that unless claims concerning the effect of deforestation in bringing about significant climatic change can be scientifically substantiated then credibility will go by the board and so too might any concerted campaign to save the world's tropical forests. The safe arguments for Hillel from a scientific point of view are 'loss of biodiversity', as well as 'the potential effect on atmospheric processes', by which I understand he found little to quibble with in the latter half of my article, devoted as it was to changes in atmospheric chemistry brought about through deforestation. In that regard, we must take very seriously the suggestion that the vast annual burning of the Brazilian Amazon is responsible, whether largely or in part, for the destruction of ozone over Antarctica.

The idea that science has to provide us with the rationale for protecting the rainforest is, to my mind, misguided, since present-day science is still far from giving us an adequate understanding of the biospheric processes that underlie the basis of our existence. Scientists were not able, for instance, to predict the phenomenon of

'waldsterben' and the dying of trees throughout the northern hemisphere brought about through the synergistic effects of air pollution. And despite years of discussion concerning the effects of CFCs on the chemistry of the stratosphere, the ozone hole came as a shock when it was actually found.

With regard to man-made changes to the biosphere, all science has been able to do to date is to provide the means for measuring the damage to our ecosystems so that its practitioners can then wrack their brains for causes. Although Lovelock's *Gaia Hypothesis* is giving us a glimpse, where in fact is there a model that comes anywhere near to resembling the real world? But do we have to wait until the scientists have got one before we come to our senses and undertake action?

There are a myriad of reasons why we need to protect tropical forests and *The Ecologist* has paraded them on many occasions. Indeed my article was somewhat peripheral to the major concerns voiced in our issue regarding the ghastly litany of destruction and suffering — some of it World Bank financed — wreaked upon the environment and the people dwelling in it. However, the basis of it was taken from the United Nations University meeting at São Jose dos Campos in Brazil in the Spring of 1985 on The Geophysiology of Amazonia, where an international group of scientists, including climate modellers, registered their concern over their ignorance of the consequences, let alone the extent, of deforestation. They stated categorically that to wait to see if their models might be correct in representing climatic changes through letting the destruction continue would be wholly immoral and untenable. The meeting concluded that protection of the Amazonian forests had to come before science and that it certainly could not wait for science.

Nevertheless, if science can be used to support arguments for protecting forests and the livelihood of forest-dwellers, then all to the good. The problem lies particularly in the broad range of disagreement between the experts over such fundamental matters as the extent of annual deforestation and the ecological consequences. Hillel, for instance, questions the extent of annual deforestation in the tropics as well as the amount of carbon that would be released as CO₂ during such deforestation. I had quoted from Ramade in his *Ecology of Natural Resources*, where he points out that fossil fuel burning leads to more than 5 billion tonnes of carbon being discharged into the atmosphere — approxi-

mately one-tenth of all the carbon respired each year by terrestrial organisms. He then carries out a generalized calculation of the amount of carbon getting into the atmosphere from deforestation:

"The total biomass of world forests is estimated to contain 743×10^9 tonnes of carbon. The average annual rate at which they are being cut down can be taken as somewhere between 1 and 2 per cent of their total area. If two-thirds of this mass is assumed to be released into the atmosphere in the form of CO₂ ... a calculation shows that deforestation injects between 5×10^9 and 10×10^9 tonnes of carbon into the atmosphere every year, of which 3 to 6×10^9 is from tropical forests alone. In addition, if the land is put to agricultural use after clearing it, then the resulting oxidation of the forest humus stored in it will release a further 2×10^9 tonnes of carbon per year.

How accurate are those figures? Is anything like that amount of forest going each year? And what is the net carbon flux? If the vegetation replacing the forest is photosynthetically as active as the forest that has gone, then the net carbon flux will be zero and the greenhouse effect non-existent from that particular source. R.A.Houghton *et al.* carry out their own estimates of the net flux of carbon from deforestation, for which they have to make an assessment of the extent of deforestation, where that is taking place and what has happened to the area concerned once the forest has gone. Their results cover a relatively wide range, from 1.0 to 2.6×10^9 billion tonnes of carbon for 1980, with an average value of 1.8×10^9 . Clearly their result is only 18 per cent of the higher value given by Ramade or 36 per cent of the lower value. Such values are still higher than those quoted by Hillel from Detwiler and Hall's recent paper in *Science*.

An important observation in the Houghton paper is that the net flux of carbon emanating from deforestation of temperate or boreal forests is barely significant; they give it a global value of just 0.1×10^9 , which is only one-fifth the value they gave it in their 1983 paper. They claim:

"The new estimate considers, in addition to regrowing vegetation, the changes in soil carbon associated with harvest and regrowth, the oxidation of harvested wood, and the loss of carbon from increases in cultivated area."

But my original article was primarily concerned with tropical forests and in particular with the Amazon Basin. In Houghton's recent paper, due note is taken of the net effects of shifting cultivation on the carbon flux and, in the main, carbon released to the atmosphere during burning

is regained during regrowth since that is when biomass accumulation is at its highest, at least for the first 40 years or so after clearance. However, the area of forests now being cleared each year by shifting cultivators is not only increasing, but the rotation time is being markedly reduced. Moreover increasing areas of forest are now being permanently cleared. The effect of all these factors is to send the carbon emissions up.

Norman Myers, for instance, has pointed out that at least 4 million hectares a year of once forested areas in the tropics are now being permanently cleared, and when this clearance is taken into account, the range of net carbon released from the tropics goes from 0.8×10^9 billion tonnes a year to 2.5×10^9 billion tonnes. That latter figure is already more than 80 per cent of Ramade's lower figure, and more than double the highly conservative figure given by Hillel and taken from Detwiler and Hall.

Unfortunately, the situation prevailing in the late 1970s and early 1980s has deteriorated sharply, particularly in the Brazilian Amazon, which encompasses by far the largest forested region of the tropics. Remote sensing now indicates that enormous areas of the Brazilian Amazon are being burnt down each year. Just one satellite picture taken over one region of the Amazon, the Matto Grosso, last summer (1987) showed 8000 separate fires, each of which was at least 1 square kilometre in size. The rate of destruction in the state of Rondonia has reached staggering proportions, as pointed out in my article. Whereas in 1980 the destruction of forest in Rondonia amounted to some 14,000 square kilometres, seven years later in 1987 it was estimated at 87,000 square kilometres, hence, an average destroyed of more than 10,000 square kilometres each year. According to recent estimates between 3 and 5 million hectares of the Brazilian Amazon are being destroyed each year. Meanwhile other estimates for the rate of destruction of humid tropical forest in Central America, again most of it permanently cleared for agriculture and cattle ranching, suggest that as much as 4000 square kilometres may be going.

Norman Myers estimates that at least 100,000 square kilometres of tropical forest worldwide are being destroyed each year and an equivalent amount seriously degraded. Hillel gives a figure of 200 tonnes per hectare of carbon in the biomass, while W.J. Junk and J.A.S. Nunes de Mello, in discussing the Amazon and the effects on carbon release of building large

hydroelectric plants such as that at Tucuruí or at Balbina, use a figure between 150 and 300 tonnes per hectare. If we take Hillel's figure, then indeed we are in the range of forest destruction and carbon release that is consistent with Ramade's broad brush figures.

In the end a discussion about the precise amount of carbon getting into the atmosphere from anthropogenic sources is an exercise in nit-picking. The situation concerning the potential greenhouse effect not only from carbon dioxide, but also methane, nitrous oxide — both the latter two gases generated in particular as a result of tropical forest clearance — as well as the CFCs, has now become alarming. Indeed the CFCs are some 100,000 times more potent as greenhouse gases than carbon dioxide.

The Amazon and Hydrology

Hillel also disputes that the loss of the Amazon as primary forest would seriously affect the hydrological cycle of the region. He claims that the vegetation that grows up in the place of the forest evapotranspires only marginally less than the original forest and, citing Shuttleworth, puts the reduction at 10 per cent "possibly resulting in a rainfall decrease of up to 20 per cent", which would take the average rainfall down from 2,500 mm per year to 2000 mm — "hardly as dramatic as your article implies".

As Luiz Molion, from the Brazilian National Space Research Institute, points out, the intact forest over the Amazon Basin is a remarkably efficient system for absorbing solar energy and keeping the Earth's surface in that region of the tropics relatively cool. The Amazon Basin encompasses 7 per cent of the tropical belt, including the oceans and 30 per cent of the tropical land mass. Nevertheless, in terms of its pumping water into the atmosphere, it is far more efficient per surface area than the oceans, primarily because of the forest biomass. From micrometeorological experiments carried out in central Amazonia, Molion finds that 75 per cent of the solar energy impinging on the Earth's surface over that region is used for evapotranspiration, of which some 40 per cent is intercepted by the canopy and the remaining 60 per cent transpired. Evaporation of water from the soil under the canopy is insignificant compared to that from the canopy.

Meanwhile as Salati and others have shown, on average 50 per cent of total precipitation over the Amazon Basin is evapotranspired, signifying that 50 per

cent of the total rainfall over the interior of the Amazon actually comes from water that has been evapotranspired earlier — an important contribution. The shortfall, the remaining 50 per cent comes from the Atlantic, as Hillel rightly indicates. In contrast, evapotranspiration over temperate regions of the globe contributes scarcely 10 per cent to local precipitation, which itself is a far smaller amount than that falling over the Amazon.

We are therefore talking of a significant change should the Amazon become deforested. The figure Hillel gives of 20 per cent, based on good secondary growth taking place and which he believes to be of no great concern, is a momentous amount. If we calculate what such a 20 per cent fall in rain would mean in terms of energy it amounts to some 10 times the total anthropogenic world energy consumption of some 10 terawatts and 50 times its electricity generation.

