The Ecologist

Journal of the Post Industrial Age Vol. 14 No. 3 1984 £2



ECOLOGY AND THE BIBLE



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Global Possible or Wishful Thinking?

On April 9th, 1984, the Queen officially opened JET—the giant European Torus project next to the Culham Laboratories in Oxfordshire. How much pleasure she and the other Heads of State present at the opening derived from their encounter with the latest in Tokamak thermonuclear fusion devices is hard to gauge, but it may not have escaped their notice that they were paying homage at the high altar of scientific endeavour to a machine costing millions that basically does not work.

Yet the message of ten, twenty years ago has not altered one jot and we have the Queen telling us (hardly in her own words): "In an energy-hungry world, JET may be a step along the road towards a virtually unlimited source of electric power. I am delighted to be able to applaud this magnificent technical achievement, the full potential of which is still to be revealed. . ."

Even such a hard-nosed enthusiast of nuclear power as Sir Walter Marshall, now chairman of the Central Electricity Generating Board, and previously chairman of the Atomic Energy Authority, was politely damning of the prospects for thermonuclear fusion when debating against members of *The Ecologist* some two years ago at King's School Canterbury. He did not foresee thermonuclear fusion being achieved before the year 2000, at least in a way that could be geared to economic electricity production.

The reasons why thermonuclear fusion is virtually a non-starter when it comes to saving an 'energy-hungry world' are made vividly clear in an article by Lawrence M. Lidsky, professor of nuclear engineering at the Massachusetts Institute of Technology, in *Technology Review* (October 1983). Lidsky is an associate director of the Plasma Fusion Center and editor of the Journal of Fusion Energy, and has worked on plasma physics and fusion reactor technology for 20 years.

As far as he is concerned the scientific goal of attaining a controlled thermonuclear reaction in some future Tokamak-like device may well be achieved, after billions of dollars have been spent, but the result will have been the creation of an engineering albatross. As he says, "The requirement is to develop a power source significantly better than those that exist today, and deuterium-tritium fusion cannot provide that solution. Even if the fusion programme produces a reactor, no one will want it."

One of the basic stupidities of today is to equate theoretical maxima with practical possibilities without bearing in mind costs and social priorities, let alone dangers. We are all well aware that water is an abundant substance composed of hydrogen and oxygen. Deuterium, heavy hydrogen, is by far the rarer of the two isotopes, there being one deuterium atom to approximately every 6,500 ordinary hydrogen atoms. Nevertheless, the energy to be released by fusing the deuterium in one *cubic metre* of seawater is equivalent to that from the burning of 2000 barrels of crude oil. With more than one billion *cubic kilometres* of water in the oceans, it would seem *prima facie* that industrialised society need never give energy another thought. So where is the rub?

Ironically, a fusion reactor will simultaneously have to operate with temperatures that are the hottest and coldest achieved on earth. The fusion reaction will take place in temperatures probably higher that 150 million°C, while the giant magnets that keep the plasma away from the reactor walls will have to be superconducting and cooled by liquid helium to within a few degrees of absolute zero, hence close to -273°C.

To compound the problem, most of the energy released during the fusion will be in the form of fast moving neutrons that are between 15 and 30 times more energetic than those released in nuclear fission reactions. Those neutrons will bombard the walls of the reactor vessel, heating it up, hence the opportunity to raise steam and generate electricity, but also knocking each atom of the wall out of its lattice position at least 30 times every year; hardly a recipe for structural longevity. Meanwhile the tritium for the fusion reaction will be bred from a lithium blanket interposed between the reactor wall and the superconducting magnets. Lithium, as Lidsky points out, is highly reactive, burning violently when in contact with either air or water.

To cap it all, the power density of a large fusion reactor will probably be at best one-tenth that obtained in a light water fission reactor (PWR), therefore the machine on a matching energy output basis will have to be considerably larger, with comparably greater costs. In summary Lidsky suggests that electricity generating utilities that have already had their fingers burned with the escalating costs and operational problems of fission reactors will hardly wax enthusiastic about fusion reactors which, even if they ever can be made to work, will cost the earth for a very limited working life. And although a fusion reactor does not produce fission products nor, if kept unmodified, transuranics such as plutonium, the highly energetic stream of neutrons will pose operational problems and induce long-lived radiation in structural

components. Moreover should the blanket material contain uranium, it would be possible to breed plutonium for bomb-making, but obviously at considerable cost.

Well, all that preamble hardly suggests we have a viable machine on our hands, and one that is going to make one jot of difference to the needs of our energy-hungry industrialised society. Among others, Amory Lovins has suggested that if we want thermonuclear fusion we should keep it 93 million miles away, on the Sun, where the process of hydrogen fusion takes place gently and at a pace that is some 10^{18} times slower than that achieved on earth with thermonuclear bombs. Indeed, lucky for life in the Universe that hydrogen and not deuterium is the common isotope.

Population: Another Kind of Astronomical Nonsense

As Edward Goldsmith has pointed out on innumerable occasions, little could be more nonsensical that pinning hopes for the future of industrial society on a device that does not work. But that exercise of wishful thinking about the future is one in which modern man appears increasingly to indulge. It is an easy enough thing to do: first look back over the trends of the past half century or so concerning population, energy, growth in gross national product, mineral use, agricultural productivity, urbanisation, and then assume on the basis of an inherent momentum in the system with regard to population size and material needs that by such and such a year there will be so many people on the earth and they will need so much energy and so much food. The exercise then is to divide the world's resources up so that they will meet the theoretical requirements of the future, taking into account improved efficiency and conservation. In effect that has been the exercise carried out at a meeting convened in May, 1984 by the World Resources Institute in Washington DC of 75 world leaders in government, industry, science, agriculture, energy and environmental studies. The conference, "The Global Possible: Resources, Development and the New Century", chaired by Martin Holdgate, chief scientist in the UK Department of the Environment, came to the conclusion that it should be possible to stabilise the world population at around 8 billion, hence double its present number somewhere around the middle of the next century. And by stabilization, the conference meant giving those 8 billion a reasonable prospect of health and security.

In effect, to achieve those numbers, the delegates called for such priorities and actions as reducing poverty through accelerating labour-intensive development and providing access to land and livestock; intensifying agriculture on the best lands; going all out for aquaculture; reducing death rates by providing basic sanitary facilities and simple health care; as well as doubling access over the next decade to family planning services. In addition it called for actions to reduce the migration to cities, and for the protection of certain habitats, singling out the Tropics in particular. In effect it suggested that 10 per cent of the world's land area should be protected from habitat destruction, through international funding by the developed countries.

Now undoubtedly many of the aims agreed on by the delegates should be pursued, and *The Ecologist* has on various occasions either itself as in WEAP (*The Ecologist* Jan/Feb 1980) or in articles (see Rubinoff: *The Ecologist* Nov/Dec 1982) suggested the protecting of tropical rain forest through cash inducements from the developed countries. But the question arises as to whether the Global Possible conference has come up with anything more than a few palliatives for a fast deteriorating situation. People are thus leaving the land by their millions, or when they are resettled, as in the Amazon, cause such incredible damage in a short space of time, that nothing is left to be salvaged. And is the saving of a mere 10 per cent of tropical forests anything like enough? In effect evidence increasingly shows that weather patterns over tropical regions are governed and controlled by the bulk of the forest, the two, the biomass and the hydrological cycle, being in intricate balance. Take most of the forest away, and the rest will be irrevocably lost through a process of desiccation. The drought-ridden region of the north east of Brazil is a tragic example of what happens when the forest is destroyed.

In fact the world cannot sustain 8 billion people and will never sustain that number. Indeed, as every year passes, the earth's ability to sustain human beings is diminished. The evidence is there in front of our eyes, and we have only to look at that vast continent Africa to see the drying up that is occurring in all quarters through the ravages which have taken place in the name of development. Even migratory birds, such as swifts can hardly make it to Europe because the Sahara desert has now become too large for them.

The tragedy is that while there are raw materials and people to be exploited, exploited they will be, and all the liberalisation of trade and increased levels of aid called for by the Global Possible conference will have the effect, if achieved, of driving the process of development faster to its own destruction.

Of course, it is easier to be negative and knocking than to put up constructive policies, and it says something of the participants at the conference that they appear to have some appreciation of the fearful problems facing humanity and the health of the planet. But the actions they propose are not just business as usual, but business at all costs.

Those who are now suffering the consequences of decades of development, the nomads of the Sahel, or the villagers in the foothills of the Himalayas, for example, have begun to express what they have always intuitively known, that the restoration of their environment rather than its development is their only option. The Chipko movement for the protection of trees and the campaign in South India against Eucalyptus plantations are manifestations of such a counter reaction; and it is at that level that the rest of us in the world must begin to act if we are to salvage something for future generations.

The growing strength of the Greens in Europe, and the politicisation of the struggle against the conventional remedies of the industrialised world is a major hope and one that we should wholeheartedly support. It is a forging link between grass-roots movements in the developing countries and those disillusioned with the 'ethics' of industrialisation and development.

Peter Bunyard

The environment isn't committing suicide, it's being murdered.

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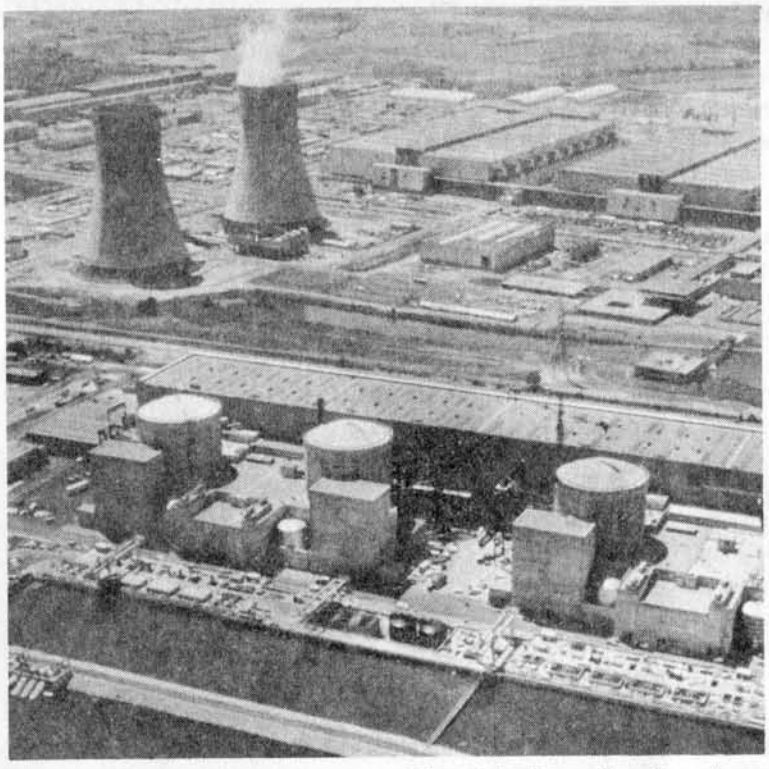
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The French Nuclear Debacle

by Jim Harding

Having set out to achieve energy independence in the early 1970s, France embarked on a massive nuclear power programme, borrowing heavily from foreign banks. EDF—the French electricity generating board—now owes more than 200 billion francs*: meanwhile electricity prices are soaring and growth in consumption is practically at a standstill. Far from giving freedom, nuclear power is proving an increasingly onerous shackle.

Current Status of Coal and Nuclear Power

The French nuclear programme is a modern marvel, built from scratch in the late 1960s into one of the twentieth century's most well-oiled cooperative ventures of government, science, and industry. No other nation has put together the unique set of social, cultural, bureaucratic, and institutional qualities needed to bring nuclear reactor technology to its citizenry. To many it is the textbook case of how to make nuclear energy work, without the impediments that have forced most of the world's other nuclear programmes into prolonged hibernation. To others it is a triumph of self-fulfilling, centralised, technocratic decision-making over all other economic, political, and cultural values.

France currently has 28,000 megawatts of operating nuclear capacity generating about half the nation's electric power. Another 9,000 megawatts are anticipated in operation by 1985. A further 21,000 megawatts in operation by 1990, of which about 15,000 megawatts have been ordered. Most of this capacity has been ordered and built while other OECD nations have cut back to pre-1975 order levels. The cost-effectiveness of this programme has never been determined with rigorous analysis, because the commitment was not conditional. It was all or nothing. Consistent with this attitude, most nuclear cost data are secret. As N.J.D. Lucas remarks in *Energy in France*, "there was no (middle) way between the strategy of 'tout electrique—tout nucleaire' and an embarrassing and, in the long term, dangerous weakening of the enterprise."

The French nuclear programme is thoroughly centralised, to the point that Giscard and Mitterand have had the last word on French nuclear orders. But the underpinnings of this Presidential commitment are to be found in the combined political effectiveness of two state-run agencies, the Commissariat a l'Energie Atomique (CEA) and Electricite de France (EdF).

The government and nuclear industry are together combined in CEA, which owns 50 per cent of the nation's reactor manufacturer (Framatome), directs nuclear research and development, controls plant safety standards, conducts military nuclear activities, and forms private subsidiaries (such as Cogema) to conduct all nuclear fuel cycle activities from uranium mining to reprocessing and final disposal of wastes.

On the utility side is EdF, which Lucas describes thus: "There can be no reasonable doubt that the initiative for almost all aspects of the nuclear programme come from EdF. This proposition is resisted strongly by the French Administration and curiously by observers from the British Administration—presumably out of administrative solidarity . . . outside the electricity supply

industry it is taken as a fact and paraphrased as 'EdF is a state within a state'; within EdF it is attributed to the fact that they present their dossiers with greater skill and technical support than do their competitors."

EdF also has the legal power to site plants without agreement of local government bodies or even substantive licensing proceedings. In recognition of undesirable impacts from power plant siting, EdF pays local governments a "patente". The patente is collected as an annual tax on anyone exercising a profession in France, paid into EdF, and distributed to regions affected by power plant sitings.

But the well-oiled machine that sites, designs, finances, manufactures, constructs, and regulates is suddenly running dry. As Energy Minister Jean Auroux warned the industry in November 1983, "The French government believes in the future of nuclear energy, but that future will be considerably compromised if the price of a nuclear kilowatt-hour continues to rise." Calling cost-containment "the third great cause" for nuclear technology after creation of the nuclear industry and nuclear weapon, Auroux warned that his government's commitment to nuclear power is no longer unconditional.

Despite the past effectiveness of EdF and CEA, France's nuclear programme today is in grave jeopardy, rocked by the same combination of growing energy efficiency, diminishing growth rates for electric power, climbing construction costs, capital shortage, and social criticism that have halted nuclear programmes in other nations. The special set of conditions that made the programme possible now undermines it.

In July 1983, France's long term energy planning group under chairman Noel Josephe determined that the nation needs no new reactor orders for the next nine years, even under high growth forecasts of 4.7-5.5 per cent annual electric growth—a factor of three above the 1980-83 record. "Only the need to consider the safeguarding of the industrial infrastructure," notes the report, "dictates the maintenance of a minimum (ordering) programme spread out over a significantly long period . . . the 'industrial constraint' is the only reason not to interrupt nuclear ordering altogether."

Indeed, the 1981 pre-election position of the Socialist party favoured a complete suspension of nuclear orders, as opposed to Giscard's recommendation of nine orders in 1982-83. Because of the difficulty in adapting to such a fall-off in orders, Mitterand decided on two orders in 1984, overruling the Planning Ministry's recommendation of one. Long term prospects, however, appear very dim.

Nuclear orders are the province of Framatome, which is owned 50 per cent by CEA and 50 per cent by the French steel and heavy construction firm Creusot-Loire. The latter owned 70 per cent of Framatome until October 1983, when grave financial losses (600 million francs in 1982) in its steel operations pushed it to the edge of bankruptcy,* and forced the 20 per cent sale to CEA. Because Framatome is both a subsidiary of Creusot-Loire and its largest customer, one recent discussion of the French reactor programme notes that Framatome probably "receives favourable price and delivery treatment."

The French reactor manufacturer was created with a capacity to produce eight reactors annually. In contrast to US and German power plant firms, which are diversified into numerous non-nuclear businesses, Framatome supplies only reactors and nuclear steam generators. As a result, the Socialist government of Francois Mitterand has found it quite difficult to deliver on its election promises and reform the company for a future of few or no orders.

The eight/year ordering rate was achieved during the 1970s, but recent overcapacity, financing limitations, and flagging demand growth have forced the French government to choose between uneconomic new orders and the collapse of its nuclear reactor manufacturer. The Mitterand goverment has opted for that middle ground of trying to keep the industry alive without bankrupting the Treasury.

The initial Treasury is that of Electricite de France, also owned and operated by the national government. EdF currently operates with a large and growing annual deficit (4.6 billion French francs in 1981 and 8 billion francs in 1982), showing that its costs, primarily those of a heavy nuclear construction programme, are not recovered in the prices it charges for electricity. The director of EdF told *Le Monde* in mid-1982 that the utility was in its worst financial condition for thirty years.

Despite substantial rate increases in 1983—7.1 to 18.5 per cent, depending on voltage level—EdF continued to run a heavy deficit in 1983, some 5.7 billion francs. The utility will need annual rate increases well above the general French inflation rate (about 10 per cent) for several years to achieve a balanced budget. EdF's financial problems are further illuminated by its renegotiation of its Framatome contract to delay payments on reactor orders by 120 days. Similarly, Framatome recently reduced its share of the Swiss Kaiseraugst reactor from 20 per cent to 7.5 per cent as an economy move.

EdF's position is also grievously challenged by an enormous international long term debt of 179 billion francs at the end of 1983. About 40 per cent of the total debt (70 billion francs) and, presumably, a higher share of the annual payments, are denominated in currencies other than the French franc. By comparison, EdF's long term debt at the end of 1980 was 75 billion francs (28 per cent of which was in non-domestic currency), which doubled to 152 billion francs by the end of 1982.

Since 40 per cent of EdF's debt is in currencies other than the French franc, it grows as the franc falls in international exchange markets. Currency re-alignments alone during 1981-82 added five billion francs to EdF's annual operating deficits. The utility concedes that its present programme will require "voracious" amounts of capital—upwards of 40 billion FF/yr—even if there is a "certain amount of delay" in the nuclear programme. With a tight capital market and troubled national economy, EdF's nuclear programme

*It actually went bankrupt in June of this year.

EdF Capital Investments (Billions of Francs)

1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
6.7	7.9	10.5	12.5	14.1	16.8	23.3	30.7	33.0	39.0

As a Percentage of Total Industrial Investment

11	11	14	14	15	16	19	21	21	23

As a Percentage of Industrial Value Added

—	—	—	—	—	4.0	4.0	4.6	4.9	5.0

costs choke-off investments in more productive sectors: the utility's capital requirements per unit of value added to the French economy are six times higher than those for the remainder of French industry. Put another way, *EdF consumes nearly one quarter of the nation's industrial capital to contribute one twentieth of the nation's industrial value added.*

EdF currently receives substantial capital subsidies from the French treasury. The 1983 OECD Economic Survey for France calculates an average subsidy of 12.4 per cent (per unit of value added) to large public enterprises in the non-competitive sector. As OECD comments, "This substantial rate of subsidy . . . was required not only to finance investment, but also to compensate for the rising burden of interest payments, particularly since 1976, as the authorities encouraged (these enterprises) to have recourse to foreign credit because of balance of payment considerations and domestic financial markets."

One way the French treasury assists EdF is to provide capital to industrial companies to purchase shares in nuclear plants. The French aluminium company, Pechiney Ugine Kuhlmann (PUK), which is largely government owned, recently received public capital to purchase an EdF nuclear plant for its own use. PUK pays EdF for fuel, operating, and maintenance costs, while France's treasury picks up the bill for construction and interest costs.

