RESOURCES & TECHNOLOGY

# sustainability

EALAND IN
UTURE WORLD

# NEW ZEALAND IN THE FUTURE WORLD

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# INTRODUCTION

The series of booklets *New Zealand in the Future World* cannot predict what will happen in the next 30 years. Its aims are far more challenging. The 3 booklets to which this is the common introduction attempt to set the basis for a public discussion about New Zealand's future. To do this, they try to identify the most important changes taking place in the present, and to use this knowledge to outline possible pathways for New Zealand to follow. This entails 2 quite different ways of looking at the future. In one, attempts are made to understand the changes the future may bring by observing the thrust of current trends. In the other the attempt is made to design alternative visions of New Zealand's future. It is a difference between what one *expects* might happen and what one would *like* to happen.

Each booklet in this series explores particular issues in depth, looking first at the world scene, and then at New Zealand's opportunities and choices. International relations, economics, trade, energy resources, agriculture, industry, technology, social services, institutions, and lifestyles — it is important that we examine each of these in turn. However, it is even more important to remember that each is but one link in the complex web of society. A change in one area will initiate change in many of the others. The choices we face in shaping the future of New Zealand are similarly linked. A particular choice in one area will define our options in many of the others. Ultimately our choices must be made within the context of the type of society we wish to create.

In recent years vision making about the future has become particularly fashionable. Why? In the late 1960s and early 1970s many began applying the principles of ecology to man's relationship with nature. Research had shown that natural resource limits constrained the growth of other animal populations, and hence many became concerned that unless man's patterns of rapid growth were constrained, crisis would result. Growth in world population, growth in the consumption of energy and materials, and growth in both the number and quantity of pollutants were all identified as potential triggers of crisis. Thus in 1974 Theodore Gordon identified five possible future world crises: deterioration of the biosphere, severe food shortages, material and energy shortages, imbalances in the distribution of wealth, and nuclear war.

The "biosphere" is the mantle of soil, water, and air which supports life on earth, and its health is threatened by pollutants (for example, chemicals and heat), together with over-use (over-fishing, over-grazing, etc.). Unless the long-term productivity of the biosphere is protected, our future supplies of food, clothing, freshwater, and clean air are in danger. Perhaps one of the most controversial and potentially far-reaching threats is that of a change in global climate. Two contradictory trends are causing concern. The first is a warming trend, triggered by man's burning of fossil fuels, which creates both heat and carbon dioxide ($CO_2$). $CO_2$ can trap heat within the earth's atmosphere, creating the so-called "greenhouse effect". The second trend is the cooling trend, which may be associated with changes in solar activity. The interaction of these two trends is a continuing source of controversy among scientists.

At present the earth produces abundant food, yet millions still go hungry in the poorer developing countries. This problem seems likely to continue as population growth outpaces what poor countries can produce for themselves or afford to buy. The problem of maldistribution of supply is compounded by threats to the long-term productivity of the biosphere. Pollutants and over-use are already taking cropland out of production, and changes in climate (locally, regionally, or globally) could have disastrous effects on crop yields. The future will probably bring more death from starvation and increasing malnutrition.

In addition to food shortages, many predict shortages of energy and materials. Man's current dependence on coal and oil cannot be sustained because these fossil fuels were formed millions of years ago and cannot be replaced. And, as we have seen, we may be threatening our own climate by burning them. In the future, solar energy and other renewable sources will become more important, and the technologies for their use are already being developed. Nuclear fusion, too, may be economically feasible by the 21st century, but it will be neither cheap nor lacking in its own particular problems. Rising energy costs will in turn make food more expensive than many people can afford to buy or produce themselves.

On the shortage of minerals there are two schools of thought. One believes that technological advance can be relied upon (as in the past) to provide minerals from ever-leaner ores, and eventually to produce substitutes for scarce minerals. The other argues that rising energy costs will constrain this pattern, and that we should reduce our consumption of minerals and recycle that which we do use. Even if there prove to be no absolute mineral shortages, the resource-rich developing nations of the world may realise the importance of their minerals to the industrialised nations and begin controlling prices or limiting supply as did OPEC. Poor countries may decide not to export their minerals but to conserve them for their own development.

World imbalance in the distribution of wealth may be a growing source of international tension. The wealth gap between the rich and poor nations has continued to widen over the last 20 years, and rising energy prices, mineral scarcity, and food shortfalls will aggravate this trend. Many people feel that it is not a question of "whether" but "how soon" the poor countries will challenge the rich for a fairer distribution of resources.

Growing international tensions such as these lead many to fear that the future will bring further global and regional wars. Some see it resulting from confrontation between China and Russia, others as the result of tension between smaller countries. Indeed it seems that the only way man might avoid further wars is by comprehensive disarmament, which in turn would require some form of world government.

We have reviewed briefly five crises which the world faces. All five are interdependent, for each is a part of the growing tension which results from increased human pressure on natural resources, and the inequalities in the distribution of those resources. Each crisis is *international* in dimension, having the potential to involve every nation of the world, including New Zealand. All nations must therefore think about these future crises when deciding their national policies on alignment, trade, and aid.

Not all futurists take such an international approach to the future. While agreeing that the world is at a critical phase in its history, many feel that it is also important to look to the changes taking place within societies. In the industrialised nations these changes are fundamental. One member of this group, Daniel Bell, has coined the term "post-industrial" to describe a new society which is emerging. Most futurists agree that the following five trends are important in bringing about post-industrial society:

(1) Industrial societies are very complex. To cope, their social and economic institutions have become very large. It is increasingly difficult for individuals to influence decision making in ways other than as members of large organised groups.
(2) Work and production patterns are being transformed, particularly by new technologies, but also by the changing role of women and the rising prices of many resources.
(3) Complexity and change are giving rise to a group of highly educated powerful experts who formulate social and economic policy.
(4) The demand for and role of education is being increased constantly.
(5) Social values and goals are changing. A new concern for "quality of life" is evident in the developed world.