But we really have to question whether the changes will be limited to just a 20 per cent reduction in rainfall. Molion points out that the relative humidity under the forest is close to 90 per cent whereas it is barely 50 per cent just 50 metres away in a clearing. Furthermore, the sun's energy can now be used for heating the air directly, and not only does the soil temperature go up, by 5°C or more, but the reduction in cloud cover will allow more solar radiation to penetrate to the Earth's surface rather than being reflected back into space.

It has also been recorded for different regions in the tropics that even though the total annual precipitation may not change dramatically the times and 'hardness' with which it falls may alter, causing flooding and widespread destruction downstream of rivers. Indeed, actual run-off may paradoxically increase after the forest has gone, although the reasons are obvious in that they involve a greater proportion of the rain reaching the ground and less being absorbed by the soil, especially when it becomes compacted. Schubart for instance, found that forested soil close to Manaus absorbed 10 times more water compared with a 5 year-old cattle pasture in the region. Meanwhile, Molion shows that just the rain normally intercepted by the canopy and then evaporated would by reaching the ground be equivalent to 4000 tonnes of extra water per hectare, to be absorbed by the soil and carried away in the rivers. It is this 'extra' water that makes the rivers retain their volume of flow, when averaged over the year, but which equally augments the tendency to flooding.

Critical Size of Ecosystems

There is increasing evidence that once ecosystems are substantially reduced in size they undergo deterioration. That notion has been discussed by Robert MacArthur and Edward O. Wilson in their *Theory of Island Biogeography*; moreover, it has been taken up by Thomas Lovejoy within the Amazon Basin itself, with Judy Rankin having carried out some of the evaluation of what happens to a patch of forest once it has been isolated from the main bulk of forest. Some of Rankin's work was documented in the television series *The Decade of Destruction* and it showed the forest drying out and suffering wind damage with sharp reductions in wildlife.

For the Amazon at least, stretching over some 5 million square kilometres, the recycling of evapotranspired vapour by means of the Walker circulation — involving perhaps as much as 6 billion tonnes of water each year — plays a crucial role in preventing excessive water deprivation and stress. It would seem to me obvious that a positive feedback situation could easily be engendered through destroying a massive belt of forest as is happening in the Eastern part of the Amazon with Brazil's plans for industrialization, through the Grande Carajas project.

We now know that large areas of the tropical forest dried out during the last ice-age and converted into savannah. Once the climate changed and became warmer and more humid, the forest could gradually recolonize from what have been called biological refuges. The situation now is totally different since we are destroying the forest with carbon dioxide levels going up rather than down and the planet becoming warmer rather than cooler. Moreover, we are doing very little to protect those areas which may have served as biological refuges during the pleistocene.

With regard to the contribution of the Amazon forest to the transport of latent heat in the form of vapour beyond the tropics to higher latitudes, it is true as Hillel points out that the oceans play a major role. We have only to think of the contribution of the Gulf Stream to Britain to realize the truth of that. Nevertheless, Molion and other atmospheric scientists do see the Amazon playing a role in this heat transfer. According to Molion:

"Amazonia is one of the most important sources of heat for the maintenance of atmospheric circulation. The heat liberated by this source, as well as others, is transported to regions outside the tropics where a

deficit of energy is found owing to their receiving smaller quantities of solar radiation compared with tropical regions. As a result the climate of the planet remains stable, even though annual fluctuations occur, probably as a result of variations in the strength of the various sources. Deforestation on a grand scale in Amazonia would reduce local evapotranspiration. As we have seen local precipitation depends on evapotranspiration in such a way that a reduction in that would lead to a reduction in precipitation. As a consequence, less latent heat would be transported into the Amazonian troposphere and therefore less heat would be available for transport to regions outside the tropics. Those regions, receiving less heat, would become relatively colder . . . The truth is that no-one knows how important the contribution of the Amazonian heat source is for the general circulation and climate, nor moreover how much the potency of this source would be affected by wholesale deforestation.

It clearly is not worth the risk of tampering with this magnificent ecosystem to the point of destroying it. I fail to see why my original article was either emotive or exaggerated and one which could be used to

discredit international action to save the tropical forests. On the contrary, I believe the insights now emerging into the role of the tropical forest as a stabilizer of the environment can only reinforce our innate respect for the extraordinary magnificence of nature.

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The next issue of The Ecologist will contain an update on the progress of our 'Save the Forest: Save the Planet' campaign, together with a reply to the letters and comments we have received.

SAVE THE FORESTS: SAVE THE PLANET

The Ecologist's Tropical Forests: A Plan for Action proposes a fourfold plan for saving the world's tropical forests:

- 1 That the Third World's debts be exchanged by international agreement for the guaranteed protection of the world's remaining tropical forests;
- 2 That a massive re-forestation programme with trees selected for their ecological rather than their commercial value be undertaken;
- 3 That the destructive development programmes which are the root cause of deforestation—namely plantation schemes, large dams, ranching schemes, colonisation schemes and road programmes—be phased out;
- 4 That current development policies be radically revised in favour of ecologically sustainable policies, based on satisfying local needs rather than international markets.

Copies of The Ecologist's *Tropical Forests: A Plan for Action* are available from
The Ecologist, Worthynvale Manor, Camelford, Cornwall Price £5 (US\$10).



Towards a Moral Economy

THE MODERN CRISIS, by Murray Bookchin, New Society Publishers, USA, 1986, £7.95. Available from The Schumacher Society, Ford House, Hartland, Bideford, Devon.

The four essays which comprise *The Modern Crisis* are united by a common theme: namely that ethical issues are at the roots of the ecological crisis which confronts the industrialized world today. The belief that human beings best realize their potential through the pursuit of self-interest and economic opportunism has, according to Bookchin, made morality so relative that "good and bad, right and wrong, virtue and evil, even the selection of strategies for social change are completely subjectivized into matters of taste or opinion" (p.8). Moreover, through the workings of the market economy, this accent on individual preferences has created an environment in which priority is given to the immediate satisfaction of short-term individual needs at the expense of medium- or long-term considerations of the public good. As a result, the criteria used for decision-making tend to emphasize operational or functional factors, in order to achieve specific and limited objectives, rather than to reflect broader philosophical questions.

Ethical issues are thus raised within the context of specific decisions, but only, as Bookchin puts it, in a 'benefit versus risk' form. For instance, the radioactivity pollution caused by nuclear power, or the social alienation caused by the destruction of a community to make way for a city centre or shops and office blocks, will, in the terminology of economists, be 'externalities' which have to be incurred if humanity is to 'advance'. This virtual editing out of ethical matters in the decision-making process is for Bookchin both an "apologia for all the ills of our time" (p.5) and as a means of accommodating the existing order of things. The failure to

imbue our activities with ethical principles is thus seen as the key feature of the crisis which besets us today. But the real strength of *The Modern Crisis* lies in its attempt to seek a resolution to this dilemma.

Nature and Society

The first step towards a new set of ethics to meet the crisis of modern industrialism is, as Bookchin argues in his first essay, to rethink the relationship between ethics, nature and society. The vibrant, self-seeking economism which is characteristic of modern society is correlated with an externalised view of nature, in which human beings and nature are 'things apart'. Moreover nature is seen as predominantly 'red in tooth and claw' — a malign and hostile force waiting 'out there' to be tamed, exploited and manipulated in order to further human interests.

Although such an approach to nature has underscored Western thought for more than two millennia, it did not reach its peak, according to Bookchin, until the Victorian era when prevailing ideas (such as *laissez-faire* economics, utilitarian philosophy and marxist theory) made the pursuit of unlimited material progress, whether at the individual or societal level, the *sine qua non* of human existence. In such circumstances, the domination of nature became the organizing principle of social life, manifesting itself in such spheres as scientific analysis and technology; the divisions of hierarchy, class, race, gender and nation; urban sprawl; the military; and institutional and bureaucratic growth. For Bookchin, the divisive and fragmented nature of modern society is predicated on the assumption that the domination of human over nature, and therefore of nature, is a natural and enduring feature of social life. Such a view reinforced ideologically by a reading of nature in which species, in their struggle for survival, are perceived to be seeking to dominate others through competition, aggression and violence. But according to Bookchin, this view of nature represents a gross misrepresentation of reality and is primarily responsible for the imminence of the ecological breakdown which we face today. Our immediate response should be to reconstruct our understanding of the interrelationship between nature, ethics and society as a basis for achieving the twin goals of human freedom and ecological harmony.

For Bookchin, the first imperative is to reconceptualise the relationship between nature and society, so that there is stress on *continuity* and *complementarity* rather than *estrangement*. An ecological view of nature emphasises participation, differentiation, symbiosis — rather than domination or hierarchy — and unity in diversity. Ecosystems are enriched and stabilised by the multiplicity

of differentiated and diverse species participating together to create the whole. Nothing is seen in isolation from anything else and the potential of any given particularity is realised against the background of a fecund, dynamic and ever-changing wholeness which "integrates the particularities into a unified form, (and) renders the unity an operable reality and a 'being' in the literal sense of the term" (p.60).

It is through this notion of wholeness based on unity in diversity — or what Bookchin calls *social ecology* — that the link is made between nature and society. Like nature, society attains its 'truth' or fulfillment through the enormous differentiation and range of activities and institutions of which it is composed; all are so interwoven that they have neither beginning nor end. Once ecological principles are applied in this way as a basis for understanding society, says Bookchin, such dualistic notions as 'subject/object', 'mind/body' and 'part/whole', for so long prevalent in Western thought, become epistemologically and ontologically meaningless. Moreover the notion of hierarchy is rejected as a natural feature of social life.

Hierarchy or Symbiosis?

The need to breakdown hierarchical relationships is central to Bookchin's analysis. It requires not only an inversion of social consciousness so that hierarchy is no longer perceived as being the natural order of things, but also a reintegration of the 'civil' and 'domestic' domains of human society. According to Bookchin, industrialisation has meant the rise of an increasingly male-dominated civil society which has marginalised the previously dominant domestic domain, in which men and women, though having quite distinctive patterns of living, were nevertheless "in a reasonable balance with each other, a balance that was notable for the absence of domination by either sex" (p.18). The re-empowerment of women thus becomes an essential prerequisite for the stabilisation of society, notwithstanding the retention of the 'sororal' and 'fraternal' as separate, identifiable elements of social life.