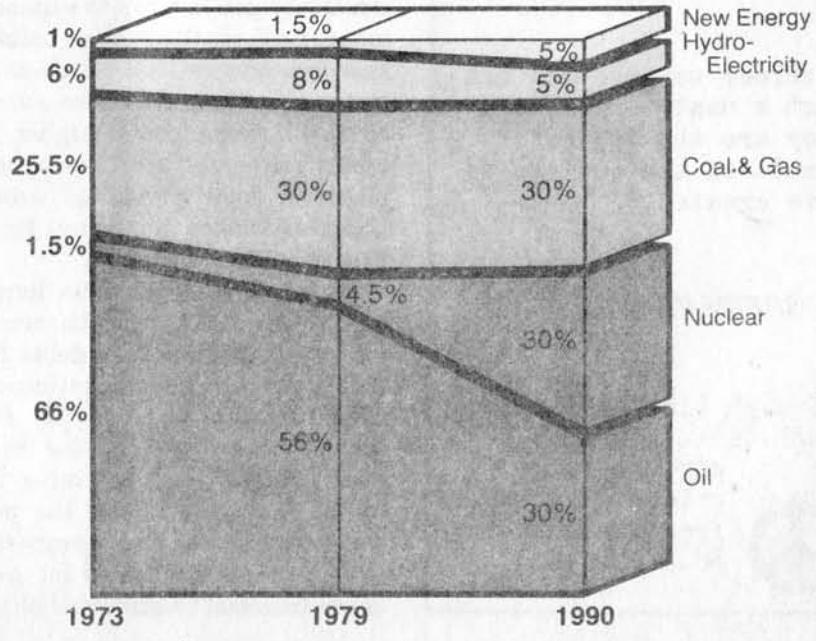
The nationalised industries in the competitive sector (not EdF) will require substantial support to cover 1983 losses almost twice those suffered in 1980. EdF's growing domestic and international debts for nuclear construction already contribute significantly to the deteriorating economic condition of less privileged sectors of the economy. As an October 1983 report in *Business Week* states: "As financing costs eat up 52 per cent of operating profits, compared with 36 per cent two years ago, foreign bankers say unprotected mid-sized companies will be squeezed out of the credit markets by the major nationalised companies and the Treasury, whose borrowing has doubled in two years."

Currently, EdF's operating deficits are either refinanced as short-term debt or with direct allocations from an over-stretched Treasury. That Treasury is hardly in a position to finance unneeded, capital-intensive nuclear capacity: *France's international debt of $50 billion makes it the third largest debtor in the world, after Mexico and Brazil.* Its domestic capital markets are already saturated. As the French economist Philippe Lefournier points out, "the huge size of that debt means that all the money France will be able to borrow in the international credit markets for a long time will go to service debt." If this is true, not only mid-sized companies, but EdF itself will be unable to finance investments through international loans or the overburdened domestic market.

To a large extent, the French nuclear programme also bears the liability of weakening France's domestic coal industry. Because of France's heavy use of nuclear power (+50 per cent) and hydro-electricity (25 per cent), fossil fuels are sparingly used on the electric grid. Nuclear power no longer displaces oil, which is only used as a peak power supplier; it cuts coal demand and this has led to growing deficits in the government-owned Charbonnages de France—7 billion francs in 1982.

Jean Syrota, director general for Energy and Raw Materials at CdF, described the problem as follows: "The execution of a massive nuclear programme means a big drop for coal-fired power stations and therefore creates difficulties in selling French mined coal. So it is normal that EdF should contribute financially to make this transition easier for the nation's pits." On March 1, 1984, EdF reached an

FRANCE'S ENERGY PLAN



agreement to purchase as much power as CdF offers at prices based on the costs of imported coal or nuclear electricity. This agreement will result in diminished capacity factors and higher costs for EdF's nuclear power plants.

The future of the French nuclear programme is heavily dependent on steady increases in electric power demand to write-off existing plants in a grid with excess capacity. The majority of this demand must come from fuel switching, rather than economic growth. Despite EdF's efforts to electrify home heating and industrial processes, growth in French electric power demand has slackened substantially over the last three years: power sales grew at an average rate of 4.6 per cent per year from 1973-80, but at only 1.7 per cent per year from 1980-83.

Overall energy consumption during 1973-82, inflated by the counting of electricity at treble its end use value, has risen only 3 per cent despite a 24 per cent rise in real GDP. The 1979-82 portion of that period shows a 1 per cent per year average rise in real GDP and 2.1 per cent per year average decline in energy consumption. Though the French policy of 'tout electrique—tout nucleaire' is time-honoured, it is of dubious effectiveness, especially for a future of rising real electric power rates and declining world fossil fuel prices. As the charts below show, electricity is not even remotely competitive as an industrial process or residential heat source with oil, natural gas, or coal.

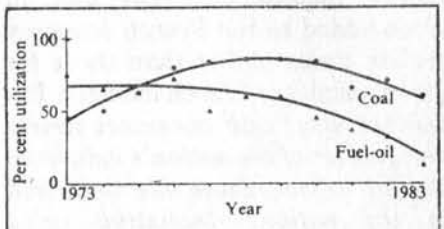
This task is made much worse by projected oversupplies of nuclear electricity's principal competitor, natural gas. France has 29 million tons of petroleum equivalent in natural gas to be delivered by the end of the decade, much of it on a "take or pay" basis. The planning ministry projects only 22 million tons of petroleum equivalent in natural gas demand by 1990. The home heating and industrial process heat markets will not be easy for EdF to penetrate.

Indeed, EdF projects a 50 per cent increase in industrial demand for electric power from 1982 to 1990. Yet, industrial electric demand fell 3.5 per cent in 1983 and most of the heavy French industries are financially strapped. One particularly important electricity consumer, the aluminium and non-ferrous metals firm of Pechiney Ugine Kuhlmann, plans to shift most of its aluminium smelting operations to Canada, where they can benefit from cheap hydro-electric power rates.

Walker and Lonnroth describe the nation's predicament: "Facing heavy capital charges on its nuclear programme, and the need to keep electricity prices down to expand demand, EdF can ill afford to build further redundancy into its electricity generating system. It risks a vicious circle of rising costs, higher electricity prices, and even lower growth rates. A long period of drought therefore seems imminent for the French nuclear industry."

Added to the problems foreseen by Walker and Lonnroth are: the worsening international debts faced by the French nation; continued declines in the value of the franc; heavy losses by EdF, the French steel industry, and the other large companies operating in the public competitive sector; competition among these companies for preferential financial treatment that is unlikely to be resolved in EdF's favour; growing gluts in gas and electricity supplies; climbing electricity costs that are dampening demand and forcing industrial customers to consider relocation; and diminishing or reversed national benefits (e.g. possible bankruptcy in the French coal industry rather than displacement of foreign oil) from expansion of nuclear capacity.

The question is not whether France's nuclear industry faces a drought in nuclear orders, but whether France will be deluged in unrecoverable nuclear debts.



Utilization of the average net operating power available from France's power stations. Coal and oil powered plants are used well below their capacity.

Source: Nature, 23 Feb. 1984

French Nuclear Capital Costs

With a combination of expeditious construction, government-backed financing, modest local opposition to nuclear technology, few siting constraints, complete central government control over the nuclear industry, limited competition from other energy resources, and a steady ordering pace, France's nuclear industry appears, at first glance, to have an unparalleled record of cost control. Whether this impression is correct remains to be seen. EdF has never released cost data for individual power plants, and all the factors that have led to rapid cost increases in other nations have finally come home to roost in France.

Because there are no independent assessments of French nuclear power costs, it is necessary to take most EdF data at face value. Nevertheless, Georges Moynet, deputy director of the utility's Budget and Planning Department, recently reported that French nuclear costs have been consistently underestimated. Moynet notes that escalation rates were kept to a level 3 per cent above the general inflation rate for a 'reference' plant over the 1976-84 period. But EdF's 'refer-

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ence' unit (four standard 900 megawatt plants on a "non-problematical" site, excluding all research and development costs, project management, and spare parts costs) is no longer being built. In fact, EdF's own increasing cost estimates (1974 costs of 2450 FF/kW and 1980 costs of 3440 FF/kW, both expressed in 1980 francs) suggest a real cost increase of 5.3 per cent per year.

It is also clear that the actual costs of French nuclear reactors are rising much more rapidly than this estimate. Current EdF projections for new 'reference' nuclear reactors total 5877 FF/kW, based on an ordering rate of three units per year and a 1.5 per cent per year real escalation rate. The current estimates for the first of the new N-4 series reactors, Choo B-1, is given as 5000 FF/kW in 1982 francs plus 43 per cent for interest during construction and architect engineering costs, for a completed capital cost of more than 7150 FF/kW.

These data suggest cost escalation rates after adjustments for inflation that are fully comparable (ca. 20 per cent real since 1980) with US, FRG, or UK experience, and which may be the result of a number of easily identifiable factors:

1) French nuclear industry planners have always claimed substantial cost savings from a 'rhythm effect' in nuclear orders, giving Framatome the opportunity to work at its maximum capacity of six reactors per year, construction crews the opportunity to stagger or overlap workloads among units at the same site, EdF the opportunity to negotiate favourable contracts, and sub-contractors the ability to work at their maximum capacities. These benefits are no longer possible in the programme. As EdF's Moynet comments, the current reduction in the 'rhythm' or 'cadence' effects is beginning to have a "non-negligible" effect on costs.

a) EdF's reduced ordering rate is projected to increase Framatome costs substantially. A recent *Nucleonics Week* report quotes a senior EdF official as saying that "it's true" Framatome is seeking reactor price increases on the order of 20-40 per cent to compensate for a reduced ordering rate of two units per year. The latest contract between Framatome and EdF contains a cost-escalation clause that is a function of the number of orders received by Framatome annually. Ordering rates lower than two per year would represent still higher costs.

b) But the elimination of a 'rhythm' effect may have its greatest impact on Framatome's 500 sub-contractors, "some of whom have indicated they may not be able to stay in the nuclear business with no more than one or two orders a year."

c) A further reduction in the 'rhythm' effect must be expected at construction sites that cannot save costs through staggered construction of four standardised units. Komanoff's estimates for the United States show a ten per cent real capital cost savings from duplicate units built on the same site, but a severe (34 per cent real) cost penalty for plants built by a utility faced with no new orders. A possible explanation is that construction crews deliberately reduce productivity if they see the end of their work, and possibly that of their industry, in sight.

2) Even more ominous are the losses suffered by Creusot-Loire in its steel operations (of which Framatome is the largest customer) which have led the company to the brink of bankruptcy and reduced its ownership in its nuclear subsidiary. As Creusot-Loire's President, Didier Pineau Valencienne, noted, "We had to question the very future of the company. The position we faced was insupportable." The other French steel companies, Usinor and Sacilor (both nationalised), are suffering the largest annual losses of all the public companies in the "competitive" sector, estimated at eight billion francs in 1983. (EdF is in the non-competitive public sector). It is certainly clear that French steel prices as a whole must rise substantially to reduce losses and that favourable price and delivery treatments probably afforded Framatome by its parent in the past must soon evaporate.

3) The best nuclear power plant sites are already taken. New sites will require higher capital costs for site preparation, cooling systems, or seismic protection. One reason for low French reactor costs has been the absence of extensive protection against seismic events or imperfect sites. The proposed Civaux reactor site, in contrast, is said to require one and a half to two years of preliminary work before reactor foundations can be laid. As EdF's Moynet added in a November 1983 presentation to the French nuclear society, the theoretical conditions of the reference plant are becoming increasingly difficult to achieve.

4) To preserve as much of a rhythm effect as possible, EdF and Framatome have agreed to stretch out nuclear construction periods by at least one additional year, adding to real interest and escalation during construction. EdF's director of construction, Remy Carle, notes that extending construction from 60 to 70 months would add 20 per cent to the cost of new reactors. Again, with slower ordering rates such stretch-outs could lengthen even further.

5) The new N-4 reactor designs of 1,450 megawatts were reportedly estimated to cost less per kilowatt than the previous P-4 1,300 megawatt series, but these proposed "economies of scale" have not been realised. In addition to higher expected costs per kilowatt than the 900 megawatt series, longer construction periods are also expected. Chooz B-1 is expected to require an 84 month construction period, compared with the 66 month schedule for the 900 megawatt P-4 units. One explanation given for these higher costs is an estimated 65 per cent improvement in safety margins compared with the 900 megawatt series of PWRs.

These factors—20-40 per cent higher prices charged by Framatome; possibly similar cost increases for its sub-contractors; continuing heavy losses at French steel companies, particularly at Creusot-Loire; possibly severe increases in costs from the substitution of "last" unit philosophies for duplicate unit benefits; 20 per cent from stretched-out construction periods; loss of "easy" construction sites; unknown increases from the new N-4 design; grave capital shortages; and the synergistic effects of all these factors combined *could double real costs for new French nuclear construction.*

Coal Capital Costs

French coal plant capital costs data are equally difficult to acquire, and one must therefore depend on very limited and debatable EdF projections. EdF's current estimate of coal plant capital costs is 4325 FF/kW (implying a nuclear/coal capital cost ratio of 1.35, or 1.65 when compared against the Chooz B-1 estimate).

In 1975, EdF's coal-plant capital cost estimate was 1820 FF/kW (in 1980 francs), suggesting a ten per cent per year real cost escalation rate, far above the coal capital cost escalation rates in any of the nations examined in this study. The French 1980 base cost estimate of 2930 FF/kW (in 1980 francs) was 20 per cent higher than the completed cost of 1978 US coal plants which had significantly better desulphurisation, nitrous oxide, and particulate controls. There is no obvious reason for such a large discrepancy.

EdF's estimate for coal desulphurisation equipment—a 32 per cent surcharge on the base cost—appears especially unreasonable. As the French trade union CFDT pointed out in an annex to the Josephe report, desulphurisation technology is known to be several times cheaper than EdF estimates. Even in the worst case assumptions of the Franke and Viefhues report on West German coal and nuclear energy costs, desulphurisation adds only 16 per cent to coal plant capital costs. For the US, Komanoff calculates a 17 per cent additional cost for the finest available desulphurisation, nitrous oxide, and particulate control technologies combined. (Such a plant would emit less pollution than an existing low-sulphur oil-fired electric plant.)

CFDT also argues that a smooth rhythm of coal orders (one per year) would reduce coal capital costs by 10 per cent from EdF assumptions. Conversely, CFDT expects the slowdown in nuclear orders to add at least 20 per cent to EdF nuclear cost estimates.

We will compare nuclear and coal costs for the French programme using the same general practices used in the US situation: first year costs, ten year levelised costs, and twenty year levelised costs. EdF's real discount rate is nine per cent, reflecting a high real cost of capital for investment decisions. Investment costs reflect CFDT's 20 per cent construction costs contingency, which still represents a very modest annual real escalation rate. EdF's construction lead times are lengthened one year. It should be noted that this set of assumptions is extremely favourable to the nuclear case, with nuclear capital costs less than half those of US plants. It is also well below the current cost estimate for the French Superphenix fast reactor, which is nearing completion at a cost of 15,670 FF/kW.

Coal and Nuclear Capacity Factors

EdF uses a range of capacity factors to project future plant capital charges. With more than 50 per cent of the nation's electricity supplied from reactors, capacity factors for existing units are being reduced for economic reasons: there is no longer enough baseload demand to permit all the nuclear plants to run whenever they are available. The resulting load-following mode allows a stretch-out in reactor core lifetimes, but is very costly for capital-intensive nuclear plants, which accumulate the bulk of their total costs whether or not they operate.

Even without future load-following, French reactors have not achieved EdF's desired 70 per cent capacity factor. Average capacity factors of French reactors are regularly published, in distinct contrast to actual capital and operating charges for individual plants. The averages for 1981, 1982 and 1983 are given below:

1981	1982	1983	Average
57.8%	53.1%	60.5%	57.1%

Coal plant capacity factors on the EdF system have been diminished, as noted earlier, by excess nuclear capacity. Once a plant is built and operating, it is proper to use marginal operating costs as the primary criterion for the order in which individual plants are brought into operation. To determine cost-effectiveness of new units, one must either correct for such economically induced outages or develop an estimate of maximum achievable capacity factor.

In the French situation, with enormous overcapacity already on the grid, it is probably preferable to reduce future estimated capacity factors to take account of economically induced load-following. The extent of economically-induced load-following will depend on the amount and nature of future French electric growth. This is a highly debatable subject, but some French energy experts estimate that future French reactors will face 25 - 45 per cent capacity factors because of the irregular nature of the residential heating market (negligible in the summer; large on cold winter nights) that EdF is trying to penetrate. Capacity factors this low would lead to further substantial diseconomies for nuclear power.

In this analysis, we will adjust the historical 57 per cent nuclear capacity downward by five points (a very modest amount for the load-following projected in new plants) and use the same figure for coal plants. The baseline coal capacity figure will be taken as an average of US and FRG empirical data collected by Komanoff (US) and Franke Viefhues (FRG).

Operating and Maintenance Costs

Operating and maintenance costs for coal and nuclear stations are given by EdF and the Josephe report as 3.8 centimes/kWh (coal) and 4.0 centimes/kWh (nuclear) at "base" or 100 per cent capacity factors in 1982 francs. Correcting for the capacity factor assumptions given above gives coal costs of 5.4 centimes/kWh and nuclear costs of 7.7 centimes/kWh. These estimates are well below German or US estimates but do not include interim replacements required during plant operation.

For example, unbudgeted replacement of control rod drive tubes and steam generator repairs during 1982 added FF 1.5 billion to the utility's net losses for the year, or about two centimes/kWh for the affected 900 megawatt plants. The average age of these plants is still quite modest; many may be troubled by the steam generator problems that have been largely responsible for increased O & M costs at US pressurised water

reactors. In fact, *Nucleonics Week* recently reported (19 January 1984) that Framatome is studying replacement of steam generators on all EdF units, and the utility has ordered five back-up steam generators for its 900 and 1300 megawatt units for delivery in mid-1985. (At the Turkey Point reactors in the US, this steam generator replacement cost about 95 million dollars per unit with a seven to eight month outage.)

Additionally, EdF's O & M projections are based on four-unit 900 megawatt 'reference' plants. The reduction to two-unit sites (or less) may boost per unit O & M costs slightly. Nevertheless, we will use the low EdF estimates above (5.4 centimes/kWh for coal and 7.7. centimes/kWh for nuclear) in projecting future French nuclear costs.

Nuclear and Coal Fuel Costs

EdF estimates nuclear fuel costs at 6.1 centimes/kWh (1982 francs) and coal costs at 20.7 centimes/kWh, both levelised over the projected lifetimes of the plants. A primary reason for the difference in these costs is EdF's assumption that real nuclear fuel costs will decline over the life of the plant (enrichment—1 per cent/yr, fuel fabrication—2 per cent/yr, reprocessing and waste storage—0 per cent/yr, while coal prices will increase at a 2 per cent/yr rate through 2000 and 1 per cent/yr thereafter.

In projecting French nuclear and coal fuel costs, we have used different assumptions more consonant with recent price escalation, particularly for uranium enrichment, reprocessing, and waste storage. Uranium enrichment prices depend heavily on electricity prices which, as noted before, must rise substantially to cover EdF's growing deficit. Reprocessing costs have risen by 26 per cent per year over inflation since 1972, and cost estimates for the new UP3 plant at La Hague suggest only a modest reduction in this phenomenal escalation rate.

EdF gives current estimates of 4660 FF/kg for fuel reprocessing at Cogema's La Hague HAO + UP2 plant. The table below indicates the rise in reprocessing costs estimates for France, in 1982 FF/kg:

1972	1974	1976	1978	1980	1981	1982
410	775	1400	3100	3500	4000	4660

The projection of zero real escalation in light-water-reactor reprocessing costs is implausible. As the French economist Dominique Finon comments, "multiple technical incidents have occurred with the HAO-UP2 plant which have only enabled reprocessing at a tenth of nominal capacity during runs with oxide fuel". The "multiple technical incidents" include a serious off-site power failure in April 1980, a trench fire in January 1981, and plutonium spills in July 1981 and February 1982.

By their very nature, reprocessing plants must dissolve, filter, and separate highly radioactive materials in a complex chemical process. Repairs are extremely difficult, dangerous to personnel, and time-consuming. Major technical difficulties have arisen in dissolving high-burnup light water reactor fuel. Dissolved particles of rare-metal fission products have proven very difficult to draw off in solutions, crystallising into a hot powder at the bottom of vessels and reacting with acid solvents. This was the cause of the blow-back accident at the Windscale facility in 1973 and has not been resolved in newer reprocessing plant designs. Because of the extraordinary levels of radiation present, such accidents can permanently disable reprocessing plants. These problems have not been nearly as serious in low-burnup military fuel reprocessing plants, but have effectively crippled the operating performance of all LWR reprocessing plants.

As a result, estimated reprocessing-plant lifetimes are very short. Present experience suggests six years for an operating plant, but official government estimates are ten years, for example, for the proposed THORP facility at Windscale. The proposed UP3 oxide-fuel facility was estimated to cost 20 billion FF in 1979, but designers were asked to reduce these costs to 11 billion FF in a simpler facility.