People differ in their visions of the type of society which should grow from this transition. Some envisage a "superindustrial" way of life, in which advanced science and technology become the central pursuit of society. The continued development of high technology will enable man to overcome any resource limits on wealth and population growth. Technologies like space colonisation, genetic engineering, and nuclear fusion energy will be important in this pursuit. Information and knowledge will thus become central to society, and consequently an intellectual elite will emerge as the new upper social class. The complexity of this society requires the development of a large and centralised political system, whose prime objective is to ensure the continuation of growth, while controlling inflation. The need for efficiency and planning in all spheres of life leads to gigantism and centralisation of all institutions, business, and pressure groups. This vision of society entails an acceleration of existing trends, and many futurists consider its large-scale features to be necessary for the solution of complex national and international problems.

The second view of post-industrial society is based on a belief that the important new frontiers are no longer technical but social. Post-industrial society should be concerned with the development of people, and hence technological advance should be directed more toward providing people with the means of self-development. Futurists like Hazel Henderson feel that economies must decentralise. They envisage the strengthening of small communities and the development of technologies which are small-scale, resource conserving, and environmentally benign. Quality rather than quantity of material goods and services becomes important. Small-scale development will humanise the workplace, community, and government, thus counteracting the growing feelings of personal alienation and powerlessness.

This second vision calls for a change in the direction of society. The new society envisaged is considered more appropriate for a world facing the five crises we outlined earlier. New attitudes toward material wealth in the rich nations might improve the development chances of the poor, while greater emphasis on human needs and human interaction would improve co-operation within and between nations.

Where does New Zealand stand in a world beset by crisis and in the midst of change? Potentially New Zealand is in a very strong position, but a changing world does present us with challenging questions about our future.

From the viewpoint of resources New Zealand is well placed. Although our oil import bill is currently very high, our endowment of energy resources per head is one of the highest in the world. We have the potential to become self-sufficient in energy, not only in electricity production but also in transport fuels. Hydro-electric capacity could be tripled if all sources were developed (although there are good reasons for leaving some rivers untouched), and the potential for geothermal generation of electricity may be about six times that of existing geothermal stations. We could alternatively use our geothermal steam directly in industry or district heating schemes. A recently discovered coalfield in Southland contains 4,400 million tonnes of coal. How should we best use this precious resource? Burning it to produce electricity is wasteful, so we may choose instead to use it for the manufacture of synthetic petrol, or as the basis of new petrochemical industries. Similarly our natural gas has many possible uses, including the production of methanol to extend and then replace petrol. But natural gas and coal are fossil fuels, and therefore will not last indefinitely. New Zealand must begin now to plan for a sustainable society based on renewable energy sources only, and here we are particularly well endowed. We already know how to manufacture transport fuels from trees and crops, and technologies for the use of wind, wave, tidal, and solar power are advancing rapidly.

New Zealand grows trees and grass well, our good climate compensating for the low natural fertility of our soils. Whereas the latter requires us currently to import large quantities of phosphate, advances in the technology of undersea mining may allow us to mine our own phosphate from the Chatham Rise. Agriculture will continue to be one of our strengths, and with our population expected to rise slowly to around 4 million by the year 2010 we can be self-sufficient in food for decades to come. Our food surplus for export should be of considerable value in a world beset by hunger and malnutrition. However, we currently sell our food primarily to luxury markets. The potential for expansion of those markets seems hopeful, especially with horticultural and processed foods. But what should be our response to the poorer nations? How can we help them to either produce or buy sufficient food for their needs?

Further resource opportunities have arisen with the declaration of our 200 mile economic zone, the fourth largest in the world. Its fish populations are as yet largely unexploited, but will be of increasing interest to nations whose traditional fishing grounds are becoming depleted. How should we strike the balance between husbanding this resource ourselves and allowing other nations access?

Our forestry resource, too, is extensive, and could feed a variety of industries, ranging from pulp and paper mills, liquid fuels and other chemical manufacture, to building materials and high quality furniture. Our choices on these and other industry options will be shaped by our views on their energy and pollution costs, and by potential markets overseas.

So New Zealand is in a good position with respect to world energy, material, and food shortages. In addition our isolation protects us from regional problems of biosphere deterioration. However, for problems of global magnitude (climate change, ocean pollution and nuclear fallout, for example) we cannot isolate ourselves, and may need to find ways of protecting the productivity of our land and water.

How do we stand with respect to international tension and the possibility of war? Our possible involvement in wars will continue to be shaped by our foreign policy. It may be prudent to continue alignment with one of the major powers, or alternatively to take advantage of our distance from the likely centre of war and develop an independent, non-aligned stance. Should we also attempt to be less dependent on the rest of the world for trade? Greater reliance on our own resources might in turn require inputs of overseas capital and expertise in their development. How do we feel about further foreign investment in New Zealand? What is our role in the Pacific region? Perhaps we should look closer to home for new export markets and for developing nations whom we can assist. In all these issues we should consider how best we might contribute to the solution of the five international crises facing the world.

In the social sphere our choices have a greater degree of independence from world events. We must decide how to take advantage of the opportunities presented by the "post-industrial society".

How should we respond to the growth of central government and the increasing size of our institutions? We can choose the extent to which power is devolved to regional and community levels. We could also decentralise our health, education, and welfare services in an attempt to revitalise community life.

How can we use changing work and production patterns to avoid a pool of permanently unemployed people? We can turn automation to our advantage by developing service industries like education and research. We can foster new attitudes towards "non-work" by creating an exciting "age of leisure" and we can encourage people who wish to establish alternative "small-scale", craft-based industries.

How should we respond to the increasing power of experts and specialisation? By encouraging semi-professional support workers in health and education, for example, some of the monopolistic power of the professions could be taken away. The fostering of small, co-operative self-help group networks would help de-emphasise the role of administrators and government officials.

How can we best satisfy the growing demand for education? We can teach children how to learn and how to evaluate their actions by a set of moral criteria. We could then provide adults with second and third chances in education by expanding opportunities for continuing education. Educational experiences could range from the formal courses offered by universities as at present to quite informal learning exchanges provided at the community level.