Whilst this may not please the ardent feminist who might wish to do away with this distinction altogether, an important point has at least been made: namely that social differentiation does not necessarily presuppose hierarchy. Indeed Bookchin's notion of 'social ecology' implies that differentiation should be maximised, leading to a society in which people relate together not competitively, but within the framework of participative relationships based on the principle of symbiosis. Only by substituting symbiosis for competition as the organising principle of social life, can an alternative set of ethics, consist-

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MAJOR WORLD BANK PROJECTS

Their impact on
People, Society
and the Environment

by Graham Searle

This study was commissioned by the International Institute for Environment and Development (IIED) to serve as a background document for a proposed meeting between the World Bank and its principal critics.

Searle looks carefully at the probable human, social and ecological consequences of three World Bank projects, the **Narmada River Development Project** in India, the **Polonoroeste Project** in Brazil and the **Indonesian Transmigration Programme**, which were to be discussed at the meeting.

The material on which the study is based was largely obtained from the World Bank itself and the study was conducted with the full co-operation of the Bank's project staff.

Unfortunately, the meeting, originally scheduled for June 1986, was postponed to October 1986 and eventually cancelled while the IIED decided against publishing the study.

The Wadebridge Ecological Centre, however, decided that this document must be published because of its value to those concerned about the role played by the World Bank in determining the present course of Third World development. This has been made possible by a generous grant from the Rowntree Social Services Trust, to whom all thanks are due.

Maps, tables and diagrams as well as references to the World Bank documents used to compile the study are included.

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tent with an ecologically balanced society, emerge.

Market Economy or Moral Economy?

Perhaps the most important essay in the book is that entitled 'Market Economy or Moral Economy?'. In it, Bookchin argues for morality to be restored to economic life. For him, human relationships in the market economy are the very antithesis of the symbiosis we find in nature. Such symbiosis — typical of the local marketplace in which buyers and sellers can know each other at the personal level and enter into reciprocal and mutually meaningful relationships — has given way to the buyer and seller estrangement characteristic of the national and international markets of advanced industrialism. The corner shop has all but gone, as has the enormous diversity of craft skills which supported a myriad of local industries where transactions between people went well beyond the economic transfer of 'goods' from one to the other and included an important ethical component: namely the attachment of the seller's 'good name' to the commodity sold. Thus, "One did not buy a 'name' that repeatedly appeared on television screens, neon signs, and billboards; one 'bought' the moral certainty of a good personal reputation" (p.86). But the rupturing of these informal moral controls by the mass market economy has opened the floodgates to a de-personalised, demoralised and commodified 'dog eat dog' world in which the production and consumption of material goods becomes the sole purpose of human existence.

Restoring Morality

It is clear that the restoration of the moral element in economic transactions is a *sine qua non* in Bookchin's appeal for a return to "social and ecological sanity" in the modern world. But the 're-moralisation' of the economy must go beyond simply setting up an ethical framework specifically for the buying and selling of goods and services: it can, and must, perform the educative task of setting ethical guidelines for every aspect of social life. A fundamental tenet underlying such guidelines is the assumption of human 'embeddedness' in a benign and fecund nature. Viewed from this perspective nature is not something 'out there' to be used as a resource for human advance; on the contrary human survival, and indeed that of all other life forms, depends on the preservation and conservation of the natural world. Moreover, the possibility of each species realising its full potential is dependent on maintaining the complexity characteristic of the many diverse life forms within a given ecosystem, and, in particular, of their interdependence

and mutualistic interaction. Any reduction in diversity must perforce threaten not only the development and survival of individual species, but also the system itself.

It is at this point that ethical inferences can be drawn for human societies. According to Bookchin, industrialisation is life threatening because the "process of simplification" (p.108) of ecosystems lies at the very heart of its rationale. For instance, the replacement of mixed farming by monocultural practices; the virtual eclipse of a wide variety of craft skills by technology; and the conformity of planned suburban estates are all indicative of the extent to which the quest for efficiency in the pursuit of profit and growth clashes with the richness and diversity which are the essential characteristics of healthy ecosystems, whether natural or social. According to Bookchin, it is our failure to construct ethical systems which would protect diversity that stands at the centre of the crisis of advanced industrialism. But is reconstruction possible? What social arrangements would ensure congruence between nature and society.

Bookchin's answer to these questions lies in his assertion that the market economy, with its stress on material growth and expansion, has seriously undermined those traditional forms of communal living which bonded people together in a network of reciprocal relationships based on mutuality and participation. Moreover the very *capacity* of humans to take control over their own destiny is severely eroded in an expansionist economy, in which vast bureaucratic complexes, staffed by professionals, and distanced from the people as a whole, lay down the criteria meeting essential human needs.

This is what Ivan Illich has called the 'institutionalisation of values': it is now a world wide process and reflects the extent to which industrialisation, by going beyond the human scale, has negated the freedom of people to participate in the satisfaction of their own needs in varied and diverse cultural settings.

Empowering People

For Bookchin, the ultimate answer to this loss of meaning and purpose in life lies in the demise of the nation state itself because its size "renders active citizenship impossible, at least at the national level, and it turns politics into a form of statecraft in which the citizen is increasingly disempowered by authoritarian executive agencies, their legislative minions, and an all-encompassing bureaucracy" (pp. 27-28).

What is required, he suggests, is for people to be 're-empowered' politically along the lines of the free citizens of the Athenian *polis*, with the municipality becoming the prime organ of political

control, so that participative democracy at the grass roots level of society can replace the representative democracy of the nation state.

Such political arrangements are consistent with the principles of social ecology, because citizen participation in the decision-making process is geared to arriving at a moral consensus embracing full compatibility between individual and collective interests. The ethical order implied by this consensus springs not from any externalised authority but from the conscious realisation among individuals that, despite their uniqueness and diversity, their interests are inextricably interwoven, and indeed synonymous, with those of the society as a whole.

Bookchin gives the town meetings of Vermont as one example of the potential for participative politics developing in the the world's most highly 'developed' industrial society. But allowing for the fact that I cannot emulate his knowledge of American politics, I find it difficult to imagine how participation can ever be more than a marginal political concept in a country with such a highly centralized and entrenched power base as the USA. Moreover, even if we accept Bookchin's point that activities 'central' to the society of the future may today be found at society's 'edges', what criteria do we use as a basis for assuming that developments such as the Vermont meetings are necessarily those at the vanguard of social change? Apart from speculative references to 'Green networks', we are given little assurance that there are mechanisms at work leading to the political re-empowerment of people in society as a whole. And without such assurance the most likely scenario for Vermont-style meetings is that they will gradually fade into insignificance in their niche at the periphery of an essentially hostile and unreceptive society.

But the most controversial issue arising from *The Modern Crisis* is Bookchin's claim that an objective ethics can be derived from his reading of nature. On what grounds can an appeal to nature be used as a basis for a normative order? Is there not a logical distinction, as Kant argued long ago, between the realm of fact and value? As Bookchin has chosen to enter the particular philosophical arena which gives rise to such questions, I think he should have done more in the book to justify his position to his intellectual peers.

Challenge to Conventional Wisdom

However the strength of *The Modern Crisis* lies in its challenge to the reading of nature which has led to the competitiveness and destructiveness we find in the modern industrialised world. The enormity of the environmental crisis is such that we can no longer waste time with theories of industrialism or capital-

ism which do not incorporate an ecological perspective within their analysis. It is in its attempt to fill this void that Murray Bookchin's *Modern Crisis*, together with his earlier writings, assume an importance to the ecological movement that it would be difficult to overestimate.

Alwyn Jones

Christianity and Ecology

THE RAPE OF MAN AND NATURE
by Philip Sherrard, Golgonooza Press,
1987. £12.50.

The Rape of Man and Nature (subtitled "An Enquiry into the Origins and Consequences of Modern Science") is one of the most powerful onslaughts on the modern scientific mentality to have issued from an Englishman's pen since the prophetic thunderings of William Blake. This virulent and uncompromising book is written by a Christian metaphysician of outstanding calibre who is deeply concerned with the quality (or lack of it) of modern life, and who is capable of writing in a uniquely illuminating, challenging and aggravating way. It is rare indeed to encounter in one small book such an astonishing mixture of spiritual profundity, lucidity of thought, and shameless misrepresentation of the views of some of the greatest and wisest thinkers of the West. It is therefore a book as likely to infuriate as it is to inspire; it will provoke outrage by its unfairness and lack of scholarly discrimination; but it will equally draw responses of full-hearted gratitude for its profound exposition of the essential truths and deepest implications of the Christian faith.

The guiding conviction upon which the argument of the book rests, is that the contemporary ecological crisis is primarily a crisis about man and not his environment. According to Sherrard, the ecological crisis arose as a consequence of an eclipse of the full Christian understanding of man — an eclipse which took place as a result of certain developments within Christian theology. The original and authentic Christian anthropology is that Christ is the archetypal human being, uniting in His eternal nature both the divine and the human. As we are created in the image of Christ, we cannot be fully human apart from God: our human nature is fulfilled only in so far as it is divinized. The corollary of this view is that God's nature is fulfilled in becoming human. The divinization of human nature and the humanization of the divine are two aspects of

the the same process. Not to raise ourselves to the divine realm is for us to fail to fulfill our human potential, just as for the divine to exist without the human dimension would be for God to be deprived of self-manifestation. The very idea of man includes the idea of his relationship to God, just as the idea of God includes His relationship to humanity.