The 11 billion-franc estimate is the basis for the 4,660 FF/kg reprocessing cost developed above. As Finon pointed out in *Energy Policy* (December 1982), it is probable that UP3 capital costs will rise to 15 to 20 billion francs at the time of commissioning in 1988, with resultant costs of 5,100-10,000 FF/kg.

Finon assumes a nine per cent discount rate, 450-700 million francs/yr operating costs, ten to fifteen year lifetime, an extraordinarily high 81-100 per cent capacity factor, and no decommissioning cost. These assumptions yield a 1982 cost of 5,550-10,860 FF/kg. Finon assumes these costs will be paid at the time of reprocessing, although most *Cogema* contracts call for long term advance payments, at least from foreign customers. As virtually all reprocessing costs reflect fixed capital and fixed operating costs, a more reasonable 20 per cent capacity factor on UP3 would give costs of 18,000-40,000 FF/kg. Even with Finon's assumptions, a median cost estimate adds 2.4 centimes/kWh to EdF's fuel costs. Using the lower capacity factor assumptions would add from 7.2 to 18 centimes to the utility's total estimated fuel-cycle cost of 6.1 centimes/kWh.

It is useful to compare these increments to those suggested by Franke and Viefhues in their detailed cost projections for new reprocessing plants in Germany, using historical capital-cost data, an 8-12 per cent real escalation rate, a decommissioning charge equal to 30 - 50 per cent of original costs, capacity factors of 25-40 per cent, and a ten to fifteen year lifetime. Those incremental costs, converted into 1982 French francs, total 10 - 95 centimes/kWh, with a most probable estimate of 28 centimes/kWh.

The nuclear fuel cycle cost estimates presented here are more conservative. Taking into consideration real cost increases for enrichment (3 per cent/yr), uranium (1 per cent/yr), and reprocessing (Finon's 1990 cost estimate of 10,860 FF/kg with no advance payments) gives a 1990 nuclear fuel cycle cost of 10 centimes/kWh. There is no final storage cost present in this figure: using US estimates would increase it by one to two centimes/kWh. Levelised costs assume a one per cent real escalation rate on uranium, three per cent rate of enrichment, and five per cent rate on reprocessing.

Coal costs are taken from the EdF base costs for world market coal prices—400 FF/tonne—and levelised at EdF's escalation and discount rates for the periods presented

below. Domestic French coal is significantly more expensive (600 FF/tonne); costs for that alternative are also shown, though the difference in cost between domestic and international coal prices is absorbed by the French government, not EdF.

Discussion

Even with favourable assumptions on future French nuclear costs, there is no case for building more nuclear capacity. Looking at the narrow issues of busbar economics, capital costs for future French reactors appear twice as high as for coal, and even high French coal costs do not offset this difference. Whether one compares first year or twenty year levelised total generating costs for nuclear stations with those of coal, reactors appear 35-60 per cent more expensive than do coal units. The high discount rates used for investment comparisons (9 per cent) are partly responsible for this difference, but so too are growing nuclear fuel costs.

But the broader issues are probably more telling. The current economic plights of Electricite de France, flagging electric power demand, the loss of a 'rhythm' effect from slowed ordering rates, and the losses suffered by Framatome contractors add up to a dismal outlook for the French industry. Already, France exports a considerable amount of electric power to other European nations to help offset high fixed charges on its existing capacity. The need for higher domestic rates to cover EdF's growing operating debt will lead to greater efficiency and possible loss of major industrial load. With substantial overcapacity problems already facing the French grid, the case for any new capacity is very weak.

Conservation and efficiency improvements, industrial cogeneration, and other cost effective energy options have been seen as threats to the French nuclear programme, and have been given short shrift in energy planning. With the prospect of higher rates and limited access to capital for new capacity, EdF's stranglehold on energy policy making must cease. Industrial customers are not likely to convert to uneconomic electric resistance heating for processes. Similarly, residential users are not likely to convert to higher priced electric power. Keeping electricity prices low would add to EdF's heavy debt burden. The commitment to the 'tout electrique' future is unsustainable, and the longer it is held on to in the face of impossibility, the greater the collapse of the French industry will be.

Indeed, the Planning Ministry acknowledges that employment considerations are the only reason not to halt the nuclear programme altogether. With a weak franc and very limited capacity to increase international debts for a programme with negligible payoff, the end of French reactor construction is in sight. To be sure, this is far from the end of French nuclear power generation. But even this future is a dubious one. It remains to be seen whether this industry is too big ever to be small or whether the French people will feel kindly towards an industry they were told was a national necessity and now appears an expensive albatross.

While this may not be a popular view in the French nuclear industry, it is unavoidable. Here is a nation with a gross national product about 2.5 times that of the US state of California, trying to pay off a 179 billion franc debt for a nuclear programme of 28,000 megawatts plus a further 32,000 planned or under construction. The nation already has the third largest international debt in the world, about 20 per cent of which is for the nuclear programme and EdF concedes that even a halt in orders would not slow its "voracious" demand for international capital over the next eight years.

Economists question whether any such capital will be available, other than to finance existing debt. EdF faces rapidly rising domestic power prices, competition for domestic and international capital from industrial customers on which the financial success of the utility (not to say that of the nation) depends, and the combination of flagging electric power sales and persistent overcapacity. Despite acknowledged administrative successes in the past, EdF's nuclear programme is beginning to look like a WPPSS (Washington Power Supply System) that could take a nation's economic health down with it.

Capital Charges for Coal and Nuclear Power Stations—First Year Costs in 1982 French francs or centimes.

	Coal	Nuclear
Capital Cost	FF4307/kWh	FF8580/kWh
Capital Charges	14.7c/kWh	38.5c/kWh
Decommissioning	0.0c/kWh	0.5c/kWh
Fuel Costs	17.8c/kWh	11.0c/kWh
Domestic coal	(20.9c/kWh)	
O & M Costs	3.0c/kWh	4.3c/kWh
Total	35.4c/kWh	54.3c/kWh
Domestic coal	(38.6c/kWh)	
	Ten Year Levelised @ 9%	
Capital Charges	11.2c/kWh	29.3c/kWh
Decommissioning	0.0c/kWh	0.5c/kWh
Fuel Costs	19.5c/kWh	12.1c/kWh
Domestic coal	(23.0c/kWh)	
O & M Costs	3.8c/kWh	5.5c/kWh
Total	34.5c/kWh	47.4c/kWh
Domestic coal	(38.0c/kWh)	
	Twenty Year Levelised @ 9%	
Capital Charges	7.9c/kWh	20.6c/kWh
Decommissioning	0.0c/kWh	2.0c/kWh
Fuel Costs	20.8c/kWh	14.7c/kWh
Domestic coal	(24.5c/kWh)	
O & M Costs	5.4c/kWh	7.7c/kWh
Total	34.1c/kWh	45.0c/kWh
Domestic coal	(37.8c/kWh)	

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Environmentalism and Electoralism

by Brian Martin

Can the goals of the environmentalists be advanced by active participation in election campaigns? To what extent should environmentalist strategies be based on building and relying on support from the labour movement? These and other similar questions are answered implicitly in the actual course of campaigns by environmental and other social movements, but are much less frequently addressed openly and critically. In addressing these questions Brian Martin looks at the strategies of two important Australian environmental movements: the anti-uranium movement and the movement against the flooding of the Franklin River in south-west Tasmania.

A large fraction of the effort of most environmentalists is spent in *ad hoc* lobbying, publicity, community education and protesting[1]. Action may be taken against a proposed freeway, against herbicide spraying, in favour of recycling legislation or in support of a new national park. The methods used depend on the individuals or groups involved and on the issues, and range from writing letters to parliamentarians or newspapers, lobbying politicians, producing and distributing leaflets, holding public meetings, holding demonstrations and using civil disobedience. In spite of the amount of effort involved in many such campaigns, they are often still *ad hoc*; indeed, activities are not coordinated into a coherent programme towards a long-term goal. Such campaigns are based on pressure group tactics, and presume the operation of a pluralist political system in which changes in policies are possible by the mobilisation of public opinion and pressure, especially on the government.

If social action on an environmental issue is sufficiently coherent, organised and sustained, it is appropriate to speak of an environmental movement. In a movement the otherwise *ad hoc* activities are tied together by a general goal and usually a sense of purpose and unity. Environmental movements often develop social goals associated with the environmental goals. The anti-nuclear power movement, for example, has promoted the 'soft energy path' alternative of energy efficiency and use of renewable energy sources.

In the case of environmental movements, it is also appropriate to speak of strategies. A strategy can be characterised as a coherent set of tactics, methods and campaigns for achieving particular specified goals. Strategies usually take into account the social and political context and in particular the role of groups favourable, unfavourable and indifferent to the movement's goals. In some cases, movement strategies are carefully formulated, continually examined and redirected when necessary. More often strategies develop out of unspoken assumptions about how campaigns should be organised. In these cases the *de facto* strategies must be inferred from the activities of the movement.

Methods

In general, environmentalists use four particular types of methods of action: appeal-to-elites methods, electoral methods, labour-based methods and grassroots methods. These are far from exhaustive and are not mutually exclusive, but they do epitomise some of the key directions and divergences of social activists. Movement strategies can and often do involve more than one type of method. But if the main approach relies on a particular type of method, such as appeal to elites, then it may be appropriate to speak of an 'appeal-to-elites strategy'.

The assumptions of the appeal-to-elites approach underlie most social action on environmental issues. The basic idea is to convince key decision-makers in government and sometimes industry of the logic and justice behind taking action and making policy to solve environmental problems. Typical appeal-to-elites methods are writing letters to politicians, sending petitions to politicians, making submissions to environmental inquiries, lobbying politicians and government bureaucrats, and writing articles aimed at elite policy-makers. The necessity for adopting such methods based on 'speaking truth to power' is seldom spelled out, but is simply assumed.

Electoral methods are based on actively intervening in parliamentary elections to support environmentally preferred policies, usually by supporting a party or running environmental candidates. In countries in which the dominant social democratic or communist party is unresponsive on environmental issues, such as in France and West Germany, parties with strong environmental orientations—'green parties'—have been started and promoted by environmentalists. The dominant social democratic party in Australia, the Australian Labour Party (ALP) has been relatively open to environmental policies. The small party, the Australian Democrats, has been even more sympathetic. For this reason no 'green party' has been considered necessary or viable in Australia. Therefore electoralism by Australian environmental movements has usually meant supporting and actively campaigning for the ALP and sometimes the Australian Democrats.

Labour-based methods look to the labour movement to further environmental goals. The two dominant formal structures most associated with the labour movement in Australia are the ALP and the trade unions. Many Australian trade unions have a tradition of activism on social issues, and in the 1970s this expanded to cover environmental issues. This receptivity, combined with the difficulties of using the Australian legal system to oppose development projects, led in the early 1970s to bans by builders' labourers on construction projects opposed by community groups on environmental grounds—the so-called 'green bans'.[2] The labour movement is wider than just the official labour party and trade union structures, and includes for example independent workers' initiatives such as wildcat strikes and labour-oriented research groups such as the TransNational Co-operative in Sydney.

The basic approach of a labour-based strategy to achieve environmental goals is to mobilise the labour movement to take action towards the goals. In Australia this typically means pushing for the adoption and implementation of environmental policies by the ALP and for environmental stands and direct action by trade unionists.

Grassroots methods aim at mobilising 'ordinary people' in all walks of life to promote social change by collectively changing their behaviour. Grassroots methods do not rely on support from elites for achieving their goals. Rather, they strongly encourage participation in a meaningful way by as many people as possible. A typical approach is to organise within a group of some sort—workers, church members, students, parents—at the level of the 'rank and file', by providing information, building networks, fostering development of skills and initiative, and taking action.

As mentioned before, considerable potential and actual overlap exists between those four types of methods. For example, all four are potentially components in a single approach of applying pressure to elites: by force of argument, by mobilising votes, by threat of industrial action, or by demonstrating citizen concern. Similarly, all the types of methods can be developed utilising grassroots methods: writing letters to politicians can be a way of encouraging people to be involved; social movement groups can be mobilised in election campaigns; and shop floor and party branch organising can be the basis for promoting labour movement concern on an issue.

Superficially, it might seem that convincing or pressuring elites holds the best chance of achieving environmental goals. The difficulty with this approach is that elites in government and industry are often the ones with the most interest in policies and practices which damage the environment. Chemical companies and electricity authorities, for example, depend for profits or bureaucratic expansion on the increasing use of their products. Those who rise to high positions in such organisations therefore have a strong stake in maintaining profit and expansion. Logical argument is notoriously inadequate to convince a person who maintains a vested interest in a contrary view. Political pressure on elites is more likely to achieve results, but the pressure must be maintained or the environmentally damaging practices may be reintroduced. But persistent and enduring political pressure is hard to sustain by social movements.

It is often assumed that any social movement of sufficient size and strength must enter electoral politics at some stage. It is worth spelling out some of the limitations of putting much energy into elections.

- ☐ It does not challenge existing structures such as the bureaucratic organisation of the state and the profit system. Rather, entering election campaigns reaffirms the value of existing structures.
- ☐ Focus on elections and dependence on sympathetic politicians does little to establish the social movement as a viable force outside the parliamentary arena. A basis for continuing struggle may not be established. Often after an exhausting election campaign, the movement virtually collapses.
- ☐ The sense of personal responsibility for environmental problems is given away to elected elites.
- ☐ Elected representatives, even those most responsive to community opinion, are still subject to intense pressures to adopt anti-environmental or 'compromise' policies. Politicians are constantly influenced by industrial lobbyists and top state bureaucrats. A more pervasive influence is the requirement to maintain economic expansion in order to finance government programmes. Politicians cannot afford to jeopardise 'business confidence' by anti-capitalist policies. The key goal of political action becomes survival in office. For these reasons elites, including elected representatives, cannot be relied on to enforce environmentally sound policies.
- ☐ Entering elections tends to polarise opinion on the environmental issue along party lines. Potential supporters in the party not supported become much harder to reach.
- ☐ Election campaigning often depends on key personalities, either as candidates themselves or as charismatic campaigners. This dependence, plus the need to coordinate policies, maintain party unity and not cause doctrinal splits, tends to centralise power in the social movement itself, to reduce meaningful participation and thus weaken the base of the movement.
- ☐ Strategies which do not depend on electioneering tend to be neglected.

Most of these problems also apply to labour-based methods. These and other points are relevant to the following discussion of the Australian anti-uranium movement and the movement against flooding of the Franklin River. These have been two of the most

powerful and overtly successful environmental movements in Australian history.

The anti-uranium movement has not prevented uranium mining, but has greatly slowed its implementation and has totally prevented the introduction of nuclear power and other parts of the nuclear fuel cycle in Australia. Furthermore, the Australian anti-uranium movement has gained strong support from the labour movement and in this regard is the envy of many overseas anti-nuclear power movements. The movement against the flooding of the Franklin generated perhaps the greatest outpouring of community concern of all Australian environmental issues. The Franklin was saved and the Tasmania Hydroelectric Commission, one of the most politically powerful government bureaucracies in Australia, was thwarted.

The campaigns of these two movements have been well run, by and large, and relatively successful in their own terms. In focussing on some of the limitations of the strategies of these two movements, I do not wish to deny their undoubted achievements. My aim is rather to draw attention to the shortcomings of even the most impressive environmental movements when they are based on pressuring elites.

The Anti-uranium Movement[3]

A grassroots orientation has underpinned much of the activity of the anti-uranium movement. The basic thrust has been to take the issues to 'the people' and encourage them to take a stand according to their own assessment of the issues. This assumes that, given an exposure to a range of views, most people will oppose uranium mining. The anti-uranium activists have seen their role as making sure that their side of the case is heard, given that the pro-uranium arguments are backed by wealthy mining interests and by politicians and state bureaucrats favouring an expansion of this area of state-regulated commercial enterprise.

In producing leaflets, writing letters and organising marches and rallies, the anti-uranium movement set out to reach as many people as possible while at the same time encouraging meaningful participation in the organising itself. For example, in 1977 a major activity was gathering signatures on a national anti-uranium petition. Although there was some interest in gathering as many signatures as possible to impress politicians and obtain media coverage, the main aim was to encourage personal interaction on the uranium issue. The signature drive not only meant that many people were approached and exposed to anti-uranium arguments, but also that an avenue was opened for involvement of people in collecting signatures. If the main purpose of the petition had been to impress politicians, it would have been mainly an appeal-to-elites method. But since the main purpose was stimulating involvement in the movement and contact with many people about the issues, the signature drive was mainly a grassroots method.

To supplement the basic grassroots approach, in 1976 the organised anti-uranium movement made an important strategic decision to concentrate on bringing the labour movement into the anti-uranium camp. The laying of such emphasis was decided upon within the broader strategy of taking the issues of nuclear power and uranium mining to the Australian public and demanding that any decision on those issues be made only after extensive and informed public debate.

Given the reality of the Australian political system, in which active community participation in policy-making has little formal basis, the focus on the labour movement provided an attractive political lever for the anti-uranium cause. Trade unions could take industrial action to oppose uranium mining, and popular support could both strengthen and be strengthened by such action. More fundamental was the perceived role of the ALP. If (1) the ALP adopted an anti-uranium policy, (2) the ALP were elected to government nationally and (3) the ALP implemented its policy, then uranium mining could be prevented or halted. Essentially the anti-uranium strategy was to build a strong grassroots base in the community and, with this support, for the labour movement to provide the direct political intervention to stop uranium mining.

The focus on the labour movement was not based on wishful thinking, since some labour activists and trade unions had been involved in anti-nuclear power activities from the very beginnings of the Australian movement. In the event, the grassroots plus labour strategy appeared to be spectacularly successful. A large fraction of 'public opinion' moved against uranium mining as the issue was debated in 1976 and 1977, and in mid 1977 both the ALP and the Australian Council of Trade Unions adopted policies opposed to uranium mining. The ALP and ACTU policy changes were quite significant in that they were pushed through as a result of concern at the party branch and shop floor level, one of the few cases of bottom-up change in labour policies. Thus the anti-uranium movement mainly used grassroots methods even in pursuing the labour-based part of its strategy.

Essentially the anti-uranium strategy was to build a strong grassroots base in the community and, with this support, for the labour movement to provide the direct political intervention to stop uranium mining.

Prior to the December 1977 national election, many anti-uranium groups reached a peak of activity in presenting the issue, especially in selected marginal electorates. While political parties were not formally endorsed, it was made clear that the Australian Democrats and the ALP were the main parties against uranium mining. Quite a few ALP activists and supporters were active in these efforts. But the ALP lost the election badly, and the anti-uranium canvassing had no perceptible effect on the targeted marginal electorates.

Involvement in the election campaign was not a positive experience for many in the anti-uranium movement. In some areas the election was used as an opportunity, owing to heightened community interest in the issues, to present the anti-uranium arguments to a wider audience without a heavy focus on the party

platforms. But in other areas strong ALP supporters dominated activities: anti-uranium activists were given plenty of work in distributing pro-ALP literature and the like, but had little say in the running of the campaign. The frenetic activity before the election resulted in emotional 'burnout' for many activists, while those used more blatantly by ALP supporters bore some resentment for their being exploited.

After the election, the anti-uranium movement went downhill. Many ALP-oriented people left the movement after the election. In 1978 morale was maintained by the resistance of the Aborigines to mining. But after that resistance was deviously and ruthlessly overcome by the Liberal-National Party government,[4] and especially after mining began in early 1979, severe demoralisation set in. Of three major participative campaigns planned for 1979—promotion of nuclear-free zones, boycott of the ANZ Bank (which is closely tied to the uranium industry), and a statement of defiance against the repressive uranium laws—only the nuclear-free zones campaign has a measure of success.[5] The actual halting of uranium mining seemed to depend more and more on the labour movement. Symbolic of that, a number of key anti-uranium activists had by then channelled their energies into the labour movement and lost contact with community groups.