How can we improve the quality of our lives? In addition to questions like the ones just posed we will have to answer questions of resource and land use and New Zealand's place in the world. Most important perhaps, we have to decide what New Zealanders understand by quality of life. We could do this by deciding on national goals which attempt to meet the basic human needs of all our people.

We have touched upon a number of issues facing New Zealand, and all of these will be discussed more fully in this series of booklets. However, in focussing on our individual areas of choice, it is important to remember that these areas are simply components of our total society. A choice made in one area shapes our options in another. For example, if we opt for greater self-sufficiency, our reduced need to find trading partners may make it easier for us to adopt an independent foreign policy. To maintain our present lifestyle we would need to develop our own heavy industry (for example machinery manufacture), which in turn would raise the total energy requirements of our society. Land use patterns would change as traditional agriculture was replaced with energy farming. Alternatively we could choose not to industrialise, and this would require the adoption of a simpler (possibly small-scale) lifestyle.

So it is important that we look not just at choices in single areas (for example, energy), but at the broader issue of how our society as a whole might develop in the future. The final booklet in this series will attempt to do just that. The options and choices identified in preceding booklets will be brought together; areas of conflict and compatibility will be defined. From this will emerge several "alternative futures" or images of how New Zealand might be in the future.

In this introduction we have been talking about change — change in the world and possible directions for change in New Zealand. But it is not commissions that can bring about change, but people. In publishing these booklets the Commission for the Future hopes to provide background information for those interested in discussing New Zealand's future, and so to begin what it hopes will be widespread debate about where New Zealand should be heading.

# 1

# PRINCIPLES OF RESOURCE USE

This booklet is the first in the series *New Zealand in the Future World.* Its focus is on natural resources, with the three aims of describing world resource supplies, summarising current knowledge on the resources of New Zealand and identifying New Zealand's options for the development of those resources.

Because technology determines the availability of many resources, and shapes the way those resources are used, this booklet also identifies some new developments in technology and their possible effects on New Zealand. Space in this booklet is too limited to describe many of the technologies which will appear before the year 2010, but detailed supplementary reports are available.*

An essential characteristic of the earth is that "everything is connected to everything else". However, for convenience this booklet is subdivided into traditional subject areas, such as "energy", "forestry", and "transport". Each of sections 2 to 7 looks in detail at one strand of the world resource fabric, while 8 and 9 consider areas of technological change. Although specific options for New Zealand are identified in each case, the choices made in one area will help shape the options available in another. For example, decisions about how New Zealand's energy resources are developed will affect patterns of land use, which in turn will shape agricultural and forestry production.

Furthermore, all New Zealand's options for resource development will be influenced by choices about trade and international alliances, the subject of the third booklet in this series. The nature of world markets, and indeed the extent to which New Zealand wishes to trade, will influence what is manufactured from New Zealand resources. Similarly, attitudes toward foreign investment in New Zealand will shape the nature of resource development and processing.

Even more importantly, patterns of resource use (and of resource conservation) are inextricably linked with present lifestyles and those to which New Zealanders aspire. Resource availability can be a constraint on what society can achieve and conversely the clear definition of social goals will guide many choices about resource use and technological innovation. New Zealand's social options will be discussed in the second booklet of this series.

The concluding section of this booklet attempts to show how New Zealand's options in the development of resources and the use of technology are interrelated, and to suggest how these options link with choices about the development of New Zealand society and foreign policy. The fourth booklet in this series weaves all these choices together in describing the main alternative paths New Zealand might take into the future.

**Future technology.* Report of Technology Working Party, CFF, 1979.
*The Electronics Age.* Prepared by the Computer Society for the CFF, 1979. Both available from P.O. Box 5053, Wellington.

### What are Resources?

A simple definition of a resource is "something useful to man". However, the word "resource" can be used either in a specifically defined way, or in a very general sense. In discussing mineral supplies, the word "resource" is used in a very specific way. For example, when geologists speak of the coal "resources" of a country, they refer to an *unquantified* estimate of the total amount of coal in the ground. "Resources" are clearly distinguished from "reserves". "Reserves" are the *quantified* deposits of coal which it is economic to extract using existing technology and at current prices. In contrast, a very general meaning of the word "resource" is usually intended when people are referred to as "a resource". In particular human skills are regarded as a valuable resource, but one which cannot easily be quantified.

This booklet is primarily concerned with two categories of resources: energy and matter. Within these two categories there are both renewable and non-renewable resources. Renewable resources are continually regenerated naturally. They include solar, wind, wave, and water energy, plus living matter such as fish, grass, and trees. Non-renewable resources, on the other hand, are of fixed supply, and once used, they cannot be replaced. The coal, gas, and oil energy sources, plus many minerals (including all metals), are non-renewable.

### The Concept of Sustainability

The theme of this booklet is "sustainability". What does it mean?

Sustainability is a criterion by which man's patterns of resource use can be judged. If, for example, a human community is catching fish more rapidly than the fish population can produce young to replace those caught, then that fishing strategy is *not sustainable*. Eventually the fish catch will drop and if fishing continues, that particular fishing resource will be destroyed. By contrast, if a community plants a new tree for every mature tree that is felled, that community's pattern of wood use is *sustainable*.

For renewable resources, a sustainable strategy is one in which the resource is used at a rate no faster than the rate at which it is renewed. Fish catches would thus be no greater than natural fish population increases; tree felling would be no faster than the rate of regrowth. The use of any renewable energy resource (solar, wind, hydro, for example) is indefinitely sustainable.

For non-renewable resources, the derivation of a sustainable strategy is more difficult. The total world supply of a mineral is fixed, and as man mines, uses and discards that mineral, remaining stocks shrink. The strategy of using and discarding minerals is therefore not sustainable. If, however, a mineral is used more efficiently, the products into which it is incorporated made more durable, and those products recycled and re-used, then total mineral stocks will last much longer. In contrast non-renewable energy sources, such as coal and oil, cannot be recycled; once burnt they are gone forever. The use of these energy resources therefore cannot be made sustainable; man must eventually return to total dependence on renewable energy sources, although there is considerable difference of opinion as to when this stage will be reached.