The fulcrum about which this relationship of God and humanity turns is Christ. The Christic principle within us, whereby the divine and the human are mediated, is the 'spiritual intellect' — a supra-rational faculty by which we know and experience metaphysical reality. Through the spiritual intellect, we come to an awareness of the immanence of God in creation — both in ourselves and in nature. Man, as the microcosm in which all degrees of nature are reflected, has the task of mediating between the divine and the natural worlds. By coming to an apprehension of the spiritual in all things, we may "offer the world to God in His praise and worship"; and through our work on the material level we may "bestow divine love and beauty upon the world". Thus our ultimate Christian purpose is — through the realization of our own divine-human nature — to effect a reconciliation of the supernatural and natural orders "in a living sacrament of the divine love and presence".

Science: Desanctifying the World

Having stated this positive thesis, Sherrard unfolds his arguments as to how the modern scientific mentality, which has resulted in the dehumanization of man and the desanctification of nature, came about within the Christian matrix. For Sherrard, the Christian view of human nature and our relationship to the world outlined above, finds its purest expression in the Eastern Orthodox tradition. This tradition, which is more deeply rooted in mystical theology than that of the West, owes much to the philosophical and conceptual framework of Plato. Although up until the Middle Ages, the Platonic Christology was to some extent shared in the West, in the 12th century it was superseded by the synthesis of Christianity and Aristotelianism wrought by Thomas Aquinas. According to Sherrard, the Aristotelian-Thomistic outlook — which became the bedrock of Roman Catholic theology — made subtle but far-reaching changes in the conception of human nature, and our relationship to God and to the natural world. In particular, Sherrard claims that in Aquinas the divine-human anthropology was eclipsed, and so likewise was the doctrine of God's immanence in nature. Thus Thomism paved the way for the scientific philosophy of Descartes, in which no higher faculty than reason was recognised as existing in human beings,

and in which it was impossible any longer to perceive the divine presence in nature. From that point on, the way was open to the exploitation of a desanctified nature by a dehumanized humanity.

It is fundamental to Sherrard's thesis that the modern scientific worldview is irreconcilable with the true sacramental spirit of Christianity. The scientific outlook is inherently evil; inhumanity is built into its very presuppositions, just as the desecration of nature is its inevitable consequence. Neither the mystical undertones of the New Physics nor the evolutionary theology of a Teilhard de Chardin break out of the fundamentally materialist mindset of scientism. The only possible way of avoiding Armageddon and the reign of the Anti-Christ, says Sherrard, is to dismantle the present scientific-industrial structures, to renounce the ideals and methods of science and embrace the only living heritage of spiritual wisdom which exists in the Western cultural orbit — namely, the Eastern Orthodox Christian tradition.

Some Theological Controversies

Such then, in outline, is the thesis of this remarkable book. In a short review such as this, it is impossible to give it the detailed critical attention which it deserves. Some brief comments may, however, be made. First of all, I believe Sherrard may be justified in upholding the more mystical theology of the Eastern Orthodox tradition as closer to the true spirit of Christianity than its western counterpart. Within Roman Catholicism, mystical writers (such as John Scotus Erigena and Eckhart) and currents of thinking which lay particular stress on the divine presence in nature (as with the Franciscans) have never been allowed a central position in Roman Catholic theology, which, as Sherrard rightly asserts, has been too much influenced by the

dualistic tone of thought of St. Augustine. However, Sherrard's critique of Thomas Aquinas, and of the Aristotelian conceptual framework upon which Aquinas built, does not do justice to the spiritual anthropology and immanentist cosmology-come-natural philosophy which is implicit in their outlook. Not only does he fail to take account of the Thomistic distinction between the 'ratio' (or reason) and the 'intellectus' (or higher, intuitive intellect), but he also ignores the central doctrine of Thomism concerning the immanence of the divine in the created world, which is stated conceptually in the interplay of the concepts of essence and existence: God is for Thomas the existence or 'isness' of all beings and, without His active presence in them, all things would drop instantly into nothingness.

Secondly, Sherrard's attack on Aristotelianism from an allegedly Platonic standpoint is misguided. For Sherrard, the root of our ills is Aristotelianism; but he is only able to give this pro-Platonic, anti-Aristotelian prejudice a semblance of plausibility by reinterpreting the inherently dualistic tenor of Platonic thought into a monism more akin — curiously — to that of Aristotle, whilst dressing up Aristotle in almost unrecognisable guise as a godless nominalist whom anyone might mistake for Bertrand Russell. While one cannot help admiring his panache, one feels that Sherrard's need to see the world in terms of a conflict between the saintly and the diabolic is paid for at the expense of both fairness and truth.

Finally, it comes as something of a surprise in a book whose subject is to trace the rise of the modern scientific mentality from within the matrix of Christian thought, that no reference is made to the Reformation. While it may be the case that in Roman Catholicism a partial eclipse or narrowing of mystical theology can be detected, this

is nothing compared to what happened with the rise of protestantism. It may be argued that the conditions for this were established in late medieval theology, but it says something of the idiosyncrasy of Sherrard's approach that he does not regard it as necessary to spell this out, and indeed leaves it out altogether. It is this lack of thoroughness on his part that perhaps lies behind his throwing all his bad eggs at Aristotle and Thomas; it certainly leads us to question the objectivity of the whole enterprise.

Despite all its failings, this book is one of the most daring and outspoken critiques of modernism to have been published since Roszak's *Where the Wasteland Ends*. It combines the petulance and rashness of judgement of a fiery malcontent, with the sagacity and intellectual perspicacity of a true metaphysician. Its great merit lies in having firmly locating within the Christian tradition a source of wisdom and spiritual depth which, for many of us brought up within this tradition, has proved sadly elusive. Ecologists do not need to turn to Taoism or Islam for their metaphysics: all that is needed is to unblock the spring in their own back garden.

Jeremy Naydler

Return to the Future

THE GREAT U-TURN by Edward Goldsmith, Green Books, Hartland, Devon.

There is a problem about the author of this book, nobody seems to take the least notice of what he is saying. Well, why then is that a problem? The answer is that what he is saying is so pregnant with shrewd observation, so rooted in a profound grasp of the ecological dangers that already have our civilisation by the throat, so buttressed with a wealth of scholarship and of the relevance of that scholarship to our danger that he not only has no equals in public life, but his published works should by now with their sales have made him a millionaire many times over.

One might have expected from this book under review alone that he might be having honorary doctorates showered on him like confetti, that our major universities would be energetically outbidding each other for his services, that millions would be flocking to his door to sit by his feet and listen, that Nobel prizes would be reaching him at regular fortnightly intervals and that he would have open access to our mass newspaper columns and to our radio and TV studios as a matter of course. Instead, he and what he has to say is largely unheard and he himself is ignored.

A New Book by the Editor of The Ecologist

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Edward Goldsmith has been at the forefront of the environmental movement for many years. In this book, he analyses the fundamental causes of the ecological crisis and suggests solutions based on social, biological and human values. This is the only book which brings together the depth and breadth of Mr. Goldsmith's thinking in one volume.

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Again, why? The answer lies in what he has to say. On every count the policies now being pursued to resolve problems of agriculture, health, education, unemployment, war, population or industry he is not merely asserting that those policies are wrong, that at least can be a basis for argument and for interviews on chat shows and the like, he is asserting something much deeper, he is saying that the conceptual horizons which produce such policies are wrong, that the philosophical tools we are using are such as to make multitudinous forms of disaster inevitable and that attempts to persist with them in the face of the general crisis of civilisation they have already produced can only make that crisis worse.

Now if you are a top politician, or industrialist, or civil servant or media manipulator or some other kind of top person, you are at once aware that since the remedies he proposes mean that it is likely you will no longer be a top person then, clearly, you have not heard, he is not there, he is talking to no effect, the present policies *must* be made to work or otherwise quite literally where will one be? And so on.

The result is a tidal wave of cognitive dissonance and the discovery that the Russian Empire is not the only place on earth where important people in public life can become non-persons. Which is all the more reason that people who have a care for anything beyond their own pockets and stomachs should rush to get a copy of this book, read it, call their friends together to discuss it and begin to organise around the issues he raises.

The author is sometimes given to making sweeping assertions from a very narrow base and occasionally some of his facts prompt a raised eyebrow for the wrong reasons, but the substance of his case is simply unarguable, that in response to a besotted quest for growth our civilisation has produced a form of industrialised living and toxified agriculture which is destroying us at a rate which constantly outdistances public comprehension of both the fact and its causes.

The author is the editor of *The Ecologist*, but he is a true polymath, equally at home in economics, social policy, medicine, agriculture, biology and I wot not what. Which does not prevent him from finding himself hopelessly at sea in politics. His final chapter on 'De-Industrialising Society', contains a number of sound points but their implementation seems to rely more on the importance of being earnest than on practical politics. There are going to be six new ministries (that's right, the central government is going to do it all) and at one point Lady Bracknell practically drops her knickers to announce "All unemployed people would automatically have to join the Restoration Corps. . ."

But I quibble about a book that demands to be read and discussed more

urgently than anything I have read in decades.

John Papworth

This review first appeared in First World Review, Nos. 28/29, 1988.

Power for What?

KILOWATTS AND CRISIS: A STUDY OF DEVELOPMENT AND SOCIAL CHANGE IN PANAMA by Alaka Wali, Westview Press, Boulder, Colorado.

This book provides a highly detailed account of the Bayano Hydro-electric Complex (BUC) in Panama, analysing the implications of this massive development scheme for the nation as a whole, as well as its impact at the local level. Wali writes in her introduction:

"Specifically, the study purports to demonstrate that the decision to construct the BHC, made at the national level and motivated by historical and economic forces, had detrimental regional consequences through changes in patterns of land tenure, economic productivity and social stratification. Simultaneously, the benefits of the dam are shown to have accrued to the service sector of the economy. The dam project therefore reinforced the existing economic structure rather than leading to its diversification as had been intended."

The Bayano region is a tropical forest ecosystem extending along the Bayano River in the South-Eastern section of the province of Panama. There are three principal groups inhabiting the area, the Kuna Indians (1,000-1,500 people), a small band of the Darien Choco Indians (350-400 people), and migrants from Western Panama, known as 'colonos' (2,000-2,500 people).