The ALP and ACTU anti-uranium platforms were reaffirmed in 1979, but the ALP lost another national election in 1980. In late 1981 the Seamen's Union and others put up a valiant resistance to the export of uranium from Darwin, but could not sustain the fight in the face of union de-registration threats from the government. The weakness of the labour-based strategy was most glaringly revealed at the 1982 ALP National Conference, where in a dramatic confrontation the ALP's anti-uranium policy was drastically watered down. What was especially significant about the change was not the new policy itself but the method by which it was introduced. Ignoring party branch opinion, the amendment was pushed through by party power brokers. The contrast with the grassroots initiative which had led to the 1977 platform could not have been much greater. One response to that defeat for the anti-uranium forces was to plead for a return to branch-level work to push for the original ALP policy.[6]

The labour-based component of anti-uranium strategy

Many people opposing uranium mining have been concerned mainly about environmental hazards of nuclear power. For them, a focus on the labour movement might be seen as a tactical measure. But in as much as anti-uranium campaigning reflected an organised effort towards transforming society in certain ways and hence was a social movement in a wide sense, the labour focus was of deeper significance.

The halting and then reversal of the extension of the nuclear fuel cycle could have potentially significant social consequences. Such action could restrain the widespread use of a technology inherently linked—by its high cost, dependence on experts, and potential hazard—with centralised political and economic power. The stopping of nuclear technology would also allow more social and political space for introducing small-



The anti-nuclear grass-roots movement takes to the streets.

scale renewable energy technologies, with the associated promotion of local self-reliance and participative decision-making. Thus, if having the labour movement on one's side could stop uranium mining, a worthwhile part of a wider social strategy might be to halt the expansion of centralised political power and increase local self-reliance and participative democracy.

In keeping with that goal, the anti-uranium movement emphasised local actions and initiatives, campaigns that involved many active participants, and organised in-groups rooted in the community such as schools, churches and women's groups. Such an approach was especially appropriate to the nuclear issue since support for and opposition to nuclear power in Australia and other countries did not fall along the usual class, party or occupational lines.[7]

Not in keeping with that grassroots orientation, and the single most important decision made by the anti-uranium movement, was its dependence and later over-dependence on the labour movement. For while the labour movement is occasionally open to change from the bottom, hierarchy, patriarchy and centralisation are dominant features of most labour organisations.

Adoption of the labour-based strategy had two undesirable consequences for the anti-uranium movement. First, once the anti-uranium position had become identified with labour politics, the issue was more easily polarised along party lines, and it became easier for the supporters of uranium mining, such as the leaders of the Liberal and National parties, to suppress any internal dissent. Furthermore, after the elec-

tions of 1977 and 1980 it could be claimed, however inaccurately, that the Liberal-National uranium policy had been endorsed.

Second, once the anti-uranium cause was taken up by the labour movement, the community-based anti-uranium movement gradually lost its power. The reason was partly psychological, inasmuch as it seemed that uranium mining could be stopped only through the actions of labour elites, and the most that community activists could do was play a supporting role. At the same time, part of the loss of power resulted from a lack of any other strategy for stopping uranium mining. Once the ALP and ACTU had been won over, there was apparently nothing else to do.

The labour-based approach thus had two main flaws. First, success within the labour movement took power from the grassroots anti-uranium movement and concealed the need for a more complete grassroots strategy. Second, anti-uranium strength at the grassroots was replaced by anti-uranium weakness at the top echelons of the labour movement. This weakness was exploited by the uranium mining companies and party right-wingers in the ALP's 1982 uranium policy change.

The election of a national Labour government in March 1983 highlighted the problems of the labour-based component of the anti-uranium strategy. The fate of uranium mining seemed more than ever to rest on decisions within the ALP, and for community-based anti-uranium activists the main focus was to apply pressure on the government, especially on the key power brokers at the top.

In August 1983 a major civil disobedience action—a nonviolent 'blockade'—was held at the site of the proposed Roxby Downs uranium mine in South Australia. This action had some success in slowing operations at Roxby, but more importantly helped stimulate a resurgence in anti-uranium activity around the country. But much of the activity once again was focused on the ALP.

Thus the anti-uranium movement initially used primarily a grassroots strategy, then moved into a labour-based strategy and ended up by appealing to elites. Luckily, grassroots organising was never entirely neglected, so a large reservoir of support for stopping uranium mining remained in the community as well as in the labour movement.

What might the anti-uranium movement have done differently in order to depend less on the labour movement? Some possibilities might have been:

- ☐ To have developed positive alternatives to nuclear power in a way that involved people locally and at the same time challenged uranium mining. As it was, the 'soft energy path' was mainly used as a basis for argument, not as an organising focus.
- ☐ As well as building support in the labour movement, to have made a greater attempt to build support and weaken opposition at the grassroots level within government bureaucracies, corporations and the conservative political parties. Such action perhaps would not have overcome the pro-uranium forces in those areas, but it might well have reduced their drive and unity, delayed the beginning of mining and provided breathing space for the anti-uranium movement.
- ☐ To have carried through the national ANZ Bank boycott and the statement of defiance campaigns planned for early 1979.
- ☐ To have built strong links with other social movements, such as feminists, Third World action groups and the peace movement, in terms of common social goals and campaigning.
- ☐ To have developed long-term strategies. In the key years 1976 to 1978, the time frame for the anti-uranium movement was the next year, the next few months or the next few weeks. Few looked ahead five or even two years, unlike the uranium mining companies. There was and still is a need for long-term strategies involving grassroots organising, interaction with the formal political system, transnational links, training for civil disobedience and linking with other social events.

It is always easy to say what might have been. There is no guarantee that the above approaches would have been any more successful in preventing uranium mining than the course of action actually adopted. But such options do show that an alternative existed to the essentially labour-based strategy in which the anti-uranium movement found itself. At the time, the focus was on the opportunities and not on the limitations of concentrating on winning over the labour movement. Perhaps even though other strategies might have been canvassed, the same one would have been chosen. But I think it would have been better to have considered the alternatives more seriously.

Furthermore, even if the above grassroots approaches could not have stopped uranium mining in the short term, they would have had benefits in terms of long-term social goals by strengthening networks and personal involvement and by laying the social basis for an energy system based on decentralisation and local control.

Southwest Tasmania

Protection of the natural environment of southwest Tasmania, especially opposition to the damming of rivers there, has been an important environmental issue in Australia for many years. In the early 1970s the key focus was stopping the building of a dam which would flood Lake Pedder. The campaign to save unflooded Lake Pedder was unsuccessful. In the early 1980s the key focus was on stopping the building of a dam on the Gordon River which would also flood the Franklin River. It is the campaign to save the Franklin River that I will discuss here.

To avoid misunderstanding, let me say at the outset that in many ways the anti-dam campaign was brilliantly run within its own assumptions, and that the campaign was motivated by high ideals. The critical analysis which I make here is of some assumptions about strategies, not about commitment or talent.

The basic approach of the Tasmanian Wilderness Society (TWS) and most other groups which campaigned to save the Franklin was to appeal to elites and to apply pressure to elites. Many types of methods were used in achieving that, including grassroots, labour-based and electoral methods as well as direct appeal-to-elites methods. As the campaign progressed, appeals were directed especially to the Tasmanian Labour government, then to the national Liberal-

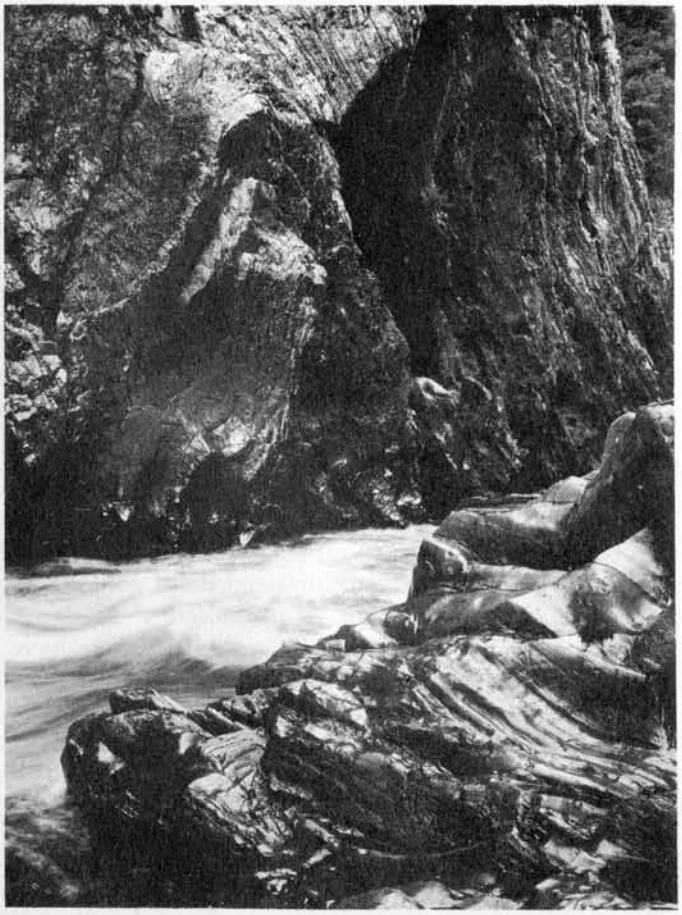
National Party government, and also to the national ALP both before and after the ALP's victory at the national polls in March 1983.

Direct appeals to elites took the form of lobbying, advertisements, letter-writing campaigns, and obtaining authoritative support. The campaign was both active and successful in all those areas. For example, many eminent scientists, artists and other figures lent their personal prestige or their expert opinion to the cause. One notable example was the action of the World Heritage Commission in listing the southwest wilderness in December 1982.

Lobbying, advertisements and obtaining authoritative support do not in themselves require much grassroots participation. The TWS did not neglect public opinion, and indeed much effort was put into cultivating it through advertisements, mailouts and obtaining favourable news coverage. But the underlying thrust was to mobilise public opinion and activism to apply pressure to elites. One main avenue for participation was through writing letters to politicians; another was contributing money to pay for advertisements, mailouts, lobbying, offices and the like.

The Tasmanian Hydroelectric Commission (HEC), promoter of the Gordon dam, is the single most powerful force in the state of Tasmania.[8] Both the Labour and Liberal parties in the state supported the dam, and the HEC workers were also solidly pro-dam. Therefore the usefulness of labour-based methods was limited. Nevertheless, the TWS made every effort to bring politicians on side, concentrating on the Tasmanian Labour politicians. (The Australian Democrats took an anti-dam position early in the debate, but with limited representation they could only raise the issues in Tasmanian parliament without much effect on policy.) Eventually, largely because of the dam issue, a split arose in the Tasmanian ALP, and Premier Doug Lowe and another parliamentarian, Mary Willey, left the party in November 1981.

The Franklin River: On July 1st 1983 the High Court of Australia declared the dam illegal. This ended years of battle, a spurious Tasmanian referendum and the Franklin blockage with its 1500 arrests.



In March 1982, Australian Democrat Norm Sanders, Doug Lowe and Mary Willey supported a no-confidence motion against the Labour government. At the resulting Tasmanian election the Liberals won a convincing victory. To the extent that this political manoeuvring was done to support the no-dams cause, it seemed to backfire politically. HEC elites still wielded considerable influence, especially in the upper house, and all that was achieved by trying to win over labour politicans was the splitting and weakening of the Tasmanian Labour Party.

After the Liberal victory in the May 1982 Tasmanian election, the Tasmanian ALP still supported the dam; hence the labour-based approach had little to offer within Tasmania. Consequently the TWS looked more and more to the national government to take action. While applying pressure of all sorts to the national Liberal-National government, the dam opponents also worked to get the national ALP to support the anti-dam policy, that being achieved in mid 1982. With the prospect of an early election at a time when media and public interest on southwest Tasmania was at a peak, the national ALP did not require much further prodding to make solid commitments, which it did in January 1983, to implement its anti-dam policy. Thus the labour-based methods which had failed in Tasmania seemed on the way to success nationally.

Even before the March 1983 national election, the TWS possessed considerable experience in electoral methods, and in the 1982 Tasmanian election, many candidates ran on a 'no-dam' ticket. The results of that election, an undoubted victory at the polls for the pro-dam forces, were hardly an advertisement for electioneering by environmentalists.

More encouraging were the efforts to get people to vote for the party they preferred, but also to write in 'No Dams'. That approach was especially appropriate in Tasmania inasmuch as the December 1981 referendum on the dam, did not include a 'no dams' option. The huge 'no dams' informal vote effectively exposed the farcical nature of the referendum choices. 'No dams' write-in campaigns in mainland by-elections were also quite effective. The result shows the effectiveness of allowing people to take a stand that does not have to be expressed via a party political channel. Although encouraging participation to the extent of a view being expressed anonymously, the 'No Dams' write-in campaign was used by the TWS mainly as a means of demonstrating to politicians the strength of the anti-dam position.

For the March 1983 national election the anti-dam movement entered electoral politics unreservedly, and a National South-West Coalition (NSWC) was formed with an anti-dam position. Massive amounts of money

and energy were poured into canvassing, advertising, leafletting, and passing out how-to-vote cards. The NSWC supported the ALP for the House of Representatives and the Democrats for the Senate. That preference was made independently of whether the other candidates had reservations about the dam, or even when they had spoken out against it. The election involvement was on behalf of a party, apparently without reservations.

As mentioned before, several methods adopted by the TWS involved grassroots participation at some level. But the most dramatic method used was the nonviolent action, launched in December 1982, to blockade construction work taking place preliminary to building the Gordon River dam. The blockade was a civil disobedience action, involving hundreds of people trained in nonviolent action techniques.

Civil disobedience can be used for several purposes. It can be: a method for involving people in a meaningful experience in challenging unjust laws or actions; a way of demonstrating to others the depth of commitment felt by a group about an issue; a means to obtain publicity and apply pressure on politicians.

The Tasmanian blockade was all of those things. For the people involved it was a moving experience, providing knowledge and understanding of nonviolent action, creating friendships and both demonstrating and forging commitment. If nothing else, the campaign against the flooding of the Franklin provided the most important means in Australia up to that time of spreading knowledge and experience in nonviolent action and training for it.

Yet for the TWS organisers, the blockade was mainly used to obtain publicity and thus to apply pressure on national politicians; it was not seen as part of a long-term strategy involving grassroots involvement in nonviolent action.

One cause and consequence of the anti-dam strategy was centralisation of decision-making power within the anti-dam movement. The centralisation developed naturally from the emphasis on influencing elites; indeed effective lobbying requires experienced lobbyists, while massive fundraising and quick allocation of funds (for example for advertisements) encourages centralised decision-making. At the same time the media likes to focus on key individuals. Many important decisions in the anti-dam campaign—such as full-page colour advertisements in newspapers costing tens of thousands of dollars, and support for the ALP in the March 1983 election—were taken with only limited consultation with the membership of the groups involved. Such action is characteristic of an elite-oriented strategy and strongly at odds with a grassroots strategy.

Another feature linked with the 'apply-pressure-to-elites strategy' was the focus on the environmental effects of the Gordon-below-Franklin dam. TWS leaflets, advertisements and material for the media often emphasised the natural features which would have been destroyed by the flooding of the Franklin: native species, scenic gorges, platypuses and white water. Less attention was given to the wider social, political and economic aspects of the dam dispute, including the entrenched political power of the HEC, the direction of Tasmanian economy, or methods for decision-making on wilderness. Arguably, the Gordon-below-Franklin dam was not the key problem, but rather a symptom of the hydro-industrialisation route pursued by the HEC in support of its own vested interests, and supported by workers and the major Tasmanian political parties that have been captives of HEC interests.

Those wider issues were well recognised by most active members of the TWS, who therefore came up with alternative energy options for Tasmania. But most media coverage nevertheless focused on the narrow environmental effects thereby helping to depoliticise the issue. Nevertheless, the TWS made little headway in promoting wider awareness of programmes for bureaucratic reform or of alternative methods for decision-making about wilderness. The main emphasis throughout the campaign was on saving the Franklin within the context of present political structures, by a change in policy at the top, rather than a restructuring of political institutions.

How did the TWS strategy fare? Considering its degree of popular support, rather poorly. The campaign suffered from all the limitations of electoralism. In particular, the enormous reservoir of concern and support was recklessly risked in the national election campaign, for a very dubious return. Many environmental organisations, including the Australian Conservation Foundation, staked their futures on an ALP victory which was by no means assured. If the Liberals had won the election, the financial squeeze on government-funded environmental organisations would have become vicious indeed, and support within the Liberal Party for environmental causes would have been squashed.

Did the participation in the election campaign by the NSWC make any difference? Anti-dam campaigners naturally enough have used statistics to show it did.[9] Opinion polls and informal opinion suggest that a number of voters were influenced by the dam issue. On the mainland the anti-dam stance of the ALP gained some votes, while in Tasmania the Liberals probably gained from their pro-dam stance.

But the question that concerns me here is not so much whether the dam issue influenced voters, but whether the campaigning by the NSWC had any effect. A close look at the figures shows only a limited effect: in the electorates in which the NSWC mounted a major effort, the swing to the ALP was somewhat higher than the national swing, but smaller than the error in the figures. This suggests that NSWC campaigning had relatively little effect on the election results.[10] In other words, anti-dam environmentalists could have taken an independent line, or promoted a 'no dams' write-in, and the election results would probably have been about the same. If such an approach had been adopted, it would have been up to the ALP to promote its anti-dam policy in order to gain votes. The risk of Liberal victory and retaliation against environmentalists would have been reduced greatly, and the possibilities of gaining the support of Liberals maintained.

Many environmentalists will not want to admit that a major election effort had minimal effect. But if envir-

onmental campaigns are to be founded on sound principles, it is necessary to recognise unpleasant truths.

Even the ALP victory was not such a wonderful thing for the anti-dam campaign. As is the usual case with reliance on electoral methods, the commitment and concern and sense of personal responsibility was given away to elected elites. After the election, the anti-dam movement went into a quick decline as people looked to the ALP government to take over the job of stopping the dam. Many anti-dam activists were 'burnt out' by the electioneering. The blockade and other forms of mass mobilisation—including demonstrations and public meetings—were downplayed to avoid antagonising public opinion during the election and afterwards.

Civil disobedience can be a method for involving people in a meaningful experience in challenging unjust laws or actions; a way of demonstrating to others the depth of commitment felt by a group about an issue; a means to obtain publicity and apply pressure on politicians.

The election further polarised opinion on the dam, and channelled opinions into party lines. In Tasmania, where the Liberals increased their majorities, the anti-dammers suffered a severe setback.

I have said that elites, including elected representatives, generally cannot be relied upon to enforce environmentally sound policies. In the case of the Gordon-below-Franklin dam, the national Labour government took a strong stand in principle. But in practice the government tossed the issue to the High Court, allowing the government a ready excuse for taking no further action should the court have ruled in favour of the Tasmanian government.

By adopting electoral methods, the anti-dam movement drained its own strength, undercut cross-party support, disempowered its supporters, and put the fate of the dam in the hands of the High Court in which public opinion and activist commitment play little role. Furthermore, the Tasmanian Liberal government was given the issue of 'states rights'—however dubious that issue is by any logical analysis—which it used in a very effective way to mobilise Tasmanian opinion for the dam. In the event, the High Court ruled against the dam, the judges dividing four to three. Thus the entire issue in the end hinged on one person—the swinging High Court judge—thus symbolising the pyramidal structure of the appeal-to-elites approach.

The High Court decision was undoubtedly important in stopping the dam. But the polarisation of opinion in Tasmania and the antagonistic reaction of pro-dam forces there to the court case loss will hamstring environmentalists on issues besides the dam for years to come. More importantly, the TWS campaign had little effect on the entrenched power of the HEC: other dam projects are underway, and the HEC is expanding its domain into other areas of activity.

Given that the national government's court case against the dam succeeded, the illusory path of pressuring elites has been given a credibility greater than it deserves. Had it failed, it would have been necessary for environmentalists to re-examine the assumptions behind their campaigns. This could have stimulated development of strategies which do not depend so much on action from the top.