The time horizon of the *New Zealand in the Future World* series is roughly 30 years. In this booklet we will focus on resource supplies over that time period. However, in discussing sustainable patterns of resource use, it is sometimes necessary to look 50 to 100 years into the future. New Zealand has sufficient coal to provide energy well into the 21st century, for example. But it is important to think about what happens after that, because it would be foolish to become dependent on a level of energy use which could not be sustained solely by renewable energy resources.

### The Role of Technology in Resource Availability

Technological change has expanded the stock of available resources, particularly minerals. Copper provides a good example. Man first mined copper from deposits with a copper content of 15–20 percent. By 1900 deposits of only 2 percent copper were being mined, and now we can profitably mine deposits containing only 0.5 percent copper. Although one could have expected the costs of copper to have risen as leaner deposits were exploited, in fact the real cost of producing copper is significantly lower today than 50 years ago.[1]

Indeed man's perception of the "resources" available for his use changes with changing technology. This creates an element of uncertainty in attempting to predict future resource supplies. Similarly the chances of discovering resource deposits as yet unknown adds another element of uncertainty. This is particularly so for minerals. Most countries estimate mineral reserves sufficient for the next 20–25 years' production but seldom for longer periods. Hence currently quoted mineral supplies seldom represent the total quantity of each mineral that is ever likely to be found and extracted; they only represent the quantity that has so far been discovered and investigated.

These uncertainties, together with a history of increasing resource availability brought about by technological change, make it difficult to specify precisely when the transition must be made to strategies of resource use which are indefinitely sustainable. Indeed one school of thought suggests that the concept of sustainability is not relevant to man's use of resources because changing technology will continue to expand the range and quantity of available resources. The alternative school of thought places less faith in technology, and believes that man must now plan for a sustainable society based on renewable resources and the recycling of minerals.

### Economic Growth, Resource Use, and Social Welfare

Just as there are conflicting views on the relevance of resource limits to the future development of society, so there are different schools of thought on the desirability of pursuing economic growth in the future.

Three main schools of thought can be identified: firstly, those who believe that economic growth *per se* is a valid goal (for example, Herman Kahn[2]), secondly, those who argue for changes in the direction of economic growth and, thirdly, those who call for transition to a stationary state economy (for example, Hazel Henderson[3]).These three schools of thought will now be sketched briefly.

1 *"Growth is Good"* (Herman Kahn and others)

Economic growth (measured as growth in national production per head) increases social welfare by widening the range of goods and services available to the individual. Although by-products of the production of goods and services, such as air and water pollution, may lower social welfare, there are many ways of ensuring that producers take these social costs into account (pollution taxes, emission laws, etc.). Furthermore economic growth may permit a nation to produce pollution control devices without reducing the production of anything else. In general, economic growth allows a nation of pursue new aims without forsaking any existing activities. In addition economic growth can eliminate poverty by continually raising incomes. Finally economic growth contributes to national prestige; note how often New Zealand's "standard of living" is ranked in comparison with those of other countries.

The problems of resource shortage which might arise with economic growth can be overcome by continued technological innovation, which not only makes recovery of resources easier but also provides substitutes for depleted resources.

2 *"Direction of Growth is Important"*

This school of thought does not maintain that growth itself is undesirable, but the wrong kind of growth. We should be concerned with the composition of national production, and not regard growth as an aggregate. For example, a particular "package" of growth may represent an increase in the production of cars (with their associated pollution), the proliferation of motorways and the spread of sprawling suburbs. Alternatively the same amount of growth might arise from the development of a less noisy, less polluting electric transit system, the establishment of public parks and the production of well-designed "neighbourhood" living areas.

If we aim for maximum growth without qualification then growth will occur in those sectors for which growth is easiest, and these may not be those sectors for which growth has the highest social value.

3 *"A Stationary-state Economy is Desirable"* (Hazel Henderson and others)

A "stationary-state" economy would have a constant stock of physical wealth (capital) and a constant stock of people (population). These stocks would be maintained by an inflow (production and birth) equal to the outflow (consumption and death). The goal of a stationary-state economy is to minimise the flows of production and consumption, i.e., throughput of goods. Hence it is very different from the growth economy, which aims to maximise throughput. A low rate of throughput means greater durability of goods and much less time spent in producing goods.

Because the stationary-state economy uses resources at a lower rate, it is more easily sustained than a growth economy. In a growth economy the pressure is on to maintain rapid technological innovation so that impending resource shortages are overcome. If technology fails to keep pace then growth cannot be sustained.

How does zero economic growth affect social welfare? Economist Ezra Mishan argues against the reasoning that economic growth expands the individual's range of choice and so increases his welfare.[4] He notes that the individual can choose only from what is presented on the market, and that many individual desires do not exist independently of the products created by industry. Through advertising, producers persuade individuals to choose their products, and hence the market is a want-creating as well as a want-satisfying mechanism. The fashion industry, for example, is dedicated to making people dissatisfied with otherwise perfectly satisfactory clothes, and to wanting new ones.

How does this school of thought deal with the issue of poverty? Critics of economic growth argue that developed countries are rich enough now to eliminate poverty, and that social and political action is required, not simply economic growth. Indeed, some economists argue that growth-oriented societies depend upon the maintenance of income differentials to serve as work incentives.[5] Further, they argue that in wealthy countries poverty is relative rather than absolute; in other words the individual feels deprived as long as his income is significantly less than anothers.