In Chapter Two, Wali examines:

"the historical roots of Panama's political and economic structure (including the role of foreign influence) in order to explain the motivations and forces behind the current government's strategy of promoting macro-development projects".

The BHC dam, constructed between 1972 and 1976, has an installed capacity of 150 megawatts (MW), is 75 metres high, 453 metres long, and impounds a reservoir of 350 square kilometres, holding 4,000 million cubic metres of water. The dam was financed by the World Bank (80 per cent), the Inter-American Development Bank, and the Venezuelan Fiduciary Fund. Wali examines the effects of the four phases of the BHC development: the construction of the dam itself; the construction of the Pan-American Highway; the formation

of the lake behind the dam; and the Economic Development Programme which was an outgrowth of relocating the area's population. The Pan-American Highway is included because Wali asserts that the Bayano Dam "provided the stimulus to proceed with the completion of the Pan-American Highway through what has come to be called the Darien Gap".

Both the construction of the highway and the dam resulted in the area being opened up for settlement and thus to an increase in logging. The improved access to the region and the increased involvement of government agencies in its development continues to alter the region's character.

However, the largest immediate impact on the ecology and inhabitants of the area resulted from the reservoir. Much of the timber from the lake area was cleared before impoundment, a sight that Wali describes as traumatic for the Kuna:

"The Kuna attitude towards the trees prior to the dam was one of reverence. Trees were only cut down to make canoes or to clear the land for planting. They were never cut indiscriminately or for sale. Watching the large-scale lumbering operation in 1974-1975, these attitudes perforce changed as it became clear to the Kuna that such large-scale destruction was possible. Some informants claim that this has facilitated engaging in lumbering for profit, virtually nonexistent before the lake."

The clearing project was not a success, since the two-year gap between cutting and flooding allowed regrowth of the cleared areas and planting by the Kuna and colonos. When flooded, the uncleared vegetation resulted in production of hydrogen sulphide and carbon dioxide, and in a severe deficit of dissolved oxygen. The smell of rotting fish filled the area for months and the lake water remains unfit for drinking.

The three indigenous groups of the region were affected differently by resettlement. The Kuna had, in 1930, set to work to define the boundaries of a reserve, and in 1931, made an agreement with the government, which legally set aside land for them in Bayano. "Both the reserve and the Bayano River were held in almost sacred regard by the Kuna," according to Wali. Thus the Kuna from the seven villages (out of a total of ten in the reserve) that were affected by the reservoir firmly resisted efforts by officials to relocate them outside of their reserve, even though some 80 per cent of it was to be flooded. They were consequently relocated within the reserve: however, nearly all of their extensive fruit orchards were lost, and while they once had some of the best soils in the region, they now found themselves on poorer quality, uphill soils, where fruit trees died within a year or two of planting.

The Choco and colonos were also relocated with resistance. The Choco had

problems in adjusting to the externally imposed village pattern of settlement, and the colonos experienced an increasing polarization of the wealthy and the poor as people competed for land with access to roads. These groups found themselves in similar straits to the Kuna, their main problem being access to fertile land. Along with the Kuna, they suffered from the delayed demarcation of their new land by the government, and were unwilling to invest time and resources in land they were not sure was theirs to keep. Inevitably, as Wali points out, "agricultural productivity for the majority of the inhabitants declined."

She goes on to write:

"In order to supplement their income, people turned to other activities: wage labour, entrepreneurship and lumbering. This last activity was rapidly coming to dominate the region. Lumbering represented fast money for everyone involved. The Bayano Corporation (a state corporation officially entitled the Bayano Corporation for the Integral Development of the Bayano) and private concessionaires, after initial investments in equipment, made large profits . . .

. . . Although ostensibly, safeguards had been instituted, such as a monthly quota on the amount of lumber that could be cut . . . privately, officially and individuals involved in lumbering claimed that there was under-reporting of (the volume of trees involved), and that the check-points were easy to bypass. To exacerbate the problem, a reforestation programme which had been planned for the region had not been instituted as late as 1980."

Interestingly Wali states:

"The actual creation of the reservoir was not in itself the major factor in influencing economic change. Rather, it was only one of a number of factors that worked to significantly alter the previous patterns. Equally important was the influence of the Bayano Corporation's policies and actions, and the extension of the road further east into the region. The Bayano Corporation not only determined policy for the region around the lake, but was itself actively engaged in a number of enterprises."

After much documentation, Wali concludes:

"The construction of the dam was motivated by a desire on the part of the national government to increase the country's self-sufficiency in energy supply and to break the monopoly of the U.S.-based utility company, Panama Power and Light Inc. . . . It was only after the decision to undertake the project had been made that any consideration was given to the impact it might have on the regional population."

As of 1980, the BHC provided about 30 per cent of Panama's electric supply. While not insignificant, Wali notes:

"What little increase in native industry occurred (as a result of

BHC) was again concentrated in the narrow metropolitan area, the corridor that runs parallel to the canal (in 1979, 82.6 per cent of the nation's total electricity supply was consumed in Panama City and Colon). Construction of the dam, then, has only reinforced the service sector of the economy, and the concentration of the wealth of urban areas."

Thomas Outerbridge

The Impact of Dams

IMPOUNDED RIVERS: PERSPECTIVES FOR ECOLOGICAL MANAGEMENT, by Geoffrey E. Petts, John Wiley and Sons, Chichester.

This book provides a general discussion of the effects of dams on all aspects of riverine ecology. Petts writes in his preface:

"Without doubt, the damming of rivers has been one of the most dramatic and widespread, deliberate impacts of Man on the environment."

He adds:

Dams represent perhaps the greatest point-source of hydrogeological interference by Man. The mean annual discharge has been reduced by up to 80 per cent as a result of river impoundment, due to increased evaporation, abstraction for industrial, domestic or other supply purposes, and seepage to groundwater storage. High flows have been reduced, and the timing of annual extremes has been altered. The changes induced by river impoundment may be transmitted over considerable distances downstream from the dam, so that even the delta or estuary can be affected. Thus, following the regulation of flows on the Peace River, the 2,500 square kilometres of the Peace-Athabasca delta — more than 1000 kilometres below Bennett Dam — were transformed from a rich floodplain and wetland environment, to a series of mudflats. Concern for the fate of the Aral Sea has arisen as a result of the fall of the water by 3 metres between 1969 and 1976, caused by the impoundment and irrigation use of run-off from the main feeding rivers, the Amu Darya and the Syr Darya. Moreover, the shoreline has receded by over 50 kilometres in the last 20 years: a major fishing industry has been lost; salinisation has reduced the fertility of the surrounding land; and climatic changes are becoming apparent.

These general effects . . . are common to all impounded rivers, and differences will occur only in terms of the magnitude of the impact — itself a function of the

design and operation of the dam.

To give an idea of the extent of Man's involvement in changing the world's hydrological systems, Petts writes:

"... on every continent, the regulatory effects of man-made lakes upon stream flows exceed that of natural lakes more than three times. . . By the year 2000, about 66 per cent of the world's total stream flow will be controlled by dams."

The major impacts of reservoirs on water quality are described by Petts as being the increase of 'travel-time' for water through the system, and the 'thermal' or 'density' stratification that may occur in reservoirs. Large bodies of standing water have a regulatory effect on thermal conditions downstream, generally dampening natural thermal variations in rivers. Most notably, Petts observes:

"... during certain periods of the year, reservoir discharges can have extremely low concentrations of dissolved oxygen, and unnaturally high concentrations of iron, manganese and hydrogen sulphide. The dissolved oxygen deficit created during summer by the Cherokee Dam, USA, downstream along the Holston River, has been equivalent to that produced by the effluent from a town of 3,500,000 people. A dissolved-oxygen sag has been observed for 100 kilometres below Hume Dam on the Murray River, Australia. These undesirable impacts are primarily the result of lake stratification."

According to Petts, "... dam construction appears to have had a greater impact on riverine fisheries than any other human activity." The initial impact is the conversion of a lotic environment to a lentic one. Discharge characteristics from the dam may then effect fish populations by altering food production, affecting the stimuli for migration, and undermining migration and spawning. The prevention of floodplain inundation may have an enormous impact on fisheries. Petts notes:

"The construction of the Pa Mong Dam, Thailand, initiated a dam-building programme which will eliminate flooding from the 49,560 square kilometre (km²) Mekong Delta, and most of the 5000 km² floodplain of the Senegal River, West Africa, will soon become dry because of headwater impoundment. Dam construction for industrial uses within the Rio Mogi Guassu, Brazil, has also resulted in the progressive loss of floodplain wetlands . . . the reaction of the fish communities of the Chari, Niger, and Senegal Rivers, Africa, to flood failures, provoked by natural climatic variations such as the Sahelian drought (1970-1974), confirm the highly detrimental effects of suppressing annual floods."

Petts also states that (for fish fauna) "water temperature may provide the dominant limiting condition." Thus the thermal changes resulting from impoundments may have significant impacts on fisheries. Most affected are

local fish fauna; reductions in native fish species are often a result of adversely affected spawning conditions.

Petts addresses a host of other issues in this book, including: channel morphology, riparian vegetation and insects, seton transport, and river management problems and prospects.

Indeed, the book is heartily recommended to all those interested in the ecological impact of water development schemes.

Thomas Outerbridge

Plants for Health

NATURE'S PHARMACY: A HISTORY OF PLANTS AND HEALING by Christine Stockwell. Century in association with the Royal Botanic Gardens, Kew. £10.95 (0-7126-1832-5)

Nature's Pharmacy should appeal to a wide range of readers. Those concerned with orthodox medicine but sympathetic to some traditional or alternative methods will find a useful outline of pharmacognosy — the study of natural sources of medicines. The general reader with an interest in plants and healing will find a book written in a style easily accessible to the layman. That there is a considerable interest in this, and similar subjects, has been shown by the number of books recently published and by bookclubs offering titles such as *The Natural Family Doctor*. However, none of these books covers quite the same area as *Natures Pharmacy*.