What would a grassroots strategy to protect the environment of southwest Tasmania look like? It would include non-hierarchical and decentralised organisation of action groups, a focus on the wider implications of stopping dams with regard to industrialisation, and a range of activities that depend and build on widescale participation and do not depend on charismatic figures, media coverage or influential patrons. It might well include a detailed plan for providing Tasmania's energy needs without further dams or fossil fuel generating plants, which simultaneously provided specific alternative employment opportunities for HEC workers. Such a plan could be developed with some input from the workers themselves, and be used to undermine the enforced unity of the HEC and other pro-dam forces. The grassroots strategy might also include a wide range of participative nonviolent actions, such as boycotts, nonpayment of electricity bills, work bans and union black bans, as well as blockade-type actions.[11]

It is true that a grassroots strategy, if it succeeds, will usually be accompanied by changes in policy or action at the top. But in a grassroots-based social transformation, elites respond not simply because of public opinion or pressure, but because of a threat to institutions or direct thwarting of goals by strikes, boycotts, or other forms of non-cooperation. So while a grassroots, nonviolent action strategy usually will be supplemented by the familiar methods of disseminating information and pushing for policy changes, that does not mean that the only way nonviolent action can succeed is by swinging public opinion and convincing political party elites to change policies. In a grassroots nonviolent action campaign that succeeds, changes in policy are essentially capitulation and acceptance of a new *de facto* distribution of power in society rather than an opportunistic swing towards public opinion.

It is a long-term project to change the HEC and other similar institutions which carry out anti-environmental practices. It can be reasonably argued, from the perspective of 1982 and 1983, that the flooding of the Franklin was an urgent short-term goal necessitating appeal-to-elites methods. But the TWS was formed in 1975: that was the time to have begun formulating a long-term grassroots strategy. So long as environmentalists remain in the 'urgent threat' syndrome, strategies based on applying pressure to elites will be most attractive and the institutional sources of environmental problems will remain intact.

Conclusion

My main intention has been to point out some of the limitations of appeal-to-elites, labour-based and electoral methods in pursuing environmental goals. The limitations have been glossed over in many campaigns, and strategies have often been taken up without any critical examination. However, in spite of their limi-

tations, appeal-to-elites, labour-based and electoral methods do have advantages. These methods should not be rejected purely out of an ideological commitment to working only at the grassroots. After all, grassroots methods themselves are in many cases just another way to influence elites, and perhaps a better way in many cases, since they do not suffer so many of the disempowering aspects of the other methods.

When are elite-oriented strategies appropriate? Basically when change is sought within the existing social institutions. For example, labour-based methods seem suitable when pursuing improvements in salaries and working conditions. That the TWS used a strategy based on pressuring elites is compatible with its emphasis on stopping a single dam rather than on achieving changes in the HEC. Much of the anti-uranium movement encompassed wider aims, such as an increase in local community self-reliance and decision-making power in tandem with increased local energy self-reliance. Activists in the anti-uranium movement were aware that nuclear power has been promoted by states because it reflects and promotes state power. To the extent that such is the case, appeals to state elites are of limited value and a grassroots strategy is called for.

In the peace movement, the implied challenge to the state is even more fundamental, since the state is founded on a monopoly of the use of violence within a territory, and so professional military forces are central to the continuance of state power. Most peace movements have nevertheless used appeals-to-elites as their basic approach. It is not surprising that those appeals have led to nothing. Nor have labour-based methods succeeded any better. To eliminate war, a grassroots approach seems essential. To the extent that peace movements have used elite-oriented methods, they essentially have sapped their own long-term potential.

If the goal is transforming the social, political and economic institutions underlying environmental and other social problems, then grassroots strategies deserve attention. But because the assumptions underlying elite-oriented strategies are so widespread, grassroots strategies are relatively undeveloped. Perhaps in the future that deficiency can be remedied.[12]

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A New Threat to Agriculture and a Window of Opportunity

by Wes Jackson

Molecular biologists now see agriculture as their domain. With genetic engineering and gene-splicing they hope to produce wonder plants that will take productivity to new heights. But they have failed to see the interconnections between agriculture and the ecosystem, and in the long run their efforts are likely to be disastrous. The author argues that biologists and ecologists with a more traditional training are far better equipped to manage agricultural problems, but they will have to act fast to prevent their being usurped by molecular biologists.

Aldo Leopold once wrote that it is easier to build a road than to think of what the country really needs. What I suppose Leopold meant is that there is a segment of our society whose sole purpose is to build roads and bridges, a segment whose sole purpose is to build and market automobiles, a segment whose sole purpose is to take oil out of the ground and transport it over the countryside. There are the Chambers of Commerce in nearly every town who understandably promote their own economic growth. Most of these are big money interests who have poured billions into lobbying our law makers and policy makers over the years. It *is* easier to build a road because we are talking about aggregations of power, most of it private, but most of it geared to profit from a road which will be built at public expense.

'Aggregations of power' is really my subject here, for what I am about to talk about is an emerging problem for agriculture as the result of such aggregation. Much of it is within the university, some within the USDA, and some within private industry. The story really begins in the mid 1940s but I am going to jump forward a decade because it makes more sense to do so.

In the mid-50s, biology departments were mostly in small colleges. Unlike the universities and major colleges, most of them could not afford the luxury of separate departments of botany, zoology, entomology and bacteriology. This was in the good old days of biology. Of course, schools with their separate departments *did* have problems. It was not unusual, for example, for botanists to refuse to speak to zoologists and the other way around. Also, because of this departmental division, students naturally believed that the differences between plants and animals were more fundamental than they are. But there were some good things in this division. For example, it kept botany from being swamped by a pre-med programme. But this separation came to a quick end as institution after institution placed all these disciplines under Biological Sciences or within a Department of Biology. Some universities did not collapse their departments under one empire, but most did.

This aggregation of power can be conveniently traced to 1957, the year the Russians threw the first Sputnik into the sky, and sent a seismic wave through all of American science. We suddenly felt old-fashioned and in need of catching up with the Russians, so we spent more money on science education and research. Science programmes expanded and the era of big science got a boost, literally from a Russian rocket. This was the beginning of the end for numerous small subdivisions in biology. In a way, money did them in. To be honest, more than money was involved. Numerous professors promoted the *biological* argument that the difference between prokaryotes and eukaryotes was more profound than the difference between plants and animals. In other words, blue-green algae and bacteria were more different from redwoods than redwoods are from lions. The old distinctions between plants and animals were said to be too arbitrary. There was other evidence coming in from other directions as well that began to make this division embarrassing to biologists. Animal ecologists were aware of the dependence of the animals they studied on the surrounding vegetation. For both animal and plant ecologists to be under the same organising umbrella in the organisational structure of the university seemed to make sense.

So in the early sixties, the cracks began to widen in the rigid organisational structure of the traditional disciplines in biology, cracks which the academic deans worked to their advantage in academic empire building. They *were* doubtlessly tired of the squabbling among the various heads of botany, zoology, entomology and bacteriology and by putting them all under one organisation, the squabbles over budgets could be settled below the dean's office. Had there not been a charismatic Kennedy, a civil rights movement, a Vietnam war, a proliferating counter-

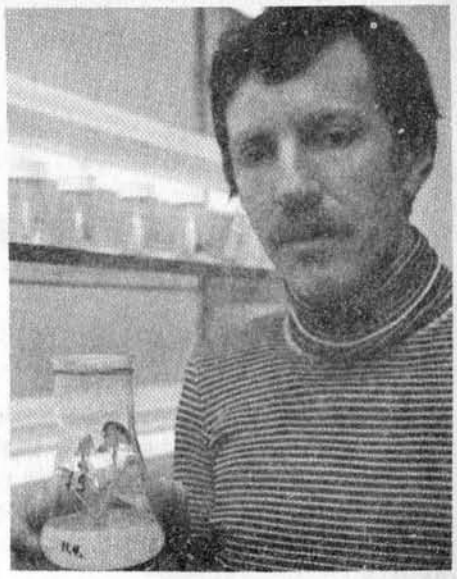
Wes Jackson *is director of The Land Institute in Salina, Kansas, USA and author of* New Roots for Agriculture: a proposal to save the soil.

culture, the public might have learned of this not-so-quiet revolution in the structure of biological learning and research. It may have made no difference that the public didn't know, but what was to follow was to have profound implications for those of us interested in sustainable agriculture.

And now we must consider another historical theme, of equal importance, a theme that would eventually intertwine with the one that I have just discussed and have a tremendous impact on biology — as, I am afraid, it will have on agriculture. We may say that this second theme began to develop in 1944, the year that Avery, MacLeod and McCarty published the results of the experiments which suggested that DNA and not protein was the chemical responsible for heredity. Less than ten years later, in 1953, James Watson and Francis Clark reported that the structure of the DNA crystal was a double helix. They got the Nobel Prize they were after and DNA and double helix became household words. The momentum for molecular biology, as a field, was now well underway. Many of these new biologists came out of chemistry. They did not come out of the tradition of biology. Most were not steeped in the biological lore, nor, I suspect, did most of them care to be. The collapse of the discipline within biology, which I discussed earlier, facilitated the rise of molecular biology. Avery, MacLeod and McCarty, Watson and Crick came to be names which crowded out other names and other concepts in undergraduate biology courses as professors upgraded their notes and changed to new texts. Even though the budgets for scientific research and teaching were expanding during this post-sputnik era, even though new buildings were being built to accommodate this growing scientific establishment of professionals and equipment, some of the traditional 'schools of thought' suffered. Countless botanists were bitter because organismic botany, in particular, suffered. It was regarded as too descriptive. Not analytical enough. As many of the old plant ecologists retired, they were not replaced, and their labs were redesigned to accommodate the new, young breed of molecular biologists. After all, as one old scientist said, there was a "killing to be made on DNA." I know what this fever was like, for as a graduate student in the 60s, taking a course in biochemical genetics, we would all wait with bated breath to read the most recent issue of the *Proceedings of the National Academy of Science* in order to learn what had been discovered in some high powered lab with eight to ten post-docs all engaged in deciphering the code of life and understanding how it worked. We waited with fascination to learn how this language of life was arranged. I have to admit that it was a most exciting time in the history of biology to be alive. During this fever, the budgets for scientific hardware went sky high. Electron microscopes, which can now cost a half million dollars, became absolutely essential, as did fast and accurate weighing equipment, growth chambers controlled by computers, etc. Department heads and deans had become responsible for multi-million dollar empires. These managerial academics had the best of both worlds. Not only could they associate with the world of high intellects, they could measure their worth in the prestige and importance that adhere to large budgets. They could compare themselves to the middle, if not the top, executives in major corporations.

Molecular Biology—A Cure for All

For a quick study of this movement to expensive high technology in science, check the ads in the weekly journal *Science* over the last twenty five years, and note the increase in technical sophistication and expense. Look, also, at the ads for positions available. 'Cutting edge' science became very expensive. We have known it is costly to the practitioners and administrators, for such science becomes the fuel for *hubris*. By *hubris* I mean an increase in our penchant to 'improve' the world by imposing our designs on it, designs which interrupt or interfere irredeemably with the designs of nature to which we have made little or no contribution. Few could have seen what the revolution in molecular biology would mean to botany. Hindsight is always 20 by 20, but we might have wondered where all those two-and-three-year post-docs who were doping out the code would go once their post-doc was over? Of course the momentum was there to accommodate *them*. They had prestigious bibliographies. They had worked in the labs of nobel laureates and near-laureates. They found good jobs in major universities. And since it is a monkey-see-monkey-do world, they, in turn, took the best graduate students available and put them to work on even more 'cutting edge' science. But almost without notice, the era of discovery moved smoothly into the era of manipulation until, almost suddenly, we had new household words and phrases such as 'gene splicing,' 'gene stitching,' and 'DNA surgery.' We were told early on and we are being told now that this new biology will help us cure cancer; that it will make temperate cereal crops full blown nitrogen fixers when we stitch in legume genes to accommodate the nodule forming nitrogen-fixing bacteria of the soil.



Test tube rape by cell fusion.

I have just described the revolution that went on in biology. What I have not yet described is the illusion of a revolution or a pseudo-revolution that went on in agricultural research. During this great change in biology, there was a tremendous change in the structure of agriculture worldwide, mostly because of yield increase. A so-called green revolution was taking place in Mexico, in India, in Asia. The casual observer might conclude that the revolution in

biology was responsible for the revolution in agriculture, that they were proceeding in lock step to increase the food supply for a hungry world.

The two revolutions were, however, more or less independent. Yield increases were more the result of the widespread use of commercial fertilizer and irrigation and more use of pesticides. Crops were designed to be less discriminating in fertilizer uptake — in other words, the genetic mechanisms responsbile for the orderly uptake of fertilizer were destroyed. We just regarded this 'destroyed mechanism' in a positive way; we said that such plants had 'high fertilizer response' genes. What is important to appreciate at this point is that molecular biology had little or no impact on agriculture. Increased sophistication in experimental design because more researchers had understood the statistical models of

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The greatest advances lay before us: positive manipulation of genetic material to create super-efficient crops and livestock.

The Furrow Jan/Feb 1984

Sir Ronald Fisher and others, led to a more efficient means of selection, an increase in the number of inbred lines, marker genes, etc. All in all, it was the establishment of the international research centres, the growing sophistication of some of the major seed houses, and the interaction of those companies with the geneticists and agronomists in the land grant universities which brought on this so called green revolution. Was it ever dramatic! In fifty years, the yield of corn went from a national average of thirty bushels per acre to one hundred. But it was not an era of discovery so much as an era of implementation.

Eventually, we came to the era in agriculture, in the mid to late 70s, in which an increase in the fertilizer was not proportionally met by an increase in yield. The fertilizer curve line was going up and the yield line was flattening. Moreover, farm yields were coming closer to the yields in experimental trials. In other words, research results were no longer far ahead of field results.

It was inevitable that these converging lines would be noticed. Agricultural researchers would coast for a while on their past dramatic achievements, but lots of bright boys would point out that the technology which breeders had employed to bring about the record yields was about milked dry and that we should start now to implement the new science and technology which had been established in biology. This would give us a new knowledge base to exploit for the purpose of feeding an increasingly hungry world, and it would shore up our ability to produce for a future export market.

In the summer of 1982 there was a landmark meeting — a potentially dangerous one, I think. Dennis Prager, a physicist who started work as a policy analyst at the Office of Science and Technology Policy during the Carter administration met with the Rockefeller Institute's John Pino. They and a few other people held a conference in the summer at Winrock in Arkansas and concluded that the land grant institutions were lagging in their basic research and were therefore desperately in need of the new knowledge in biology. The best work, they concluded, was being done outside the agricultural system. As a result, there is now a move to upgrade agricultural research.

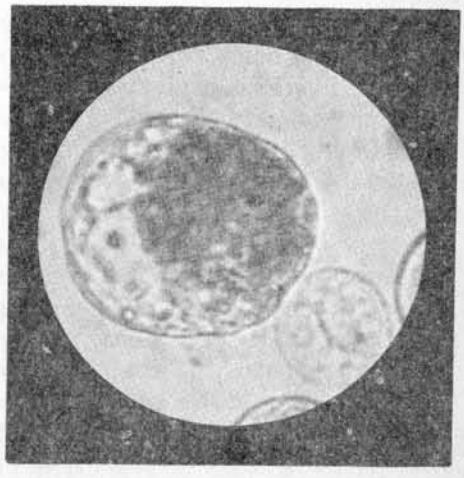
In response to this high level conference in the summer of 1982, the wheels of bureaucracy squeaked forward. Orville Bentley, a biochemical nutritionist and former dean of the University of Illinois agricultural school, is the assistant secretary for science and education in the USDA. He presides over the Agricultural Research Service, the Cooperative State Research Service (the agency that administers the Hatch Act funds) and the Extension Service. He says there is a change taking place that is more rapid than gradual. He says that "There will be a swing toward mobilizing our resources toward biotechnology, genetic manipulation. Two other important areas are resource utilization and protection of soil and water." But he goes on to say, "I still think the driving force will be efforts to increase yields, productivity and production as a way to keep the level of technology high." Bentley does say that there will be investigations into the feasibility of diverting some of the farm subsidy money, approximately 7 billion dollars toward research and conservation but admits that that will involve a fight.

William E. Marshall, a biochemist who is technical director in the development sector of General Foods Corporation, has been studying federally funded agricultural research as a member of President Reagan's Task Force on Cost Control. He contends that the best work is being done outside the agricultural research system, and he concludes that "What's needed is to bridge the gap between molecular biology and the future of agriculture."

During the past twenty years, the molecular biologists who were taking their post-docs during the sixties have professionally cloned themselves. The modern day descendants of the new breed in the sixties, like their predecessors, may never have had a field biology course, never milked a cow or goat, maybe never have driven a tractor. But they are looking for work. There are only so many pharmaceutical houses, only so much interferon to be made, only so many who can work at tricking bacteria to make insulin. There they are, credentialed, knowledgeable of the equipment, toned up on the literature, ready to roll.

What they have in mind is currently limited, but the future is boundless. They plan to turn grasses, for example, into plants that will fix nitrogen as readily as some of the major legume crops. They hope to introduce genes for resistance to various insects and pathogens. They hope to boost yields. Sounds good,

Fused petunia and tomato cells.



doesn't it? Their agenda for agriculture is difficult to argue with. They are presenting a world of the future that makes one think that one is watching the upbeat ads during the Superbowl. But it is clear that what they are doing is trying to write large the last fifty years of agriculture. They are offering the 'specific problem-specific solution' approach as the infallible recipe. This approach assumes that everything outside the specific problem for which they intend to splice in a solution can be held still, that nothing else will wobble, or if it does, that they can splice in a correction for that, too.

All of this is high tech research and you can bet your bottom dollar that any outfit that gives you a crop with a spliced-in gene is going to demand a patent and some kind of a royalty payment, and they will have the power of slick advertising. It is doubtful that their primary concern will be the high energy cost of American agriculture. One also doubts that they will care greatly about the national and global soil loss problem.

Of course, agriculture needs very little of what molecular biologists have to offer. But if we are to win in this round, we all have to get cracking now. Now none of us want to be merely against something; we want to be for something as well. We are fortunate, then, that another kind of change which offers some possibilities has been going on in biology, a change that has scarcely been noticed, and one that can help agriculture but will not do so automatically.

The New Synthesis: An alternative view

It is a revolution which has come from several fields, from people who have had various motivations. They are taxonomists, ecologists, geneticists and they have been putting together a new synthesis, in fact a new field that might be called, for want of a better name, population biology. The primary contributors to this field have been plant ecologists and population geneticists, people with interests in evolutionary biology. They study species strategies like r and K selection — whether a species emphasises reproduction or 'hanging-in-there'—once established. They study source-sink relationships in the production and allocation of energy in plants: does a plant send the harvested sunlight to the seed or to the root to over-winter? They study senescense in plants, the mechanisms of interaction among plant species, the diversity and natural dynamics of populations. They are interested in weeds as colonising species, insect interactions and the role of pathogens.

Especially in the US, these researchers have been just as interested as the 'cutting edge' scientists in molecular biology in accumulating this knowledge for its own sake. One difference, of course, is that the pharmaceutical houses aren't interested in hiring the students of the population biologists to turn out insulin or interferon. None of these professors will be invited to join a new company like Genotech with a starting salary at 100,000 dollars per year with all sorts of stock options. Some of the motives of these population biologists, ecologists, etc., may be the same as that of the molecular biologists. Too many have used their degrees and their bibliographies as passports to privilege rather than responsibility. Nevertheless, they are more in the tradition of the long distance runners in research than they are like the sprinters in molecular biology. Their roots are in traditional biology. They can trace their academic ancestry back to many of the old names in biology. They know the lore of their heritage in the long tradition of biology, the kinds of things you pick up around a department, up and down the halls. They know the work of Asa Gray, Bessey, Weaver, Clements, Stebbins, Dobzhansky; Charles Darwin and Liberty Hyde Bailey are part of their being.

How are we going to run agriculture and culture on sunlight? What are we going to do when the oil is gone? What are we going to do to stop soil erosion? Ecosystem agriculture has answers to all of these questions. Molecular biology has few or none.

The work of these plant population biologists or ecologists is admittedly still at the 'knowledge-for-its-own-sake' level. But they are working so high above the individual gene that the nature of their research is fundamentally different from that of the molecular biologist. What they have accumulated and what they have to offer is what those of us interested in a sustainable agriculture need to pay attention to, for the sustainable agriculturist begins with the notion that agriculture cannot be understood in its own terms — that it comes out of nature. The test for this is the question whether a crop plant should be regarded more as the property of the human or as a relative of wild things. If it is viewed primarily as the property of the human, then it is almost wide open for the kind of manipulation molecular biologists are good at. If, on the other hand, it is viewed as a product of nature primarily, as a relative of wild things, then we acknowledge that most of its evolution occurred in an ecological context, in a nature that was of a design not of our making. I want to underscore the fact that the scientists who study this are at the other end of the spectrum from the molecular biologists. They may admit that humans learn faster than nature but they acknowledge also that nature is hard to beat because she has been accumulating information longer. Most of the mistakes of nature have been corrected over time.