No country in the world has instituted a stationary-state economy. For poor countries this type of economy is inappropriate because further growth of capital stock (wealth) is necessary before an appropriate level of social well-being can be achieved. For many of the developed countries, however, the level of wealth is now sufficiently high that further growth may well lower total welfare because of the resource and environmental costs involved. Where does New Zealand stand? Many would argue that New Zealanders are not yet sufficiently wealthy to switch to a stationary-state economy. But should that be an ultimate goal, and, if so, at what level of wealth? Can the decision be made independent of the direction chosen by other countries? In the meantime New Zealand certainly does have choices about the rate and direction of growth which should be pursued. An important aim of this booklet is to identify where some of these choices lie.

# 2

# FOOD AND AGRICULTURE

Food is a basic human need. Yet while most people in the developed countries eat very well, starvation and hunger-related illness affect an estimated 700 million people in the developing regions.[1] This section examines the outlook for world food production and distribution and looks briefly at some of the other products of agriculture. The responses New Zealand might make to the world scene are then outlined.

### Malnutrition

World population currently stands at 4000 million people, and by the year 2000 this may have risen to 6000 million, according to United Nations projections. The most rapid growth rates are in the poorer, developing countries, which in turn have the greatest problems in feeding their people. But population growth alone is not the reason for hunger. Rather, both hunger and rapid population growth reflect poverty. Those whose incomes are very low cannot afford to buy the food they need. For those that are poor, more children often represent more hands to either grow or gather food.

The poorer developing nations lack the necessary overseas funds to buy food on world markets. Such inequalities in wealth are compounded by inequalities in the ability to produce food. Many developing nations have the land resources to be self-sufficient, but lack the additional inputs needed to raise yields. In addition, land which might otherwise be used to grow food crops for local consumption is devoted to growing "cash crops" (such as coffee, tea, sugar, cotton, and flowers) for export. These crops often take priority for research, irrigation, fertilisers, pesticides, and machinery. The growing of cash crops may be justifiable if the overseas funds so earned are used to buy food, but often this is not the case. Rather, cash crop earnings buy luxury items for the wealthy few in such countries.[2]

In attempting to help the poorer nations, the developed world must introduce technologies which fit with the social structure of the receiving country. In particular, the resource-poor farmer needs technologies which are compatible with his social and physical environment. The "Green Revolution", for example, introduced new strains of wheat and rice to the developing countries, and crop yields rose. But the new varieties are dependent on precisely-timed applications of fertilisers, pesticides, and irrigation, which only the larger, wealthier landowners can implement. The poorer, smaller landowners, lacking access to back-up services, have often experienced even lower yields than from their traditional varieties.[3]

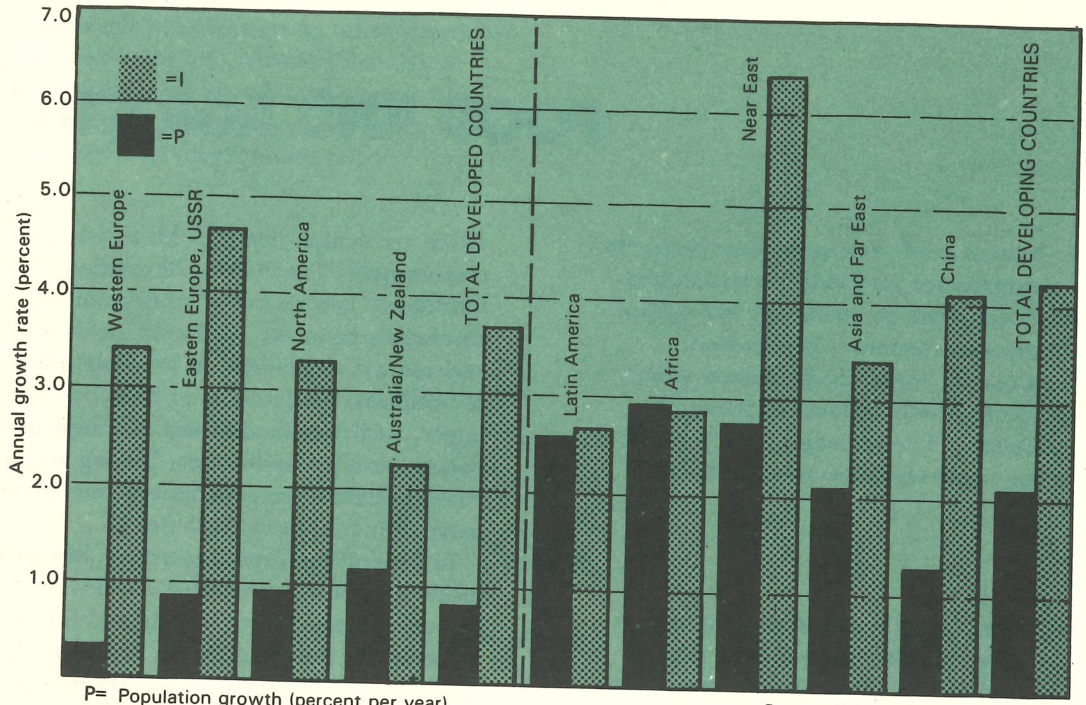
In general the capital-intensive, energy-intensive techniques of the developed world will fail where capital and energy are lacking and labour abundant. In addition, the replacement of human labour with machines could aggravate poverty in poor countries among the thousands whose livelihood depends on employment by the larger landowners.

### Future Patterns of Demand for Food

Population growth and rising incomes both contribute to a rising demand for food. The higher the national income of a country the greater its ability to buy food on world markets. Income growth also tends to shift the type of food which people eat. At low incomes people can afford only basic food such as cereals, root crops, and oilseeds. As income increases, more is spent on more expensive food items, such as meat, dairy products, and for city dwellers fruits and green vegetables also. In particular, beef forms a larger part of the diet as incomes rise.

Figure 2.1 summarises recent population and income growth projections used by the Food and Agriculture Organisation (FAO) of the United Nations. Populations in the developing countries are expected to grow at an average rate of 1.7 percent per year, while a growth rate of 0.7 percent is predicted for the developed countries. Average income per person in the developing countries is expected to rise by 3.1 percent per year, compared with an average income growth rate of 3.7 percent in the developed countries. These averages mask the differences in growth rates between regions, as illustrated in figure 2.1.