Christine Stockwell has based her book on the Pharmaceutical Society's Museum Collection at the Royal Botanic Gardens, Kew. This is a collection of natural substances which have been used throughout the world as medicines. Although many are no longer used, modern medicines often include active ingredients which come from plant products, or which are synthetic analogues of plant medicines. Some surprising plants are included. How many people growing hollyhocks know them as "the poor man's aspirin"?

The book is organised to provide a history of plants and healing from early man to the present day. Neanderthal man, for example, was aware of the medicinal properties of some plants and cared for sick members of his group. We also learn that, in some groups, curare for poisoned arrows was mixed by the oldest woman of the tribe in closed huts: if they were not dead from the fumes by the second day, they had to mix a more potent brew.

Following this section, the book moves on to biblical references to plant

medicines, and the discoveries of the Greeks and Romans. Particular attention is given to the work of such people as Hippocrates, Theophrastus and Galen. The next chapter, 'The New Learning', gives brief accounts of the work of well known herbalists such as Gerard, Culpeper and Parkinson, and concludes with the work of Joseph Banks and William Jenner.

The healing properties of plants had been well-established by this time but their scientific study was somewhat haphazard. In 'Pharmacists and Plant Hunters', Stockwell looks at advances such as William Withering's 'An Account of the Foxglove' and the development of the Royal Botanic Gardens under their first director, William Hooker. There is also an account of the discovery of quinine, and the chequered history of coca.

The final chapter, 'New Growth', looks at changing attitudes during recent years, and is followed by a bibliography and an index of common and botanical names.

As a whole, the book should be enjoyed by anyone interested in the history of plant medicine. Its style is far from that of a report or textbook. In fact, perhaps inspired by the subject matter, it can sometimes be a little flowery. However, it includes some useful, and occasionally unusual, information on a popular subject. A good number of line drawings of plants and personalities illustrate the text, and emphasise the chronological organisation of the material.

Frances Ball

Acid Rain and Conservation

ACID RAIN AND NATURE CONSERVATION IN BRITAIN, Nature Conservancy Council, London, 1988.

This 15-page booklet gives a clear, easy to follow, account of the problems caused by acid rain, explaining the science by means of some well-presented diagrams. The effect of acid deposition on selected species are briefly described. There is also a short history of the growing awareness of the problem and its complexity in the United Kingdom. Some mention is made of the work of other groups, such as the tree damage survey by Friends of the Earth and the subsequent surveys by the Forestry Commission confirming the poor state of Britain's trees.

The publication includes a very limited discussion of emission reduction as a solution to the problem. This seems to be tied to the equally limited policies of the Central Electricity Generating Board. The account recognises the environ-

mental damage caused by flue gas desulphurisation (such as increased quarrying and disposal problems). It is therefore surprising that there is no mention of more efficient use of coal, such as through combined heat and power stations. Nor is there mention of low sulphur fuels, such as biomass waste. The only sensible solution to acid rain and many other problems is reduced energy use through increased efficiency and conservation, with decreased fossil fuel use, together with an increased participation of renewable energy sources.

The nature conservation of the title seems limited to species conservation, although the current research programme of the Nature Conservancy Council (NCC) does seem wider. Certainly, the value of nature reserves which are no longer islands protected against damage needs to be considered. Reserves are going to become peripheral and a waste of time unless the rest of the global environment is cleaned up.

The influence of the Greenhouse Effect is another similar problem. Nature conservation organisations will have to respond to the damage caused by continuous rapid climatic change on isolated populations in nature reserves. Otherwise, the efforts put into establishing and maintaining reserves will have been completely wasted. Such organisations must come out on the side of sensible energy policies.

The booklet deserves some congratulations on making some comments about the costs of cutting emissions. It is perhaps as outspoken as we can hope for from such a publication, but the issues make very urgent demands. As it says, monetary value cannot normally be placed on damage to nature. The current government probably sees this as a good reason for giving the issue a low priority.

John Porter

The International Rivers Network

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Letters

Veganism and Ecological Living

Dear Sirs,
Tim Turner's letter to you in your January/February issue deserves an answer from, if I may put it so, the other camp.

Of course any sane person would condemn the excesses of the over-intensive stock farmer with his hormones, over-concentrated feeding regimes, early weaning, cruelly confined accommodation, dependence on tropical foodstuffs (although actually Europe imports most of its animal foodstuffs from the United States) and the stupid practice of divorcing the animals from the land which feeds them. In the words of Wendell Berry, this last practice has "taken a solution and cut it neatly down the middle into two problems" — namely, the problem of what to do with manure, and the other problem of how to fertilize the land that grew the food for the animals.

Mr Turner says that "heavy machinery, artificial fertilisers and pesticides" are used to grow the crops needed to feed animals. This may be so in the kind of agribusiness farming that is often practised but it does not need to be so. The very reason why artificial fertilizers and pesticides are used so lavishly on most of our arable land is that the animals have been divorced from the land which feeds them. Thus the manure from the animals (which the vegan camp conveniently and consistently ignore) does not get returned to the soil and artificial fertilizers and pesticides become necessary. There are many highly productive, organically-run farms in Europe now, and almost all of them practice a balanced animal husbandry with the two great kingdoms of living creatures on this planet represented. My own experience has shown me that farming with vegetable compost only is very unproductive if chemicals are not used and a vast amount of vegetable matter is not imported into the hold-

ing. And when the oil and natural gas run out (and thus artificial fertilizers) what then?

It is also incorrect to say that "of course the majority of people in the world have always lived with little or no animal food". Simply, they have not. I have travelled extensively in four continents and in perhaps forty countries, I have lived with people at every stage of development from the Paleolithic to Technological Man, and I have never come across a people most of the members of which do not eat meat, and drink milk if they can get it.

Another factor that city based vegans tend to ignore is that by far the greater part of the British Isles is down to permanent grass. We cannot eat grass. To plough our upland grassland is to invite erosion. We do not *need* to treat animals cruelly to produce meat. We do not *need* to import feedstuffs. By good organic husbandry, the people of any country can have a balanced diet, such as humans are evolved to live upon, without cruelty, and without impoverishing the land.

Yours faithfully

John Seymour,
New Ross
Eire

Bring Back Darwin?

Dear Sirs,
I have long suspected that our ecological problems are due to the pre-eminence, over the past two or three centuries and today, of the physical sciences as opposed to the biological sciences, no doubt due to the fact that the physical sciences facilitate technological applications of science.

This was recently confirmed for me in reading Ernst Mayr's *The Growth of Biological Thought*, but brought home more forcefully by Alwyn Jones' 'From Fragmentation to Wholeness: A Green View of Science and Society' in Vol.18 No.1 of *The Ecologist*.

The article is mainly about physics, its laws and operations, but the most revealing point regarding the author's own perspective comes at the end when he compares 'shallow' and 'deep' ecology, stating that 'deep ecology' is based on "... a complex web of interdependencies involving the exchange of matter and energy in continual cycles".

Good God! One would have fervently hoped that such a mechanistic reductionism (from a sociologist no

less) would have been discarded by now. One would also have hoped that scientists, sociologists included, would have taken Darwin to heart, and the lessons of evolution, to wit, that life is more than matter and energy. It is more than molecules; it is individual organisms interacting, it is populations and species in biotic as well as physical communities, eating, being eaten; it is individuals within living systems that are *evolving* together.

These individuals within communities are linked by more than matter and energy; they are linked at a higher more complex level by biological processes based not on fixed laws, like those of physics, but on *change*: adaptations, speciation, and above all, diversification. Philosophically, biology is based on diversity and change; physics on uniformity and fixity.

As Mayr implies, this notion of change seems to go down hard with physicists, who prefer the safety of predictability (even if it is really probabilistic). Nonetheless, change is the inherent nature — or definition — of evolution, the process which has brought our magnificent world into its complex rich fascinating existence. God — or Nature — save us from the atomistic view of physicists. Long may Darwin, Nature and the unpredictable processes shaping life prevail.

Yours faithfully

Lorna Saltzman
East Quogue.
NY 11942
USA.

Bracken: An Asset or a Poison

Dear Sirs,
Further to Marjorie Sykes' doubt as to the assertion that the presence of bracken heightens the probability of a person developing stomach cancer in areas that use water from catchment areas inundated with the fern, I think you will find the following research described makes this claim irrefutable. The correlation was made between the 2nd Land Utilisation Survey, conducted at King's College London, and the *Atlas of disease mortality in the UK*, collated by Melvyn Howe. The survey mapped bracken cover to an accuracy of 99 per cent over the whole of England and Wales and made a medium strong correlation with the rates of stomach cancer produced from corresponding areas in the atlas.