Rather than embrace gene splicing, the 'cutting edge' agricultural research can benefit more from this inherently broader tradition. A new agriculture must come from people who are students of nature at the ecological level. For after all, a natural ecosystem, like a prairie, sponsors its own fertility, recycles its nutrients, avoids the epidemic from both insects and pathogens, and does not lose soil beyond replacement levels. People who make it their lifetime occupation to study the kinds of ecosystems that feature all these elements of sustainability must be pried loose from the perches where they discover and accumulate 'pure' knowledge. We need to get some of them to turn their heads and hearts to work with us in the development of a sustainable agriculture. *Mol-*

ecular biologists can have a role, but they must follow, not lead.

We have a clear agenda ahead of us for now. Our first task is to say 'no' to the imperative of molecular biology. We must not allow it to horn-in on agricultural research, only to increase the size of the production-only Leviathan. Secondly, we must encourage and aid the resistance of the current researchers in agriculture who resent this intrusion of molecular biology into agriculture. Third, we must work on the other breed of 'pristine' scientists in the biology departments — the physiological ecologists, the population geneticists, population biologists, evolutionary biologists, biosystematists, and the rest of the biologists — and let them know that we think it is time for them to begin the difficult task of working in the area of ecosystem agriculture. Nature can work to our advantage in agriculture. Some work of this kind is already going on. We all know about the work of Rodale in Pennsylvania, the work of Richard Merrill of the Portola Institute in California, that of John Jeavons at Willetts, the permaculture work of Bill Mollison, Fukuoka's work in Japan, and Sir Albert Howard's work in India early this century. Steve Gliessman is now working at Santa Cruz, Miguel Altieri at Berkeley, and we are at work at The Land Institute.

But all of us have just begun. We need to take the ecological knowledge that has been accumulating for the last thirty years or so, and think on its applicability to agriculture. It is going to take a concentrated effort to move this knowledge into the Agricultural Research Service of the USDA, into the land grant institutions, and onto the farm.

What those of us interested in sustainable agriculture need always to keep before us are the questions: How are we going to run agriculture and culture on sunlight? What are we going to do when the oil is gone? What are we going to do to stop soil erosion? Ecosystem agriculture has answers to all of these questions. Molecular biology has few or none.

It might be argued that the fields of population biology and ecology are so complex and that so little is known of living things and the physical-chemical world which surrounds them that to concentrate at the ecosystem level, rather than at the population or organism level, will be impractical. Work at the ecosystem level could get argued down even if our goal is to save soils, prevent chemical contamination of the countryside and get farms to sponsor their own fertility and energy. The argument could be made instead that the payoff from the likes of gene splicing is so sure and so promising for solving the immediate problems of agriculture and that molecular biology is mature enough that we should get cracking now. Conventional wisdom may hold, in other words, that we should go with our long suit.

I don't think so. The synthetic field of population biology or evolutionary biology and ecology are just as mature. They haven't received the same amount of media coverage. They haven't been featured in *Time* and *Newsweek*. But consider the barriers molecular biology must overcome to be able to deliver on the promises which have to do with production only, promises which never include the notion of sustainability.

Complex organisms too complex

With few exceptions, and they are exceptions because of certain anomalies, the gene splicing work to date has featured the relatively simple prokaryotic organisms, the bacteria and their associated viruses. Such organisms are several orders of magnitude simpler than the kinds of cells nature has used to make redwoods and lions, lilies and people, and with the help of humans, corn plants and holsteins. For gene splicing to be useful at this level, there must be a method of incorporating the gene into the entire genetic complement of the recipient species. This will be no small trick, but let us assume that it can be done.

First off, the team of molecular biologists must know what gene or genes they want to transfer from one creature to another. Next, they must find a source. Then they have to be able to extract the small amount of DNA representing that gene or genes out of the rest of the DNA in a complex cell. So far, maybe so good. What if the transferred gene fails to work in the new environment? They will have to find out why. Most of the requirements necessary for that gene to function in its new and alien world will be unforeseen and unforeseeable. Furthermore, it is unlikely that the newly-modified genome (all of the old gene material of the host cell, plus the newly-introduced material) can be easily propagated.

So much for the easy part. I call it easy because it involves the most straight-forward kind of manipulations imaginable so far. Now for the hard part, the more formidable problems. Because all genes interact to some degree, the traits which are *strongly* influenced by several genes working together will stand as a barrier to the gene splicer. They are still beyond the current 'state of the art' for gene splicing. Professor Dick Richardson, geneticist at The University of Texas at Austin, points out that some traits such as 'growth rate' are affected by many hormones, including episodal ones that are present for short periods of time in low concentrations. Many of these are only now being discovered. When their existence is known, isolation may begin, but if the genes are from widely divergent organisms, their regulation may differ in the new host and fail to work as planned.

Professor Richardson reminds us that a gene is often separated into several pieces and located in widely separated places on the chromosome or even on another chromosome. While this is a tricky problem to overcome, it is no more tricky than isolating the various genetic components which regulate a particular gene in question. Once a complete gene and all of its regulators are isolated, there is the problem of the entire assembly becoming precisely incorporated into the genetic material of the recipient organism. If it isn't incorporated early enough in development and misses being transferred into the germ line so it can be transferred to

If we continue to lose soil, if our soils and groundwater supplies continue to be polluted because of our single vision focus on production, the day will come when few will care whether molecular biology ever existed as a discipline.

the offspring, for all *practical* purposes, it is a dead end.

Let us assume that all of the barriers to the present have been overcome. We are now faced with a problem somewhat similar to what geneticists confronted nearly forty years ago, during the heyday of radiation genetics. This was a time in which numerous geneticists believed we could improve crops and speed up evolution by irradiating the germ plasm and then selecting the desirable products. What that generation of geneticists and plant breeders learned is that they had on their hands the same problem as the previous generation of geneticists who believed that some biological wonders could be pulled out of the progeny of some very wide crosses. The problem they had was how to get rid of all the variation they suddenly found on their hands, and how to *re-optimise* the desirable traits against such a scrambled genetic background. The background of spliced in genes may not be so scrambled, but the problem of re-optimisation is still there. In other words, even if all the steps are taken successfully up to the point where the spliced gene and its regulators from a distant plant family are successfully transferred, an untold amount of breeding work remains before the genetic background is shaken down enough to accommodate the newly-introduced tract and its regulators.

The Ecosystem—a better starting point

The ecosystem level of biological organisation is complex, much more complex than the DNA level of any species, but it is not necessarily more *complicated for the human* to work and deal with. For that matter, the level of the molecule is more complex than the atomic level but molecular biology as a field is no more complicated than physics as a field. At the ecosystem level, if researchers and farmers take advantage of the natural integrities which have evolved over the millions of years, they may be dealing with great complexity but it may be much less complicated for the human than gene splicing at a much less complex level of biological organisation. Ecosystem researchers will simply be dealing with huge chunks or blocks of what works.

The point is, if we continue to lose soil, if our soils and groundwater supplies continue to be polluted because of our single vision focus on production, the day will come when few will care whether molecular biology ever existed as a discipline. There is enough 'on-the-shelf' knowledge now, all in the area of population biology, evolutionary biology and ecology, to begin to meet the needs of the land and the needs of this species of ours which was shaped by the land.

Why have we been so slow in getting started? Well, such an ecological agriculture was really not possible until the last ten or fifteen years, until the great synthesis began to emerge, until sufficient knowledge about the workings of natural ecosystems had been discovered.

An Opportunity for the Traditionalists

We still have a great opportunity to do something about the problem of agriculture, but we have little time in which to take advantage of that opportunity. Right now, the average age of the agricultural researchers is around fifty-seven, about the age of the average Kansas farmer and pretty close to the average age for the farmer in America. This means that in the next five to fifteen years, a lot of agricultural researchers are going to retire; 60,000 professional slots will open in agriculture next year and there are only 52,000 people trained to fill them, a deficit of 8,000. There will undoubtedly be deficits in subsequent years, as well. What this means is obvious — if we can get people trained in ecological agriculture, we can change the structure of American agriculture very fast, for in another ten to fifteen years, many of these people would move into positions of responsibility. If we fail to produce enough students of ecological agriculture, then molecular biology will win the day.

Numerous problems still lie before us, but the day may not be too far off when scientists who have been studying natural ecosystems will begin to talk to farmers as equals and that farmers and scientists will join together in the common task of learning how to live *decently* on the land surface of the planet and make a *decent* living while doing it. We should acknowledge what molecular biology does have to offer sustainable agriculture. It won't be much. We next have to use whatever energy we can to tilt future agricultural research toward an ecological emphasis. That will be tough because powerful interests are becoming more aligned with exploitative agriculture as each day goes by. With apologies to Aldo Leopold, it will be easier to stitch alien genes into many of our major crops than to save the soils of America and the world. "It *is* easier to build a road than to think of what the country really needs," but it is not impossible.

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The Israelites and their Environment

by Nigel Pollard

The Biblical heritage has been blamed as one of the root causes of our environment crisis. But how did the early Israelites view their natural environment, and how did they change it? Why do those who make decisions persist in seeking a technological, and not an ecological solution to the present environmental crisis? One reason, undoubtedly, lies in the belief that man is separate from, and above the natural world, which is there for him to exploit, dominate and control. In that respect there has been considerable controversy over the last two decades as to the extent to which the Judaeo-Christian tradition has influenced, or even brought about such a world view.

One passage of the Bible has aroused particular interest; the first creation myth as recorded in the first chapter of *Genesis*. Here mankind is told to be fruitful and multiply, subdue the earth, and have dominion over all living things;[1] a passage to be repeated later in the *Psalms*[2]. It is possible to distinguish five major approaches that have been taken in what has come to be known as the Judaeo-Christian debate; most of which have been centred around *Genesis*.

1. Among academics, who have yet failed to perceive any environmental crisis *Genesis* is often interpreted anthropocentrically. Thus Man is given not just the right, but the *duty* to exploit the resources of nature for his own use, in order to civilize the world according to God's wishes.[3, 4] Nevertheless Maimonides, the influential mediaeval Jewish philosopher in his *Guide for the perplexed* states that dominion was not the purpose of man's creation; "but only that this was the nature which God gave to man".[5]
2. Many studies consider that the separation of man from nature, which lies at the root of our environmental crisis is inherent in *Genesis* and the Judaeo-Christian tradition.[6] Turner argues that this separation led to a view that was anti-nature and fearful of the wilderness, while Barbour suggests that the separation was a formative factor in the making of a counter-culture that actually rejected such separation. Swift and Morris have argued that separation was incorporated into, and added to, the 17th century philosophy of progress through science and technology. Perhaps best known was Lyn-White's widely reprinted essay *The historical roots of our ecological crisis,* originally appearing in *Science* magazine. White argued that the early Christian church; "not only established a dualism of man and nature but also insisted that it was God's will that man exploited nature for his proper ends".
3. Other studies find the Judaeo-Christian tradition one of the factors that may have contributed to the environmental crisis, but in general consider the Bible too ambiguous or inconclusive to make any definite correlation.[7] O'Riordan asserts that man and nature are separated entities anyway because of man's cognition of his environment: I think, therefore I am separate from nature. He therefore reduces the Judeao-Christian debate to; "part of man's seemingly infinite capacity to rationalise is his ability to fix blame, preferably on people or forces beyond his control." O'Riordan argues, via Black's thesis, that man's role is to become the rational steward of his resources.
4. Numerous studies take the view that the Judaeo-Christian tradition has no responsibility in causing any rift of man from nature, or providing any impetus for the domination of nature.[8] Among them Skolimowski asserts that the idea is a, "fundamental mistake"; Dubos, that the Judeao—Christian peoples were, "the first to develop a large-scale concern for land management and an ethic of nature." Glacken (1967a) asserts that "man as part of nature was never forgotten", and Coleman argues that it was just used as an apologetic to cover industrial capitalism.
5. Finally there has been a response from both the Judaic and Christian communities. Some of them argue that the present anthropocentricity was never a Judeao-Christian axiom; others that it may

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have been, and what is needed now is a new ecological interpretation of the scriptures.[9] Lamm argues that for centuries the Bible was seen as an impediment to scientific research and technological progress, and only now is seen as the root cause of the ecological disruption made by science. Freudenstein argues around the concept of; '*Bal-tashhit*—do not destroy' as always having provided a conservation ethic. However his arguments are weakened when he finally informs us that *admonition* is; "limited to purposeless destruction and does not prohibit destruction for the sake of economic gain." Jacobs (Rabbi) informs us that it is quite irrelevant to quote *Genesis* now as a cause, as at that time there was no problem of ecology; "quite the contrary, at the time man's problem was how to master the environment".

The Judeao-Christian debate has largely centred around whether the correlation between the command in *Genesis* to subdue the earth and have dominion over all other species, and the current environmental crisis in which the above has occurred, are in fact in a cause and effect relationship. For instance, had the particular verse in *Genesis* happened to read; "subsist on the earth, and live in harmony with all living things", would that have meant that Judeao-Christian cultures would have had an undisputed environmental tradition? Or was there something within the larger world-view of the emerging monotheism that dictated the man/nature relationship; making the contents of any specific verse relatively unimportant? This notion has been argued in considerable depth by Roszak who discusses different ways of *knowing* and *perceiving* the environment. He claims that the restricted cosmological world-view of Judaic monotheism was a necessary pre-condition for the eventual emergence of our single-vision science.[10]

The root source of the debate in question lies with the Israelites, the Old Testament, and a natural or semi-natural environment. How did a theological thesis which has aroused such controversy over its relationship with the natural environment get formed, and function in those circumstances? How therefore did the Israelites modifiy their natural environment, and what attitudes did they hold towards nature?

Milk and Honey

After their exodus from Egypt, and throughout their wanderings in the wilderness, the Children of Israel were sustained by the concept that finally they would reach the promised land; "a land flowing with milk and honey". Mentioned no less than twenty times throughout the books of the Old Testament[11], the phrase "milk and honey" encapsulates a changing interpretation of how the Israelites saw their relationship to the land. The phrase now carries a connotation of general agricultural abundance, and a highly fertile soil. In the early semi-nomadic Israelite culture the reference would have a more literal meaning: that of non-arable potential pasture land for the cattle and sheep flocks of the tribes, which would provide milk, one of the mainstays of their economy. Those same regions of natural or semi-natural landscape would also provide the habitat for wild bees, honey being the nomads' favourite sweetmeat. This combination of milk and honey is not an exclusively Biblical concept; the assoication is made in other Mediterranean and middle-eastern landscapes where cattle and sheep farming play an important role; milk and honey are combined both in Euripide's *Bachae*, and Ovid's *Metamorphoses*, as well as in middle-eastern literature from ancient Mesopotamia[12].

After the settlement of the Israelites in the promised land the nomadic pastoral way of life became increasingly a thing of the past, as a transition was made to a settled agricultural existence. As Hareuveni points out[13], a few centuries later at the time of the Prophets, when Isaiah makes reference to milk and honey[14], the association has an entirely different implication. It is now used as a warning to a settled agricultural population that their villages will be laid waste and revert to wilderness and grazing land, owing to depopulation caused by war.

Entry into Canaan

An uncritical reading of the Old Testament could lead to the assumption that as the Israelites enter Canaan, in the book of *Joshua*, their emerging world-view is based on the previous first five books of *Moses*, or the Torah. However on the basis of linguistic patterns it is now held that the first creation myth as given in the first chapter of *Genesis* was added at a much later date by the priestly writers.[15] It was the second creation myth as given in the second chapter of *Genesis* that was most likely to be known at that time, in which man was given only to name the animals. Thus it would seem likely that the early Israelites did not have any direct Biblical directive to subdue and have dominion. In fact scholarly criticism maintains that little or nothing of the so-called Mosaic legislation in the Torah may have originated from Moses.[16] Finds such as the Dead Sea Scroll Biblical Text confirmed that the Old Testament was subject to much editing and compilation.[17]

Thus a reliable record of the views of the Israelites as they entered Canaan around 1200 years before the Christian era (b.c.e.) is not known. It is considered most likely that the tribal culture was still based on earlier semitic views. The gradual emergence of a monotheistic culture was to be established in competition with the Canaanites.

Canaanite Religion

Prior to the arrival or return of the Israelites, Canaan had already been invaded by three large empires; the Babylonian, Hittite, and finally Egyptian. While the Canaanites borrowed some aspects of the material civilization from their invaders, in religion they maintained their own beliefs and mythology, representing an early agricultural religion.

The main God was El whose consort Asherah rode on her sacred animal the lion.[18] The weather was controlled by Haddu, but most important was the local deity, or Ba-al, associated with a specific area of land. As with other semitic tribes the local Ba-al would be considered in kinship with the tribe of that area. Personal names within the tribe were usually linked to

one of the Gods by some kinship terminology. Robertson-Smith considered the linkage between a clan and its deity to have been so close as to be considered a single organic whole in its function.[19] No absolute beginning or end was enshrined in the myths, nature went round and round continuously: The seasonal cycles corresponding to the birth/death, sleep/awakening of the deity. Festivals were agricultural with the main one taking place after the gathering and pressing of the grapes. This was celebrated by a wild drinking party, often leading to self-inflicted wounds in order to make a blood bond with Ba-al Berith. Hills, watering places, and some trees were particularly sacred: Shrines were usually constructed in high places with a sacred altar stone representing a male symbol, and surrounding trees, a female symbol. The priestly class consisted of sacred men and women who took the role of prostitutes; their services were sought in order to achieve a closer union with the Ba-al, thus ensuring the fertility of the soil and of cattle.[20] The remains of the Canaanite temples often show multiple deities associated with each temple, mostly of human form.[21] Bulls representing strength and fertilising power were also worshipped.[22]

The Canaanites lived mostly in the valleys and coastal regions in a number of small city states; the hills being utilized only for grazing and shrines. Part of the forested hillsides had probably been cleared by fire since paleolithic hunter-gatherer times 500,000 years before.[23] Annual grasses and legumes resistant to drought, fire, and grazing were among the first domesticated plants.[24] Jericho had for many centuries been a large city, being possibly in one of the first centres of agricultural civilization. Records of the Egyptian raids on Canaan show it to have been very productive. One raid on the important Megiddo state records a plunder taken of; 1,926 large cattle, 2,000 small cattle, 20,500 white small cattle, and 112,632 bushels of grain.[25]

The Origins of Monotheism

As the Israelites entered Canaan, most of their basic religious beliefs were probably very similar to that of the Canaanites'. Monotheism as a theological idea had been introduced, but the bulk of the population still held to the old semitic ways.[26]

Exactly where the idea of monotheism originated is uncertain. Some suggest that from the start the Patriarchs worshipped a single God[27], but it is most likely that they were polytheist or animists[28]. Inasmuch as Moses and other Israelite leaders were assimilated into Egyptian culture[29], it is most unlikely that the idea was derived from Egypt[30], as the Egyptians were polytheists[31]. Nor can the origins of monotheism be found in surrounding cultures such as the Hittites[32], Phoenicians[33], or the cultures of Mesopotamia[34], which were also polytheistic. Some aspects of the emerging religion can be explained by cultural ecology: Fish without scales were classed as unclean; suggesting an Egyptian origin, as scaleless fish are most likely to be fairly static bottom mud-dwellers, and thereby more susceptible to parasitic infection, particularly in the sluggish reaches of the lower Nile.[35] Harris has also



This 10th Century B.C. altar from Megiddo stands 22 inches high and was probably used by priests of Samuel's time for burning incense. The horns symbolise divine power; their shape may have evolved from bull figures worshipped by early Canaanites.

argued that the taboo on pigs can be explained by a cost/benefit analysis of domestic pig-raising in sub-optimum conditions.[36] Or possibly the taboo on pigs was a tribal distinction from the Canaanites who hunted and ate large quantities of wild pigs.[37] However, many facets of the emerging religion are much more difficult to explain by any scientific materialistic theory. The seventh sabbatical year in which all agricultural work was forbidden, meant that the sixth year had to supply both the seventh and eighth years since both a harvest and a sowing were lost.[38] It was also prohibited to eat the fruit from all trees in the first four seasons of their fruiting.[39] Such examples and the idea of a single God have as yet no satisfactory explanation within the framework of being a cultural adaptation to the environment.