FIGURE 2.1: PREDICTED RATES OF POPULATION AND REAL INCOME GROWTH IN MAJOR REGIONS OF THE WORLD 1975-2000




P= Population growth (percent per year)
I= Income growth (increase in gross domestic production per person per year as percentage)

Source: UN and FAO

Based on these FAO projections, the following increases in demand to the year 2000 have been predicted for the main food groups.[4]

> The world demand for cereals will grow slightly faster than world population. Demand will increase most in the developing countries where cereals are consumed as human food. In the developed countries cereals may be increasingly used to feed growing livestock industries. As incomes rise, demand for beef, veal and sheepmeat will grow throughout the world, but especially in the developing countries. Demand for milk and dairy products is unlikely to grow on a per capita basis in the developed countries but will increase in the developing countries.

## The Outlook for World Food Production

Agricultural production in the developed countries has been increasing at about 2 percent per year during the 1960s and 1970s. This growth has exceeded population growth, thereby allowing for increases in exports. If this pattern continues, the developed countries should be self-sufficient in food and have an increasing surplus for export.

Although agricultural output has grown much faster in the developing countries, it has failed to keep ahead of population growth in some regions, and thus the future for them does not look bright. In Africa, for example, agricultural output would have to grow three-and-a-half times as fast as in the 1970s in order to keep up with growth in demand for food. However, if the countries of Latin America, the Near East, Asia, and China can maintain the rates of agricultural expansion which they achieved in the 1970s, then food production in those countries may be able to keep up with population growth.

## Factors Affecting Food Production

### *Cropland Availability*

Those who have investigated world cropland figures generally agree that only half the potential area of suitable land is used. A recent Dutch study, for example, suggests that in addition to the world's 3200 million hectares currently used, the area of further potential cropland is 3714 million hectares.[5] However, man has already selected the most productive land for farming, and the cost of irrigation and other development costs may work against bringing this extra land into production.[6] Furthermore, much of the land yet undeveloped is some distance from population concentrations.

*Energy*

The amount of energy used to produce food from the land varies with different agricultural practices. The increases in energy inputs to agriculture, in the form of cheap fossil fuels, have enabled man to increase crop yields dramatically in recent decades. Oil products are used to power tractors and irrigation pumps, and also in the production of chemical fertilisers. The post-war trend of rising annual yield per hectare has slowed in many countries (e.g., the USA, France, and China), and one of the contributing factors has been increasing oil prices during the 1970s.[7]

Rising energy prices may cause a shift to agricultural practices which use comparatively less energy. For example, beef can be produced either by grazing cattle on pasture (as in New Zealand) or by fattening them on grain in "feed-lots". The energy input per kilogram of meat produced is much less in the grass-fed situation than in the feed-lot, where the feed-grain has been produced by a process of land cultivation, seeding, application of weedicides, harvesting, drying, transportation, storage, and feeding-out, all energy-using activities. Rising energy costs may therefore favour the production of beef on pasture, and may give countries like Australia and New Zealand, which produce beef predominantly from pasture feed, an increasing comparative advantage.

*Water*

Irrigation can raise crop yields substantially, but the possibilities for future large-scale irrigation schemes may be limited. Table 2.1 gives the projections of Lester Brown (Director of the Worldwatch Institute), who suggests that the potential of the world's major rivers (the Yangtze, the Indus, the Colorado, and the Nile) has largely been realised[8]. Water will therefore be a constraint in some areas. In parts of Asia, however, there are abundant underground water supplies which can be tapped with wells. In addition, new water management systems which are not dependent on large-scale irrigation schemes are being developed.

The technology exists for increasing freshwater supplies by desalting seawater, and has been used successfully in Israel and Saudi Arabia. However, the need for large amounts of energy in the process will probably make desalination increasingly expensive.

*Climate*

At the local and regional levels natural short-term climatic variability can have marked effects on crop yields. The future may see improved techniques for weather prediction and possibly weather control. The breeding of plants more tolerant to temperature change is also a possibility.

At the global level natural climatic changes may in the coming decades decrease the world's ability to produce food, for it seems that weather has been generally favourable for world agriculture over the two or three decades up to 1970. In addition there is the possibility that changes in climate may be induced by man's activities. The following quote is taken from the declaration of the World Climate Conference (February 1979) and summarises the current state of knowledge on this contentious issue.

> We can say with some confidence that the burning of fossil fuels, deforestation, and changes of land use have increased the amount of carbon dioxide in the atmosphere by about 15 per cent during the last century and it is at present increasing by about 0.4 per cent per year. It is likely that an increase will continue in the future. Carbon dioxide plays a fundamental role in determining the temperature of the earth's

TABLE 2.1: ESTIMATED WORLD IRRIGATED AREA, 1900–1975, WITH PROJECTIONS TO 2000[8]

| Year | Irrigated Area (Million hectares) | Average Annual Increase (Percent) |
|---|---|---|
| 1900 | 40 | |
| 1950 | 110 | 1.9 |
| 1975 | 200 | 2.6 |
| 2000 (projected) | 260 | 1.1 |

atmosphere, and it appears plausible that an increased amount of carbon dioxide in the atmosphere can contribute to a gradual warming of the lower atmosphere, especially at high latitudes. Patterns of change would be likely to affect the distribution of temperature, rainfall and other meteorological parameters, but the details of the changes are still poorly understood.

It is possible that some effects on a regional and global scale may be detectable before the end of this century and become significant before the middle of the next century. This time scale is similar to that required to redirect, if necessary, the operation of many aspects of the world economy, including agriculture and the production of energy.[9]

*Long-term Soil Productivity*

The concept of sustainability is central to agriculture. There is little point in raising the ability of land to yield crops if that increase cannot be sustained almost indefinitely. Natural soil fertility (and hence productivity) is being increased in many parts of the world and there is scope to do this even further. However, some past methods of doing so have not been sustainable, and natural soil fertility is now declining on an estimated one-fifth of the world's cropland.[10]

An important cause of declining soil productivity is erosion. In addition to the natural movement of soil by wind and water, land clearance and ploughing loosen the soil, and make it more easily washed or blown away, both on hillsides and plains. Erosion prevention practices should therefore be employed as new land is brought into production.