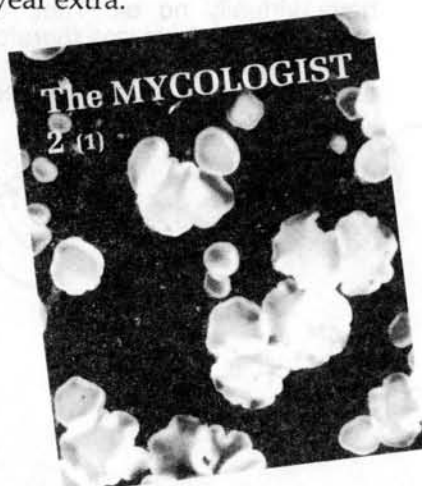
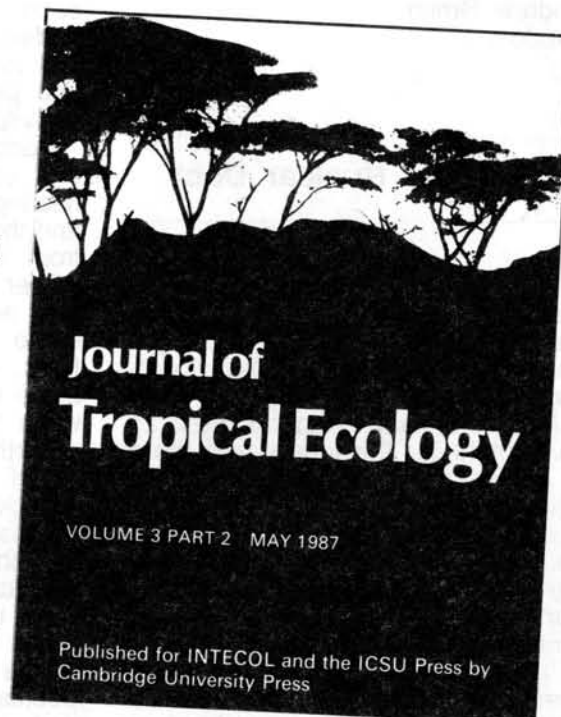
However, other evidence, such as

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the place with the highest stomach cancer rate in England and Wales, Merthyr Tydfil, also having the highest bracken cover, adds further validity to this assertion.

Yours faithfully

Andrew Smith
London.

France's Nuclear Debt

Dear Sirs,
Perhaps the title of *The Ecologist* should be changed to *The Soothsayer*.

Any major capital expenditure is an investment for the future, and there is as yet no way of reliably telling whether the heavy investment in nuclear power by France has been financially justifiable. To know this, we need to know the cost of imported alternative fuels over the next three or four decades, and we need to know the effects of these on the French balance of payments over the same period. I do not pretend to know the answer myself, but it is possible that the French Government

can foretell these factors better than can Peter Bunyard.

I am myself more concerned with ecology than with costs — especially costs to other people — and the ecological effects of the French investment are favourable and large. Each French nuclear power station each working year will save the addition to the atmosphere of around four million tonnes of carbon dioxide and perhaps forty thousand tonnes of sulphur dioxide.

I accept John Bennet's thesis that the use of electricity for home heating is wasteful of total energy, and that three times as much energy from uranium (or from coal in a power station) would be needed for this as would be needed for the same home heating by the fossil fuels, coal, oil or gas. But to conserve the fossil fuels is more worthwhile than to conserve uranium.

Furthermore, the increased burning of fossil fuels in towns would be a backward step. The latest available figures for England and Wales show that there are 14,000 more deaths from cancer annually in urban areas than would have occurred if the urban rate could have been reduced to the rural rate. The most recent Scottish figures show that Glasgow had a rate for the seven most commonest cancers 40 per cent higher than the rate in the Scottish

Western Isles, where most of the time the inhabitants breathe clean air from the Atlantic. Some of the excess deaths may result from more cigarette smoking in towns, and some must result from carcinogens such as benzo-a-pyrene in the exhaust fumes from motor vehicles; but many must result from the burning in small, not always well adjusted, units of fossil fuels.

Yours faithfully

J H Fremlin
Emeritus Professor
46, Vernon Road,
Edgbaston,
Birmingham

Nuclear Beams and Moats

Dear Sirs,
I was interested in your recent article about France and Nuclear energy.

It is a very different matter for the French who have to import coal and have virtually no oil. Their options over the long term are therefore severely restricted. Their nuclear power technology has so far proved very

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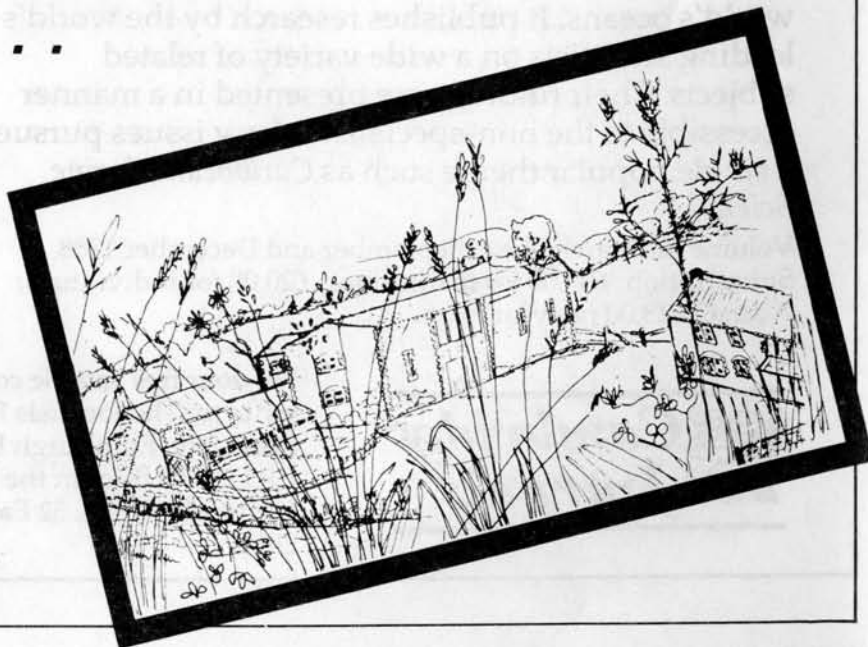
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successful and we have imported electricity from France occasionally at favourable rates.

It is rather a matter of beams and moles. Our power stations, fuelled by coal, are pouring out acid rain; not to mention the domestic chimneys, even in rural districts of the north of England, whose pungent smell is nowhere paralleled in the EEC. The total result of this is far worse than possible risk from French nuclear technology for which future generations in France will be grateful.

Yours faithfully

W M Reid.
36, St. Peter's Square,
London, W.6

The Fluoride Debate

Dear Sirs,

The letter by Professor Jackson in *The Ecologist* (vol.17, No.1, 1987) contains many errors and must surely be described as a document of misinformation.

Firstly, he failed to quote the biased wording in the gallop poll; secondly, he failed to state that the Government was very close to defeat in the House Of Lords when the Fluoridation Act was debated; thirdly, he failed to draw attention to the questionable non-attendance of politicians present in the House of Commons the night it voted on the Fluoridation Act.

Can it really be said that the 400-odd politicians who failed to face up to the House that particular night demonstrated their individual opposition to the Act, when a conscience vote was not allowed and when each of these politicians were thus unable to represent their electorate as requested by "the will of the people"?

Professor Jackson and many other fluoridation promoters throughout the world quote the Judge in the Strathclyde Court Case in a false manner. In Australia, there have been many faulty Judge Jauncey quotations, and Jackson joined the club! He misquotes Judge Jauncey who did not say "... the message is loud and clear from all parts of the world". He said (page 343) "... from different parts of the world." That makes a propaganda difference.

When asked to state "that there was no possibility of fluoride causing cancer", Lord Jauncey said: "I could not be satisfied on the evidence in this case, and indeed proof of such a negative would be very difficult, if not impossible." Yet, Japanese and Russian scientists have demon-

strated with living cells the possibility of fluoride causing cancer.¹

Lord Jauncey made one particularly interesting remark (page 257): "The burden of proof remains upon the petitioner (the anti-fluoridationist)." Isn't that wonderful! Jackson can claim anything, but the burden of proof is the responsibility of the objector, not on Jackson to prove the outrageous claims of the dental profession.

Jackson objects to any criticism directed towards the pro-fluoridationists who give most of the advice to the government via the bureaucracy. He shows his bias when he suggests that *any* scientist not having direct knowledge of fluoridation can sit in judgement on all matters pertaining to fluoridation. Of course, this is his defence for dentists having now become the spokespeople for the medical profession on all matters from cancer, bones, kidneys, enzymes, hearts and all other organs of the body, and associated diseases and their effect from fluorides and fluoridation.

If Jackson wishes to cite Judge Jauncey in his defense, then in conclusion, I submit the following statement from the Judge: "... I consider that the petitioner (the anti-fluoridationist) is well founded in submitting that drinking water fluoridated to 1ppm can in some circumstances cause enzyme inhibition".

If fluoridated water can inhibit enzymes, then no scientist in the world can argue that such a process can be classified as safe.

Yours faithfully,

G S R Walker,
Freedom from Fluoridation Federation,
Victoria,
Australia.

1. T.Tsutsui, *et al*: **Cancer Research** 44, 938-941 March, 1984; L S Stochkova, *et al*, **Proceedings of Conference held by the International Society for Fluoride Research**, New Delhi, India., Nov.14-17, 1983.

Greater Carajas: A Reply

Dear Sirs,

Maria de Lourdes Davies Freitas' disingenuous concern not to "confuse" Brazil's government-led Greater Carajas Programme with the CVRD's Carajas Iron Ore Project (*The Ecologist*, Vol. 4/5, 1987) serves the CVRD's need to absolve itself, and the Project's other major funders (which include the EEC and the World Bank), from their responsibility for an economic, social and

environmental disaster the size of Britain and France. To suggest that the two schemes are somehow independent of one another is like claiming that there is no link between nuclear power and nuclear weapons. The name they share, Carajas, is everything. For the "externalities" (Ms Freitas' euphemistic term) which the Iron Ore Project is "suffering" from the Greater Carajas Programme, such as the pig-iron industries, owe their very existence the Iron Ore Project itself.

The plain historical fact is that the Iron Ore Project was originally shelved as unviable, and only resuscitated as the nucleus of the regional development programme. Thus, the iron ore mine, the 900 kilometre railway and the deep-sea port at Sao Luis (the components of the Iron Ore Project) were to constitute the economic and transport infrastructure, the so called Carajas Export Corridor, necessary to attract the other mining, metallurgical, timber and food-processing companies into the region.