It may be that the Bible is actually reflecting a changing ecology, rather than forcing change on account of some preconceptions. Therefore the changing environmental conditions would then be justified by a religious injunction as distinct from the environment being changed as a result of holding a certain set of original and non-traditional beliefs.

Conquest of Canaan

There are two conquest stories given in *Joshua*. It is probable that an outright conquest could not be achieved, and the Israelite tribes had to be content with occupying some of the hilly regions by clearing the forests.[40] Whilst such action almost certainly resulted in a reduction in the forested area as the settlements expanded,[41] possibly the forested area had already been reduced by fire clearance.[42] No Biblical passage attributes any intrinsic value to forested land. One often-cited verse of *Deuteronomy* states that trees should not be destroyed; "for the tree of the field is Man's life". The subsequent verse, which tends to be omitted, states that the injunction applies only to trees which bear edible fruit for man.[43] In the settling

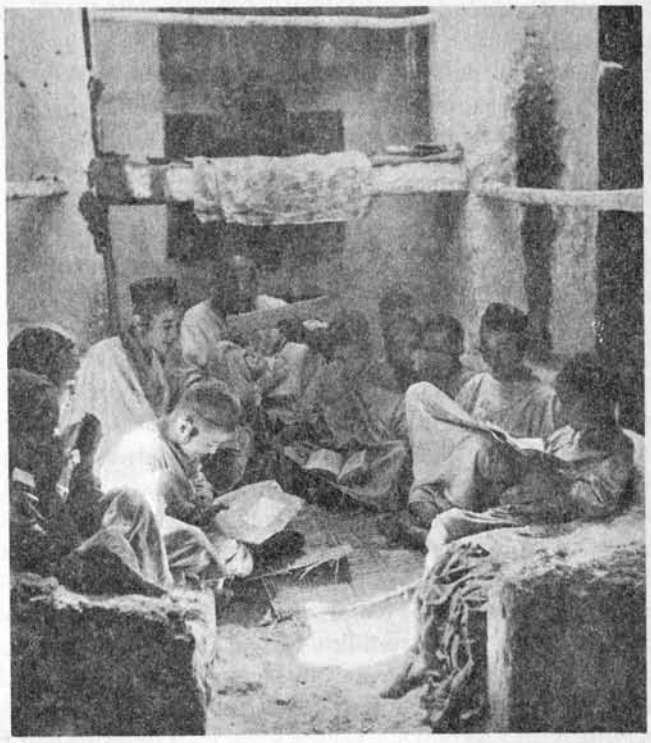
of Canaan the hills are to be deforested to provide land; "But the mountain shall be thine, for it is a wood and thou shalt cut it down"[44]. Later in Kings, in order to remove the Moabites from the land, a scorched earth policy is recommended: "And ye shall smite every fenced city, and every choice city, and shall fell every good tree, and stop all wells of water, and mar every good piece of land with stones"[45]. This verse calling for the felling of good edible trees, troubled the later sages of Judaism: it was considered that at that time the Children of Israel "descended to the lowest rung"[46].

The Israelites were able to use the hillsides by the construction of mortar cisterns for storing rainwater. This innovation was probably learnt in Egypt and enabled rapid expansion of agricultural settlements in the hillside.[47] Soil erosion, the greatest immediate danger in deforestation projects, was largely avoided by the construction of contoured terraces.[48] The southern dry region, the Negev, was also settled by using a run-off system to direct the rain-water from the hillsides to the agricultural settlements.[49]

Several verses in the Old Testament indicate that the Israelites continued with the basic agricultural techniques of the Canaanites.[50] The forefathers of the Israelites having witnessed in the Nile valley peasant families producing three times their food requirements, would no doubt have seen agriculture as a lucrative proposition.[51] The Canaanite and Hebrew tribes started a process of merging and assimilation during that period.[52]

Clearly the Israelite settlers saw that the land was bountiful and could be used for their agricultural use. The danger for emerging monotheism was that the local Ba-al would be seen as the benefactor for those Israelite tribes that had been assimilated into the Canaanite agricultural religion. Hareuveni gives an interesting interpretation of one of the steps taken to avoid such a belief.[53]

The agricultural bounty of the land came to be symbolised by 'seven varieties;' Wheat, barley, vines, figs, pomegranates, olives and honey (from crushed dates).[54] The first fruits of these products were required to be brought from all over Canaan to the temple in Jerusalem.[55] The critical period for the success or failure of those crops in the agricultural year is between mid-April (passover), and mid-June (shavuot-pentecost). The flowers of the olive, grape, pomegranate and date open, the embryonic figs begin to develop, and the kernels of the wheat and barley fill with starch. The same period is marked by sharp changes in the climate; southern winds bring hot dry weather, northern winds cold wet weather. The northern wind which is beneficial to grain crops when they are one-third ripened, and is damaging to trees in blossom, is required first. The southern wind is damaging to grain crops one-third ripened, but beneficial to trees in blossom. Tradition required that in offering the first fruits the grain crops were placed to the north, and the blossoms symbolised by an olive-oil lamp to the south. This was a symbolic representation of the desire for the winds to come at the right times for the crops. Bringing all the first fruits from the different areas to Jerusalem was thus to demonstrate that there was only one God for all the land. The selection of fruits brought and their traditional manner of offering was also a recognition that the one God was also responsible for the weather.



Young Moroccan Jews studying the Bible.

As Epstein[56] and Felix[57] point out, in conjunction with the agricultural development, a high ethical relationship to man's beasts of burden was developed. For example in both *Genesis*[58], and *Deuteronomy*[59], and also when Joseph greets his brothers in Egypt, the provision of fodder for animals takes precedence over the feeding of man. Animals employed in labour, for example an ox treading corn, were not to be muzzled.[60] Animals of different species were not to be yoked together as this would cause unnecessary strain on one animal.[61] The *Proverbs* state; "A righteous man regardeth the life of his beast."[62]



Photo: N. Pollard

Erosion takes its toll — an unterraced site in modern Israel.

The first temple was constructed in Jerusalem in 950 b.c.e. under Solomon's guidance, which required the import of cedar trees from Lebanon for its construction.[63] Worship was still conducted at the high places throughout the land. The tribal units remained intact but largely disaffiliated to each other and every man "did what was right in his own eyes".[64] Solomon himself maintained a city at the old Canaanite site of Megiddo. Much of Solomon's wisdom was based on bureaucratic knowledge and cleverness; he introduced taxation in order to pay for his large public works.[65] Omri and Ahab later created administrative districts to facilitate taxation and in order to destroy the tribal organisation and centralise royal power. Slowly tribal alliance changed to territorial or village alliance. Worship of Ba-al in the high places continued throughout the period in conjunction with Jahwah (the monotheistic God).[66] The King started to assume special importance and was promoted to be almost next to Jahwah in his power and influence in worldly affairs.[67]

The land of Canaan was conquered by the Assyrians in 722 b.c.e. who exercised a large measure of cultural influence over the population. Then towards the end of the Israelite monarchy, Isiah, and a number of other prophets warned of calamities to come, and in 586 b.c.e. an Israelite uprising occurred which resulted in the destruction of the first temple. Around one quarter of the population was transported to Babylon, thus making it difficult for the remaining population to maintain the terraces. The Jewish population at that time became divided into three groups; those deported to Babylon, those remaining in Canaan, and a large group who chose to move to Egypt.

Monotheism had yet to be firmly established. Having been warned of the forthcoming calamities by the prophets the general population at last came to interpret the misfortunes of its nation as the will of a single God, and Judaism proper was formed. The priestly class became well established with authority centered in Babylon and in Jerusalem. The second temple was constructed, that coincided with the period of Persian rule over Palestine. The priestly editors started to compile the history of their people and establish a complementary oral law.[68]

That was the period when the priestly writers may have added the first creation myth to the book of *Genesis*. Establishing man as separate from, and above, nature would serve to stamp out any last remaining tendencies to worship nature. Furthermore if the priestly writers had inserted the new version of the creation myth in order to adduce proof of Jahwah and the scriptures, it would imply that man had already 'subdued' and enjoyed 'dominion' over his environment. Therefore it can be argued that the priestly concepts of 'subdue' and 'dominion' may have meant no more than to bring existing agricultural ecosystems, and the use of animals as beasts of burdens under an ethical code. Thus with the cultural ecology theory it can be argued that the priestly writers were merely trying to justify, as well as derive proof from, a changed environmental situation. If that interpretation is correct then the change in emphasis, together with deriding the worship of idols, was to combat the adherence to Canaanite religious practices taking place on sacred hillsides.

Many writers find the transition from the polytheistic cult to the monotheism of Judaism, favourable for the ecology of the land. Ashe argues that the separation from nature enabled an ethic towards nature to be developed, whereas the Canaanites were merely restricted to nature worship as a means of survival: "By deposing nature and keeping a personal being firmly at the summit of things, Israel made its universe moral, intelligible, and purposeful; the Canaanite universe was amoral, incomprehensible and aimless."[69] In a similar vein Donald Hughes finds *Genesis:* "One of the finest descriptions of nature in all ancient literature". The ensuing concept of stewardship was a positive step forward: "The Jews conceived no evil countercreator and thus everything in nature was conceived as good in itself . . . compared with the nature cults of the surrounding peoples Judaic thought regarded the natural environment with great respect and care".[70]

Greek Rule in Palestine

Greek rule succeeded Persian rule in Palestine in 332 b.c.e. and continued until 140 b.c.e. Judaism, now firmly established as a monotheistic religion, thus remained in contact with a polytheistic ruling class. The Greeks allowed Judaism religious freedom, with few taking any great interest in such beliefs. One Greek, Theophrastus, whom Donald Hughes has called "the father of ecology"[71] held diaspora Jews in high esteem, and declared them to be a philosophical race. It has been argued that his writings show he may have had some vague knowledge of *Genesis*[72].

The cultural transmission from Hellenism to Judaism was much greater than the other way round. Many Jews particularly in the urban centres learnt the



Ancient terraces in the Judean hills.

Greek language. The Sadducees, many of whom were priests, had direct contact with the Greek authorities and thought Homer's writings to be of value. The Rabbis were increasingly opposed to Hellenisation and in the Talmud[73] stated that "cursed be the man who teaches his son the culture of the Greeks"[74]. However, under the Rabbinic code of strictly following the letter of the law, that admonition did not prohibit self-teaching and many Rabbis became well acquainted with classical Greek literature. In the natural sciences such information was often directly used in order to interpret the Torah and in the formation of Jewish law. For example Plinius describes the creation of mice by spontaneous generation from water and earth after the flooding of the Nile, a view that was apparently accepted by one contemporary Rabbi. It created a problem of how to classify a mouse, and whether touching one would incur defilement as it was made from earth. The ruling was discussed in the Talmud with the Rabbi himself claiming to have witnessed the creation of mice from earth.[75] In this instance, and in a similar one in which Aristotle gives advice as to when to mate cattle, cultural transmission rather then convergence has probably taken place.

It was in Greek Alexandria that the greatest cultural transmission occurred. Philo, a notable Jewish philosopher tried to demonstrate that both Greek philosophy and the Jewish religion were in fact parallels reflecting the same truth.[76] Influenced by the naturalistic modes of thought that were current in Greek philosophy[77], he tried to extract from the Old Testament a Biblical equivalent and proclaimed; "The Patriarchs went to no school; self-taught they loved to follow nature, for they regarded nature as the most venerable law."[78]

Such concepts also occasionally infiltrated into the views of the Talmudic sages. Rabbi Johanan: "Had the Torah not been given we could have learnt modesty from the cat, (the prohibition of) robbery from the ant, and (the prohibition of) forbidden relations from the dove"[78]. Those views were quickly countered by the other Rabbis; "The Torah has already been given so there is no need . . . It is a pity that man should have to learn from the ant."[78]

Nature was to be studied only in as far as it could further the understanding of the Torah. As Felix points out, the Bible records about 150 species of animals and 100 plants, plus many synonyms of their names.[79] Since every word of the Bible is considered to have a definite and chosen purpose, the Judaic study of the Bible can include the identification of these species, and a knowledge of their ecological relationships in order to understand their full significance. Nature was thus only approached through and in order to understand the Bible. For example Job's statement; "Let thistles grow instead of wheat, and cockle (noisome weed-*baashah*) instead of barley",[80] could lead to an understanding of plants acting as soil quality indicators: Hence the Rabbinic commentary; "The Torah here taught you a law of nature: a field that produces thistles is suitable for the growing of wheat, a field that brings forth cockle (Identified as *Ridolfia segetum*) is suitable for the growing of barley."[81]

Outside the Rabbinic circles the influence of Hellenism was even more marked. Based on extensive studies of archaeological excavations Goodenough found a large number of Greek symbols incorporated into all aspects of Jewish life. In worship, for example, many temple and tombstone remains were engraved with Greek symbols. The one God of the Jews was often maintained only by incorporating the various facets of the Greek Gods, rather than by maintaining a distinct identity.[82]



Roman Rule in Palestine

Greek rule was finally removed by the Maccabees, and Judaism had independence for eighty years under the Hasmonean kingdom. This was replaced in 63 b.c.e. by yet another polytheistic empire, that of the Romans. Later, in the year 323 of the Christian era (c.e.) Palestine made the transition to Byzantine rule.

During the Roman period Palestine underwent accelerated agricultural development, with the Nabateans now farming in the Negev, and Jewish settlement in the northern regions. It has been estimated that nearly 60 per cent of the Judean hills in the Jerusalem region were terraced.[83] In parts of Galilee, 97 per cent of the area was cultivated; either by terracing, or by strip lynchets, in which narrow fields ran up and down gentle slopes, without being contoured.[84] Providing the terraces were maintained, soil erosion did not become a major problem. Indeed, in some small areas around Jerusalem where the terraces never fell into disrepair the soils have remained intact until today.[85] Aristeas in a letter gives the following description of Palestine:

> Much labour is devoted to agriculture for the land is thickly planted with olive-groves, cornfields and herbs, vines and honey. Their fruit trees and palms are innumerable, they have animals of all sorts and plenty of pasture for them. Wherefore as they clearly saw that their country needed a multitude of people they arranged the size of their cities and villages accordingly.[86]

Agriculture was intensive with farmers owning a number of small plots, animals for labour were either hired or owned. Land was usually left fallow every other year, a normal practice throughout much of the Roman empire.[87] In the fallow year the fields would be ploughed five to seven times to control weeds and restore fertility. Including the seventh sabbatical year, this meant that fields were only sown three out of every seven years.[88] In the relatively dry areas of Palestine the main effect of the fallow was to increase the soil moisture content, which in turn facilitated nitrification.[89] Sowing took place at intervals during the winter to avoid any climatic fluctuations affecting the entire crop, and to stagger the harvest. Yields were reported to be in the region of a one to thirty to forty return, with in exceptional years a one to one hundred return.[88] Fertility was maintained by enclosing cattle on the plot after the harvest, and by applications of compost, as mentioned in the Talmud.[90]

The Jewish population throughout the Roman empire swelled during that period, and in Palestine is thought to have reached three million, or according to Flavius Josephus five million (including Transjordan).[91] By comprising some ten per cent of the population in the Roman empire the large Jewish population is thought to have caused concern to the Roman authorities. Uprising in Palestine precipitated the Roman-Jewish war which resulted in the destruction of the second temple in 70 b.c.e.[92] Whereas the Greeks and Romans practised various measures of family planning, the Jews did not.[93] In fact the command in *Genesis* to be fruitful and multiply forms the first of 613 *Mitzvot* or commandments from the Torah which all Jews should try and fulfill.[94]

After the destruction of the second temple, and the Bar-Kokhba rebellion the oral law was compiled and written into the Mishna and Talmud. That is often seen as a response by the Rabbinic authorities to impose control and direction on a society which was in the process of disintegration.[95] It also served to give a more liberal interpretation of the agricultural laws of the Torah, which in practice were found very difficult to realise. The new meaning enabled agriculture to continue under difficult circumstances.[96]

After a period of intensive agriculture and high yields, the agricultural situation declined as in other parts of the Roman Empire. That may partly have resulted from top-soil loss, because of soil erosion from the terraces, that had been neglected during the periods of war. The primary cause was the high taxes demanded by the Romans to support their bureaucracy and building projects. Many of the middle-classes and prosperous land owners sold up and left the country; others were forced to sell and become tenants on their own land. The changing situation was reflected in Rabbinic sources, one Rabbi declaring: "There is no profession more degrading than to work on the land"[97]. With the intensive settlement pattern shepherds were also forced to move away from the populated areas in order to find pastures for their flocks. In his commentary on the famous *Psalm* "The Lord is my shepherd I shall not want"[98] one Rabbi commented; "There is no more lowly and despicable vocation than that of a shepherd who must all his life trudge along with his staff and satchel"[99]. Others warned against the movement from land to city and the search for quick profits.[100]

With the consolidation and compilation of Rabbinic literature a clearer view of the attitude to nature becomes apparent. A major indication was the relative omission of the role of nature in any discussion. Little praise can be given to nature itself as that would imply neglecting the creator and source of nature. Thus Rabbi Akiva in the Talmud merely resorts to quoting *Psalm* 104:24, "How mighty are thy works O'Lord"[101]. In fact the aesthetic appreciation of nature was played down, "He who walks by the way studying, and interrupts his studying by saying; "how pleasant is this tree, how pleasant this ploughed field . . . it is as if he was deserving of death."[101]

It is clear from the Biblical commentaries (*Middrash*) that all of nature is there for the benefit of man:

> He has not created a single thing in vain. Sometimes He achieves his purpose (for man) by means of a frog, sometimes by means of a hornet, and sometimes again by means of a scorpion.[102]

The same idea is found in folk-lore sources:

> Whatever God has created has value for man, thus even animals that at first sight seem useless and noxious have a vocation to fill: the slime of snails therefore serves as a remedy for boils, the sting of a hornet is healed by crushed house-fly heads.[103]

Since every species has such a direct and beneficial use for man this notion could serve as the underlying basis for a conservation ethic. At the same time it excludes the concept of an ecosystem in which all species have a value to the ecosystem, with man being just one part.

Not that this was an entirely Judaic mode of thought during that era. The Roman, Cicero, having spent a number of years studying the Stoics in Rhodes, came to the same conclusion in his *The Nature of the Gods.*

> All this abundance of nature has been provided for the sake of men (possibly Gods also) . . . The animals far from being partakers of this blessing were themselves obviously made for the use of man . . . of what use would sheep be except for wool? . . . what is the pig good for except to eat? . . . Let your minds eye sweep the whole earth . . . in its dark depths many useful things lie hidden, which having been made for man, can be discovered only by man.[104]

Despite the anthropocentricity of Judaism, the same authorities also required a high ethical standard which restricted any excesses. These ethics, while centred on man's relationship to fellow man, also had some application to the rest of God's creation. During the time of the second temple, taking the life of animals was considered a crime. If an animal was to be destroyed a court meeting was required and a judgement passed. The slaughter of animals was under Rabbinic supervision. Even for the death sentence to be passed on a wolf, lion, leopard, hyaena or snake that had killed a human-being required a court sitting of twenty-three people for a judgement to be passed, according to the Talmud.[105]

In the commentaries on *Genesis* the Rabbis reminded that the word for to 'have dominion' contains the same root letters as the word for to 'go down': "The

choice is left in man's own hand. If you maintain your heaven-born dignity you will have dominion over all things, if not, you will descend to the level of brute creation"[106] Heaven-born dignity clearly refers to observing the ethical code and commandments such as; "Thou shalt not kill", which itself restricted the sphere of dominion.