Over-grazing by animals, or repeated cropping without resting the soil, produce short-term increases in yield, but they are not sustainable. Pressures such as these are contributing to the growth of the world's desert areas, and hence to the loss of cropland. As a counterbalance, in some areas irrigation is bringing desert areas into production. However, irrigation systems must be well designed and managed in order to protect the long-term productivity of the land. In areas with inadequate soil drainage, for example, the irrigated soil may eventually become waterlogged, depriving crop roots of needed oxygen. In addition, the evaporation of water concentrates minerals and salts in the topsoil. This process, called "salinization",reduces and may eventually inhibit plant growth; it is particularly a problem with the irrigation systems in north-western India and Pakistan.

All these pitfalls must be taken into account if increases in area and productivity of cropland are to be sustainable.

*Other Factors*

Land area, energy and water availability, climate, and soil quality are the most basic factors affecting the productivity of world agriculture. There are many additional factors which will shape future patterns of production, but space here is too limited to discuss them fully. The following list suggests just some of the important factors:

methods of weed and pest control in crops

availability of soil nutrients

production and distribution of fertilisers

yield losses during storage and transport

development of multiple cropping

breeding of new crop and animal varieties

animal nutrition needs

animal disease control

development of new cultivation techniques

harvesting methods

yield improvements in grains

use of satellites in forecasting crop production

Genetic engineering is particularly important among the areas of technology which might contribute to future increases in food production. Conventional plant and animal selection and breeding practices are forms of genetic engineering. However, more recently man has developed new techniques for manipulating the genetic information (and hence the characteristics) of new breeds. These include the joining (in test-tube) of genetic sequences from different organisms, the fusion of two cells to form a hybrid with the genes of both parent cells, and the cloning of plants and animals to obtain genetically-identical offspring. These techniques have many potential benefits, for medicine as well as agriculture.[11] However, potential hazards (particularly of test-tube work), include the possibility of creating new infectious diseases (of humans, animals, and crops), and of producing a cancer-causing organism. Controls and guidelines for genetic engineering research are therefore being produced in many countries.

### Possible World Trade Patterns

Of importance to New Zealand are the possible future patterns of world food trade. For every country, government policy is important in determining whether deficiencies in local production are actually met by importing, whether production surpluses are actually exported, and the extent to which that country will attempt to become self-sufficient in food. In many countries agriculture is already protected from international competition by government subsidies and pricing mechanisms and this trend is likely to continue.

Despite these uncertainties an attempt is made below to describe future food world trade patterns to the year 2000.[12]

*Cereals*

Although Japan and the USSR may be importing more grain to feed livestock, the developed countries as a group will continue to be cereal exporters, matching their export surplus to the commercial import and food aid requirements of the developing countries. Import requirements of the wealthier developing countries will be met by commercial trade, while the poorer countries may be more dependent on food aid or financial assistance.

*Beef and Veal*

Among the developed nations, import expansion is likely for the USA, Canada, Japan, Greece, and Israel. Eastern Europe may become a net exporting zone. In the richer developing nations, such as the oil-exporting countries and the Republic of Korea, the demand for beef seems likely to increase faster than domestic livestock production. These countries could therefore have rising imports for at least 10–15 years, and because of their climate and lack of adequate pasture land, some may never seek self-sufficiency in beef. These rising beef import needs of the oil exporting nations may provide markets for some nearby developing countries, in particular Asian and African countries, if meat exporting potential can be developed there.

*Sheepmeat*

The EEC may become more self-sufficient in sheepmeat as demand falls faster than production. Of the developed countries, only North America, Japan, and Greece are likely to have rising import deficits. The demand for sheepmeat may grow faster than domestic production in the oil-exporting countries and possibly also in South Korea. This will give rise to trade expansion, benefiting new and traditional exporters.

*Milk and Dairy Products*

In Western Europe artificially high prices maintained for dairy products are causing production to rise and consumption to fall. Hence surpluses for export from that region may increase. The USSR and Eastern Europe may also show slowly rising exports. Among the developed countries, North America and Japan may have rising import needs, although Japan could well pursue a policy of self-sufficiency in dairy products, using high prices to depress demand and stimulate production. The import needs of all developing

TABLE 2.2 POSSIBLE CHANGES IN MARKET OPPORTUNITIES FOR NEW ZEALAND'S MAIN FOOD EXPORTS

| | Beef | Sheepmeat | Dairy Products |
|---|---|---|---|
| Western and Eastern Europe and USSR | Decrease | Decrease | Decrease |
| North America | Gradual increase | Increase | At least maintained |
| Japan | Increase | Increase | Possible increase |
| East and South-east Asia | Gradual increase | Gradual increase | Possible increase |
| Near East | Increase | Substantial increase | Possible increase |
| Latin America | Little change | Little change | Possible increase in northern and west-tern zones |
| Africa, North and West | Possible increase | Gradual increase | Possible increase |

Source: Ministry of Agriculture and Fisheries countries are expected to increase. In 1972–74 the net imports of developing countries were four times those of the developed world.

*Horticultural Products*

Horticultural products include both stable foods (such as potatoes and peas) and luxury or novelty foods (such as kiwi fruit). The demand for the latter products seems to be very high in the affluent countries, relative to current production of potential suppliers.

The above picture of future world trade is based on the FAO's assumptions (figure 2.1) about population and income growth in individual countries. If, however, income growth in developing countries is slower than assumed, then the need for additional food will not be translated into effective demand. On the other hand, if incomes grow more rapidly than assumed, agricultural industries may also grow more rapidly, and thus the level of self-sufficiency may remain constant, or rise.

What do all these projections mean for New Zealand? Table 2.2 summarises possible changes in market opportunities for New Zealand's main food exports.