CVRD, it should be said, has shown no scruples in taking advantage of this infrastructure. Its Docegeo subsidiary is one of several mining companies which invaded the territory of the most threatened tribal people in the region, the Guaja. Having discovered a deposit of bauxite on the Indian's land, CVRD refused to hand over money set aside for the Indian's protection, in an attempt to force the government agency, FUNAI, to remove the Guaja. Meanwhile, the Catete Indian reserve, adjacent to the Iron Ore mine, has been carved up by Docegeo and CVRD's seventeen other subsidiaries in the form of claims for mineral exploitation. Free-lance gold panners already attracted by the commercial activities on the Indians' lands have been polluting their rivers and disrupting their traditional lifestyle, exposing them to malaria and other devastating diseases.

While Survival International welcomes the news that CVRD and FUNAI have, under pressure and criticism, extended their Indian sub-project, it remains the case that even the new allocation for land demarcation (14.76 per cent) is still woefully inadequate and reflects a lack of commitment to provide effective protection for the outstanding territories. Compare Ms. Freitas' claim that "almost the whole area embraced by the agreement has already been demarcated", with the actual figures, extracted from CEDI's widely respected survey *Indian Lands in Brazil* (1987). Even leaving aside the territories which, although within the sphere of influence of Carajas, CVRD has seen fit to exclude, only

36.9 per cent of the area occupied by tribal lands in the Carajas region has completed the legal process of demarcation. Ms Freitas appears to be using the term 'demarcation' loosely, to say the least. In fact, the remaining two thirds of Indian lands may have started on the long, and often endless road to full ratification and registration, but unless and until they complete that process, they cannot even hope for legal protection against invasion by major companies such as CVRD.

If, as they must, CVRD and FUNAI ever carry out their responsibilities under the Carajas accord, then it will be no more than the Indians' due (and long overdue at that). For, if the

World Bank's policy statements had been adhered to, the project should never have begun without the full demarcation of all the Indian lands affected. Then, as now, there was no informing, let alone consultation, of the Indians over the measures which are dramatically changing and threatening their way of life. As long as the tribal peoples are excluded from the decision-making process, and while the above deficiencies remain, CVRD's claim to be running a socially and environmentally "serious and carefully managed project" rings somewhat hollow.

Yours Faithfully,

David Treece,
Brazil Consultant,
Survival International,
London.

should be consulted to obtain their views and such projects should be implemented only if a majority of them are positively enthusiastic about it. The World Bank has more than enough financial resources to undertake this kind of survey and must desist if people are even slightly doubtful. We know that the Narmada Valley people and those in Tehri certainly do not want these projects. Many people here and in other societies are fighting against these constructions but unfortunately to no avail.

Yours faithfully

S.S. Srivastava.
Auto Tractors Ltd.
Lucknow-Varanasi Highway,
Pratapgarh-230001,
Uttar Pradesh
India.

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The World Bank

Dear Sirs,
Your open letter addressed to Mr Conable of the World Bank was published in *Sanctuary* magazine of India. Those of us who are becoming increasingly concerned with the illogical destruction of natural resources in the name of "progress" and have the opportunity of reading your letter now find that there are more jokers in the pack than there ought to be and that the arch-joker is the World Bank, which professes to raise standard of living by providing financial assistance. The result is for all of us to see.

In the natural scheme of nature, there is a balance between everything which exists in its natural form. We do not need the Tehri Dam or the Narmada Dam which will destroy virgin forests and uproot vast sections of the population. Those who live there (tribals) really do not need this so called 'upliftment'. Yes, hunger and disease should be removed, and there should be some level of vernacular literacy, but financing such un mindful schemes will quickly turn all our land into a concrete jungle.

But who is here to hear our voice? The Government will not listen. Is there no international law which can be invoked at The Hague which can compel the World Bank or such bodies to be responsible should environmental degradation take place as a consequence of their aid? If no law exists, one should be initiated. In addition, perhaps the people living in the vicinity of sites which it is proposed to 'develop'

The ODA and the Environment

Dear Sirs,
I was one of the few concerned individuals able to attend the Oxford Forestry Institute conference on 'The Future of the Tropical Rainforests' on June 27th and 28th. Although I had previously written to express concern over deforestation to the British Government's Overseas Development Administration, my letters generally produced dismissive or ludicrous replies, and there had been no chance to speak to ODA staff — until the conference.

Jill Hanna, the ODA's liaison officer with Non-Government Organisations, represented the ODA at the conference and also spoke to me informally. During the conversation, Ms. Hanna described my concern for species loss as "religious" and remarked that probably "only one in a thousand" of the plant species we are forcing to extinction would have provided any medicinal product, apparently lacking any more holistic view of how we depend on genetic diversity for our survival.

Perhaps Ms Hanna has administrative or diplomatic talents which compensate for her alarmingly simplistic views of the environment. Whatever the case, I hope that such views of the environment are not common to other key ODA staff.

Yours Faithfully,

Tim Rickman,
Co-Ordinator,
South Cheshire Friends of the Earth,
Crewe, Cheshire.

Classified

DIARY DATES

THE BRITISH ECOLOGICAL SOCIETY announces two public lectures to celebrate the 75th Anniversary of The British Ecological Society (founded 1913). The lectures are given by Professor A.D. Bradshaw of Liverpool University on **INDUSTRY, ECOLOGY AND WILDLIFE**. Venue: The Royal Society, London (main lecture theatre) on Thursday 27 October 1988 at 5.30 pm as well as at the University of Manchester (Roscoe Theatre A) on Wednesday 2 November 1988 at 5 pm. Please apply for free tickets to: Linda Glavin, Burlington House, Piccadilly, London W1V 0LQ. Tel 01 434 2641.

Congress **ALTERNATIVE TECHNOLOGIES OF DEVELOPMENT**. International Meeting of Entities and Groups of Development and Technology. Madrid 8-10 October 1988. Lecture Room of the Administration Building of the Polytechnic University, University Campus. Information and inscriptions: BioCultura, Gran Via 618, 08007 Barcelona. Tel 3 302 5357.

WATERSHED 89, The Robens Institute, University of Surrey is held from 17-20 April 1989. A three-day meeting with the title: **THE FUTURE FOR WATER QUALITY IN EUROPE**. For details write to: Rosemary McMahon, 189a Old Brompton Road, London SW5 0AR. Tel 01 370 4437.

THE CENTRE FOR PROFESSIONAL ADVANCEMENT is again holding various conferences and courses on subjects such as Evaporation Technology, Process Plant Start-up, Good Design Parameters for Laboratories, Fundamentals of Biochemistry etc. Please contact the Center at Palestijnstraat 1, 1071 LC Amsterdam, The Netherlands.

CHRISTIAN ECOLOGY GROUP CONFERENCE, 28-30 October 1988 at Savio

House, Bollington, Macclesfield, Cheshire. The title of the conference is 'Ethical Living in a Materialistic Age'. For details write to: The Secretary, 58 Quest Hills Road, Malvern, Worcs WR14 1RW.

Two conferences by the Institute of Acoustics, at the Windermere Hydro Hotel. 3-6 November 1988 **REPRODUCED SOUND 4**; 25-27 November 1988, **NOISE IN AND AROUND BUILDINGS**. Information from Institute of Acoustics, 25 Chambers Street, Edinburgh EH1 1HU.

University of Reading Agricultural Club—Annual Conference to be held on Monday 6th February 1989 at 7.15 pm. Admission free. The theme is 'Agriculture and the Environment'. Details from the conference organiser: Robert Dickenson, Earley Gate, Whiteknights Road, Reading RG6 2AT.

The Institution of Environmental Sciences announces several open meetings to be held at the Commercial Gas Centre, 139 Tottenham Court Road in London. Dates are October 4, November 1, December 7, January 10, February 8 and March 7. For programme phone Roy Waller on 01 647 5015.

World Congress **CLIMATE AND DEVELOPMENT**, November 7-10, 1988, Congress Centre, Hamburg, West Germany. For details write to: Deutsche Institut zur Erforschung der Informationsgesellschaft (d.ii), An der Blankenburg 64, D-4500 Osnabrück, West Germany.

ANNUAL GANDHI LECTURE by Petra Kelly (MP for the Green Party, West Germany). Theme: Mahatma Gandhi and the Green Movement. The lecture will be held on Monday, 3rd of October 1988, 7.30-9.30 pm at Friends House, Euston Road, London NW1. Entrance Fee £3.00. Tel: 01-981 5017/7628.

SITUATIONS VACANT

THE ECOLOGIST is looking for a Trainee Assistant Editor. The job will involve sub-editing, proof-reading and lay-out of The Ecologist. A knowledge of green issues is essential, and a working knowledge of computers preferred. Salary Negotiable. Please reply in writing to: The Ecologist, Corner House, Station Road, Sturminster Newton, Dorset, DT10 1BB.

PUBLICATIONS

AGROFORESTRY IN AGRICULTURAL EDUCATION with a Focus on the Practical Implementation by Joachim Boehnert. Price DM 49 or US \$ 35. Available from Verlag Josef Margraf, Scientific Books, Eichendorffstr.9, D-8074 Gaimersheim, FR Germany.

Send for **FREE** booklet **VIDEOS and FILMS** on **ECOLOGY** giving details of over 50 titles. Concord Video and Film Council, 201 Felixstowe Road, Ipswich IP3 9BJ. Tel (0473) 726012/715754.

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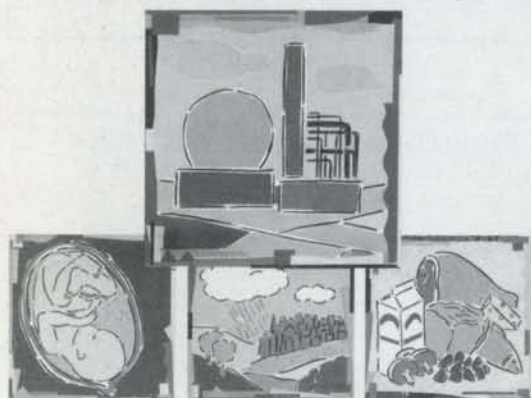
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PAPERMAC

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