This general view point is reflected in the early periods of Judaism. They changed and modified their environment from natural or semi-natural landscapes to intensive agricultural ecosystems. Beyond this there is no evidence that they caused a major ecological deterioration in the region. Since all truth, past and present, and future was contained within the Torah, this became the subject to study and develop: The Torah gave no impetus for scientific or technological advancement.[107] In fact it was the polytheistic Greek and Romans who were the forerunners in technological developments[108], particularly the Romans with advanced hydraulic technology.[109] Not surprisingly those countries suffered from ecological disruption.[110]

In later centuries after the bulk of the Jewish people had left the land, Palestine also suffered severe environmental degradation. The population became insufficient to maintian the terraced hillsides that in itself leading to very heavy soil erosion. Indeed some twenty foot of topsoil was found covering the old Roman sites in the valleys. It has been estimated that somewhere between 2-4 x 10^9 cubic metres of soil was lost from the Judean hills alone[111]. Archaeological excavations of the village sites in the Judean hills indicate that in the higher and middle regions of the hillsides 77 and 67 per cent respectively of the villages were abandoned compared to the number of today's settlements. In the valley regions the figure drops to eleven per cent.[112] Similarly what remained of the forested areas were cut down during the Ottoman period.[113]

Conclusion

The theological idea of monotheism was established over a period of some six hundred years in competition with a nature-worshipping polytheistic cult. The greatest danger to the emerging religion was that the people would continue to see nature as something sacred, and thereby worship it. Nature therefore had to be de-sanctified, which was achieved by the writings of the priests, rather than by any divine revelation. From this new perspective nature was seen in purely ethical terms. With the consolidation of Judaism there remained a danger of cultural infiltration from the polytheistic ruling classes. Some naturalistic infiltration occurred, but in general a strong Rabbinic influence was exerted to keep nature in a secondary and subsidiary role. Under the ethical code of the new religion the natural environment was highly utilised for man's needs. However, major ecological degradation was avoided, as there was no impetus for technological manipulation of the environment; that being part of the other-worldly facet of Judaism and the limitations of the Biblical concepts.

The examination of this early historical period reflects many of the arguments put forward in the Judaeo-Christian debate. Those who view man as a rational steward of his environment, with an ethical approach to conservation, and professional management using the latest techniques, can find much support in Judaic tradition. Those who reject the basic thesis that man is separate from, and above, nature and rather take an ecological perspective of the total environment, thus seeking an ecological and not a technological solution to present day environmental ills, will see in Judaism an unacceptable attitude to technology and the environment.

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Books

MISGUIDED INVESTMENT

DEVELOPING ELECTRIC POWER; THIRTY YEARS OF WORLD BANK EXPERIENCE, Hugh Collier, The John Hopkins University Press, Baltimore, 189 pages, 1984.

This book was produced for the International Bank for Reconstruction and Development, in other words The World Bank. Its most striking feature is its lack of concern for the social and environmental effects of generating electricity. Only three paragraphs are devoted to this essential issue; they are worth quoting in full.

"One of the most important changes of the past two decades to affect attitudes toward economic growth has been concern for the environment. Most economic activities affect the environment in one way or another, and some can have significantly detrimental effects unless specific measures, which usually cost money, are taken to avoid them. The possible environmental effects of development projects are now investigated as part of the Bank's appraisal, and an Office of Environmental Affairs is responsible for providing expertise and devising guidelines for handling environmental problems.

"The economic activities which have the most impact on the environment are industrial and mining development and urbanization. Power projects, however, can also have environmental effects: thermal power stations can cause air pollution, and the water from the cooling process can effect life in the bodies of water into which it is discharged. These can normally be taken care of without too great a cost. Hydro projects are often fairly "clean", although the reservoirs they sometimes create can contribute to the spread of water-borne diseases if preventative measures are not taken.

"One potentially serious problem is the necessity to relocate the inhabitants of areas which will be inundated by a hydro project. The involuntary resettlement of people can give rise to many socioeconomic problems, particularly if whole communities are to be relocated in unfamiliar surroundings. In some of the Bank's early operations these problems were not well foreseen or planned for and created a great deal of difficulty. Since then the problems of resettlement have been the subject of sociological research, and the implications are better understood. In the past decade resettlement has been handled effectively in many instances with a minimum of danger to the well-being of the people concerned. One of the first was the Paulo Alfonso hydro project in Brazil, which involved the relocation of some 10,000 people. Detailed plans for resettlement were an integral part of the design of the project, and the Bank's agricultural staff reviewed the progress of this program. A great deal was learned from this experience which was used to good effect in other cases such as a water supply project in Ghana and a hydro project in Thailand. In 1980 the Bank prepared an operational memorandum for its staff covering all aspects of involuntary resettlement programs."

Needless to say, even what the Bank has published is very misleading. Indeed the above extract could even be construed as being *designed to mislead* in order to justify the Bank's totally irresponsible policies. Thus it is misleading to say that thermal power station *can* cause air pollution. The Bank should admit that thermal power stations do cause air pollution unless vast sums are spent on scrubbers that few Third World countries can afford—indeed which America, the richest country in the world, appears unable to afford.

It is misleading to talk about the reservoirs which hydro projects "sometimes create". A reservoir is an essential part of a hydro project. Such projects, we are told, can contribute to the spread of water-borne diseases "if preventative measures are not taken". In fact, in tropical areas, these schemes *inevitably* contribute to the spread of water-borne diseases, and preventative measures, which are rarely taken, have never succeeded in controlling them.

The Bank then tries to imply that the problem of resettling people whose villages and towns have to be flooded to make way for a vast reservoir has now been solved. This is totally false. The resettlement problem is, if anything, worse today than it was twenty years ago. The world is becoming an ever more overcrowded place and when several hundred thousand people have got to be resettled there is almost never a suitable place to which they can be moved. If any area is uninhabited in most of the dry hot countries where large dams are being built today, it is because such areas are in fact *uninhabitable.* Moreover, as Third World countries get further and further into debt, less rather than more money is being made available for resettlement. The one and a half million people, who are to be resettled as a result of the Mahaweli Scheme in Sri Lanka, for instance, will be given a pittance to finance their proper resettlement (£90 per family). They will then be moved from the fertile humid zone in the Kandy area into arid, infertile and malaria-infested areas.

No mention is made by the Bank of all the other terrible social and environmental costs of building large dams in hot dry areas—such as the flooding of valuable agricultural land and forests; the annihilation of the local wildlife; and the premature siltation of reservoirs which, in the Indian experience, have silted up between 3 and 17 times faster than predicted. Nor does the Bank mention that by financing massive hydroelectric schemes—and a considerable proportion of the money lent to the Third World is for this purpose—they have severely exacerbated the global problems of poverty, malnutrition and disease.

Edward Goldsmith

METICULOUS CONCERN

THE ETHICS OF ENVIRONMENTAL CONCERN by Robin Attfield, Basil Blackwell, Oxford, 1983, £17.50.

The treatment of environmental issues by academic philosophers may give rise to two contrary responses in the minds and hearts of ecologists. On the one hand, we may welcome the sophisticated and minute analysis which is part of the philosopher's expertise, for this can undoubtedly contribute to our clarity when thinking about these issues. On the other hand, we may feel a certain unease that these issues, once they have crossed the academic threshold, seem to take on an artificial existence in the learned journals, and books such as Robin Attfield's *The Ethics of Environmental Concern.* Sad to say, this finely reasoned volume, gloriously freckled with footnote numbers referring to most of the important philosophical texts that have been written on the subject of environmental philosophy to date, is likely to be inaccessible to those who have the most lively concern for the problems it discusses. As a contribution to the debate amongst academic philo-

sophers, however, its value will be widely acknowledged. Next to John Passmore's *Man's Responsibility for Nature*, which this book supercedes, *The Ethics of Environmental Concern* will be essential reading for students of environmental philosophy.

The first half of the book is devoted to an examination of Western religious and philosophical traditions, with a view to establishing upon their basis an environmental ethic appropriate for dealing with contemporary ecological problems. Attfield gives a cogent defence of the Judaeo-Christian tradition, which is so often accused of encouraging an anthropocentric and despotic attitude towards nature. While it is true that the creation doctrine removes from nature the glow of the numinous, this is more than compensated for by God's well documented love of the world. Again, the doctrine of dominion by no means necessarily implies an exploitative attitude towards creation, but has always been closely associated with the belief that we have been entrusted, as stewards or caretakers, with duties and responsibilities towards nature. Although the doctrine of dominion has been used as a justification for the exploitation of natural resources and the maltreatment of other creatures for human ends, this is a misrepresentation of the true concept of dominion which should always be complemented by the idea of stewardship.

Having thus exonerated the Judaeo-Christian heritage from culpability for fostering anti-ecological attitudes, Attfield proceeds to a somewhat half-hearted defence of the philosophers of the scientific revolution—particularly Bacon and Descartes. Through the employment of one of two isolated and uncharacteristic quotations, they appear as surprisingly innocuous—even benign—figures in the history of environmental philosophy, while by the same means Thomas Aquinas himself an early advocate of the natural rights of plants and animals—is unfairly saddled with an instrumentalist view of nature. This is, in my opinion, the weakest part of the book, where Attfield's pro-modernist prejudices colour his appraisal of the true contributions of past philosophers. According to Attfield, the real culprit responsible for our falling our of harmony with nature is the idea of progress, the development of which he traces from its origins in Enlightenment thought, through the evolutionary philosophy of Spencer and the social and economic theories of Marxism. While Attfield is right to condemn the belief in material progress as having contributed to our current ecological demise, his overcautious and apologetic treatment of the philosophical tradition underlying the modern scientific outlook means that he does not seriously tackle the metaphysical causes of this demise.

The second half of *The Ethics of Environmental Concern* is devoted to the construction of an environmental ethic on the basis of a modified utilitarianism. Here Attfield is clearly in his element, confidently and painstakingly reasoning his way through a plethora of possible ethical positions, but it is in this part of the book that the non-philosophical reader is likely to lose patience with his excessive meticulousness. This is unfortunate because Attfield arrives at some very sane and welcome conclusions. Not only does he regard all nonhuman sentient creatures as worthy of moral consideration, but he also insists on the moral status of non-sentient living organisms, for they too have needs and interests which can be furthered or harmed by our actions. Nevertheless, he stresses that while we must respect the intrinsic value of each creature realizing its own good, we have also to acknowledge that creatures with greater potentialities take moral priority over those with lesser when the exercise of the former's higher capacities is at stake. At the same time there will be circumstances when the intrinsic value of nonhuman creatures must preclude possible actions by us which bear little relevance to the fulfilment of our essential capacities.

In regard to the pressing problems of resource depletion and environmental pollution, Attfield advocates that we adopt as our moral standard the principle that each generation is obliged to leave to future generations that same amount and quality of resources as were left to it, with technological improvements to match the destruction of non-renewable resources. In relation to population growth, he emphasises the need to stabilize world population levels, while arguing strongly against the view that each additional human life is the curse that some ecological writers purport it to be. Environmental ethics must be built on the principle that the value of an ecosystem resides in the value of the individual creatures that compose it; to make the beauty or stability of the ecosystem itself the supreme good would be to take holism down the road of eco-fascism.

Whether or not such ethical principles are, as Attfield claims, extrapolations from Western religious and modern philosophical traditions is debatable. I am inclined to agree that the kind of moral outlook Attfield proposes is compatible with the Judaeo-Christian tradition, but the appeal of much of his modified utilitarianism—though Attfield would not wish to admit it—largely resides in the extent to which it breaks with the empiricist traditions of modern philosphy.

Jeremy Naydler

INSULATING AGAINST ENERGY LOSS

ENERGY AND SOCIAL POLICY, edited by Jonathan Bradshaw and Toby Harris, Routledge and Kegan Paul, London £6.95.

Billed as the first book devoted entirely to the social aspects of energy policy, *Energy and Social Policy* should appear on the shelves of any self-respecting energy library. But, while the book is well put together and for the most part easy to read, its subject, as its editors admit early on, remains very much a minority interest.

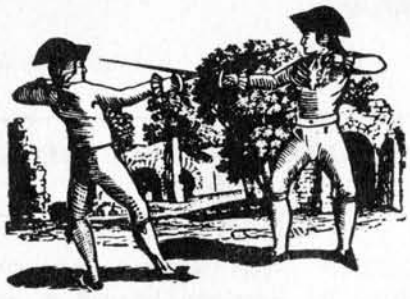
Rising energy prices have resulted in increased human misery, with the poorer members of our society generally spending a much higher than average proportion of their income on energy—and locked into buildings and equipment which, in energy terms at least, is highly inefficient. In some ways, the book can be seen as a manifesto for social scientists working in the energy policy field. Interestingly, while some sections may only be of real interest to social scientists, the central thrust of the book is highly compatible with the analysis of the energy prospect developed in successive issues of *The Ecologist*.

At worst, rising energy prices may result in death, with the aged and infirm dying from hypothermia and similar conditions, but health problems are only part of the picture. There are also the many problems associated with debt and disconnection, for example.

Ultimately, however, the problem has got to be tackled at its root. "While income maintenance measures and more flexible payment methods are all essential in a package of policies to mitigate the problems people have in meeting their fuel bills," the editors conclude, "they cannot be fully effective until everyone lives in an adequately insulated and efficiently heated home. Conservation and insulation measures must therefore be a priority."

A strong plea is made for a comprehensive direct insulation programme along the lines of the North Sea gas conversion programme, with the underlying analysis covering a good deal of familiar ground. But it is reassuring that even a small number of social scientists are actively working on real-world problems associated with the energy transition.

John Elkington



Letters

Nandy's Humanism

Dear Sir,

Ashis Nandy's excellent analysis of "The Pathology of Objectivity" has only one fault which is pointed out by one of the illustrations provided by "The Ecologist": the rat shown as "a victim of scientific objectivity" in this Orwellian shot taken from inside "little brother's" cage has not been considered worthy of any mention by Mr Nandy who limits his vision to human victims alone. Surely the animal world has a just claim to being given a prominent place in any study of the schizophrenia of science. Objectivised human beings only form the tip of the iceberg created by the pathologically split scientific mind: the huge mass of living beings frozen by science into objects are non-human. If we want to melt the iceberg and cure scientists of their disease, we have to start at the bottom which is where the animals are. We cannot by-pass them without getting off the track.

Yours faithfully,
Godofredo Stutzin,
Santiago, Chile.

No Ecological Defence Policy Without Deindustrialisation

Dear Sir,

Congratulations to Edward Goldsmith for putting forward "An Ecological Defence Policy for Britain", and to John Seymour for his interesting contribution to the theme. There are a number of merits to the idea of basing national defence on preparing all citizens to wage constant guerilla warfare on any invader. This would be very cheap. It would be a purely defensive system and therefore no threat to any other country. It would revive community responsibility, loyalty and participation, since individuals would be preparing for the direct defence of their own families and neighbourhoods and it would be invincible. No amount of enemy troops or hardware could function effectively if the entire subject population were prepared to resist and had been carefully trained and equipped to do so.

But there is a snag. This strategy is without doubt the one we could adopt after we had begun the great transition to a just and ecologically sane world, but it is a serious mistake to think that any rich nation could adopt the strategy now. The defence of our present way of life is not possible unless we have a massive military machine capable of securing the foreign sources of our affluence. *The rich nations cannot go on enjoying material living standards about 15 times those of the poorest half of the world's people if they do not keep in place the unjust global economic structures that enable them to grab most of the world's resource output, if they do not go on using much of the land and labour and capital of the Third World to produce luxuries for us (perhaps 40 million acres in hungry countries grows coffee and similar luxuries for export), and if they do not continue to prop up brutal dictatorships willing to keep their countries to a development model that mainly benefits us.*

We cannot expect to achieve a just and peaceful world unless we shift to ways of life that will enable us to live on far lower levels of resource consumption per person. I have no doubt that such a shift could be made without difficulty, while actually raising the quality of life.

It is crucial that those who want to see a peaceful world and those who want to see an ecologically sound world should come to terms with this issue. We cannot disarm and stay affluent. The Goldsmith defence strategy only becomes a possibility if we have first accepted the need for fundamental social change to a "de-veloped" society.

Yours faithfully,
Ted Trainer,
East Hills,
NSW, Australia.

Population a Vital and Neglected Factor

Dear Sir,

Colin Hines and Barbara Dinham's survey of the activities of agribusiness in Africa was in most respects commendable. First hand experience of what is happening in Kenya convinces me of the accuracy of their findings.

However, the authors overlook one vitally important factor in the per capita decline of food production that is affecting much of Africa. To me it is a glaring omission that population growth rates in the continent (for e.g. Kenya's is roughly four per cent per annum) are not even mentioned.

All of the charges levelled against Northern agribusiness—the big transnationals—surely stand. But it is not possible to place the responsibility for Africa's continued high birth rates—which parallel the various successes of 'death control'—at their doorstep. Even without neo-colonialist pressures on African agricultural land, it is highly debatable whether the subsistence farmers of the region would have succeeded, over the last twenty years, in keeping pace with increasing food demands.

The authors could also have referred to such other aspects of Africa's current crisis as the disastrous climatic disruptions of agricultural production over the last decade, and to that proportion of the soil erosion in the continent that is a direct result of deforestation by fuel-hungry rural populations. But it is chiefly the neglect of the population factor that I feel to be the main gap in an otherwise sound analysis of a terrifying problem.

Yours faithfully,
Bryan Cunningham,
Lecturer in Geography,
City & East London College.

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International Conference on ARCTIC WATER POLLUTION RESEARCH:—Applications of Science and Technology, will be held at Yellowknife, Northwest Territories, Canada from 28 April to 1 May 1985. Deadline for submission of abstracts (maximum 250 words) of papers to be considered for presentation is 1 September 1984. For details write to: K. Charbonneau, Conference Services Office, National Research Council of Canada, Ottawa, Ontario K1A OR6, Canada.

DIARY DATES

CO-OPS FAIR 1984 on Saturday 28 July and Sunday 29 July at Beechwood College, Elmete Lane, Leeds 8. The organisers are all members of workers' co-ops or housing co-ops. Please write for programme and details to Jillian Roose, Co-ops Fair 1984, c/o Dennis Central Housing Co-op, 29 Bracken House, Watts Grove, London, Bow E3.

Education for Peace SUMMER SEMINAR will be held from 15-21 July 1984 at the International People's College, Helsingør, Denmark. For details write to: The International People's College, Montebello Alle 1, DK-3000 Helsingør, Denmark.

The Soil Association of South Australia are organising The ADELAIDE FESTIVAL AND CONFERENCE from 1-4 November 1984 in Adelaide, Australia. This year's theme is 'Healthy Food from Healthy Soil'. Write for details to Hon Secretary, Soil Association of South Australia, Inc GPO Box 2497, Adelaide, SA 5001, Australia.

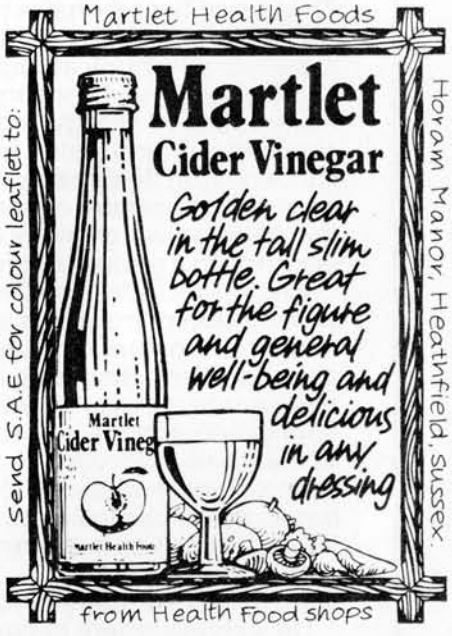
A seminar RURAL DEVELOPMENT AND CONSERVATION—New Approaches, will be held in conjunction with Landscape Research Group from 5-7 November 1984 at the Peak National Park Study Centre. For more information contact Peter Townsend, Principal, Losehill Hall, Castleton, Derbyshire S30 2WB.

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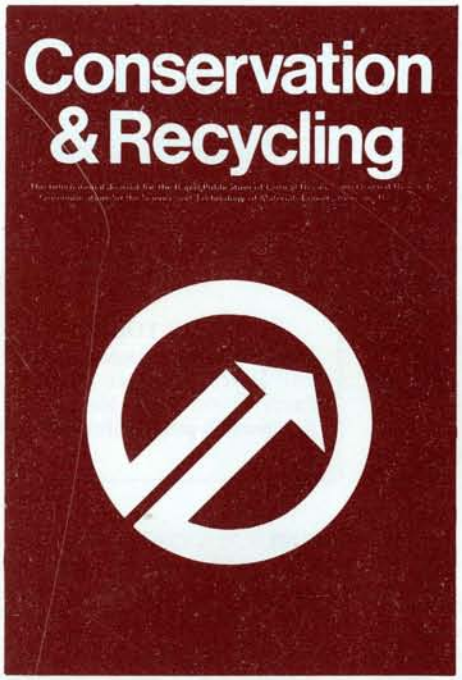
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Editors: M B BEVER, *Department of Materials Science & Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139, USA* and M E HENSTOCK, *Department of Metallurgy and Materials Science, The University of Nottingham, NG7 2RD, UK*

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Utilization of incinerator residue in concrete, JOO-HWA TAY *et al.*

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