## Non-food Products of Agriculture

In addition to food, agriculture produces wool, cotton, jute, leather, rubber, and chemicals. In recent years these natural products have been widely replaced by synthetic substitutes, especially those derived from oil (plastics, nylons, synthetic rubber, etc.). In some cases the synthetic substitute is needed to meet the supply shortfall of the natural product. For example, the demand for rubber is likely to continue to grow faster than the supply of natural rubber. Wool, too, may become more and more a premium fibre in affluent countries.

The rises in oil price expected before the end of the century (see section 7) may weaken the competitive advantage which synthetics have over natural products. In addition there is a growing revival of interest in natural products, especially in the developed countries. These two trends may lead to an increased allocation of land to the growth of non-food products.

These trends suggest growing market opportunities for wool-producing countries such as New Zealand. Livestock producers such as New Zealand may also find growing markets for animal by-products, including leather, bone protein and pharmaceuticals (such as gelatine, rennet, heparin, and insulin).

## New Zealand's Resource Base for Agriculture

Productive agriculture in New Zealand takes place on 14 million hectares of the total land area of 26.9 million hectares[13]. New Zealand agriculture is based on pasture fodder rather than feed grains, and hence is less energy-intensive than that of other developed countries. New Zealand's main energy disadvantage is the high cost of transporting exports to overseas markets. Even so, New Zealand can sell its pastoral products more cheaply on world markets than most other developed nations. New Zealand's temperate climate is particularly favourable for pastoral farming. Natural soil fertility is increased by the application of chemical fertilisers. In addition, clover is grown to build up nitrogen in pastures.

New Zealand's patterns of agriculture are shaped by the country's topography. Only 30 percent of the land area is classed as rolling or flat (with a slope less than 18 degrees), 20 percent is classed as hill land (with a slope between 18 and 30 degrees) and 50 percent is steep (with a slope in excess of 30 degrees). Most of New Zealand's meat and wool is produced on 9 million hectares of hill country and lowland farms. The 3 million hectares of farmland which can be ploughed is used primarily for dairy production, cereals, fruit and vegetables, and some meat and wool. Although 10 percent of New Zealand's land is suitable for horticulture, only one-sixth of this is at present used intensively.[14]

Although New Zealand's food production as a percentage of world food production is very small, New Zealand's main food exports make a significant contribution to world trade in these products, as table 2.3 shows. New Zealand's agricultural products account for over 70 percent of the country's export earnings.

## New Zealand's Options for Agricultural Production

There are two features of the world agricultural scene to which New Zealand can respond. The first is the expanding opportunities for commercial trade identified above. The second is the problem of world malnutrition. We shall look at each of these in turn.

*Commercial Trade Possibilities*

The FAO's projections (figure 2.1) indicate that to the year 2000, New Zealand will be faced with a world in which the buying power of many nations is expanding. In response, New Zealand could choose to increase the output of traditional pastoral products,

TABLE 2.3: NEW ZEALAND AND WORLD FOOD PRODUCTION AND FOOD EXPORT COMPARED

(Based on 1977 Production in Tonnes)

| Product | New Zealand Exports as percentage of World Exports | New Zealand Exports as percentage of New Zealand Production | World Exports as percentage of World Production | New Zealand Production as percentage of World Production |
|---|---|---|---|---|
| Lamb and mutton | 50.0 | 80.9 | 14.4 | 8.9 |
| Beef and veal | 8.9 | 46.7 | 6.3 | 1.2 |
| Butter | 20.8 | 76.8 | 15.0 | 4.1 |
| Cheese | 6.6 | 97.5 | 11.7 | 0.8 |
| Dried milk | 10.6 | 85.4 | 39.5 | 4.9 |

Source: New Zealand Monthly Abstracts of Statistics, FAO Production/Trade Yearbooks

and so take maximum advantage of the country's comparative advantage in the low-energy production of luxury foods. There are, however, risks associated with choosing this option. The FAO's projections may over-estimate future increases in population and income growth, and hence in demand. In addition, growing trade protectionism and the self-sufficiency policies of other countries work against New Zealand's comparative advantage. Furthermore the costs of transporting products overseas may rise.

If New Zealand chooses not to expand traditional pastoral outputs then the following options are available.

1 Dependence on imports, and hence on agricultural exports, could be reduced. The cost of petroleum imports, for example, is greater than that earned from dairy exports. As New Zealand moves towards self-sufficiency in energy, the need to export will decline. In the long term some farmland may be used to grow crops for energy. To produce enough ethanol from crops for present transport fuel needs might require as much as 1 million hectares of land. (This area is more than one-third of New Zealand's high quality horticultural land.)

2 New Zealand can choose to increase the value of agriculture exports by greater processing before export. Rather than shipping meat carcasses, fish, wool bales, and dairy products in bulk across the world, New Zealand could search out markets for products such as hamburger beef, TV-dinners, tinned fish and fish pastes, carpets and knitwear, and cheesecakes. New Zealand has already moved some way along this path, although there are some risks and disadvantages involved. New Zealand's wage levels are generally higher than those in countries which import and process New Zealand's unprocessed agricultural products. This factor, together with the higher energy costs of food processing, would mean a loss in New Zealand's comparative advantage on world markets. The trade barriers to processed foods may also be higher. In addition, there is currently a small move away from packaged and highly processed foods. While there is indeed a much larger move toward instant, pre-prepared foods, there is a possibility that the former trend may increase greatly by the end of the century. If so, New Zealand could have difficulty finding markets for highly processed foods.

3 A third option for New Zealand is the diversification of exports. Within this option New Zealand could choose to foster a wider variety of manufacturing industries for export, or to diversify production from the land. The latter could entail increased exports from the forestry sector (see section 4), more horticultural products, and new products from deer, rabbit, and goat farming. Again, New Zealand has already taken some steps along this path. Energy resources may also be potential export earners for the future (see section 7).

These three options are not mutually exclusive; some mix of all three is possible.

*Responses to World Malnutrition*

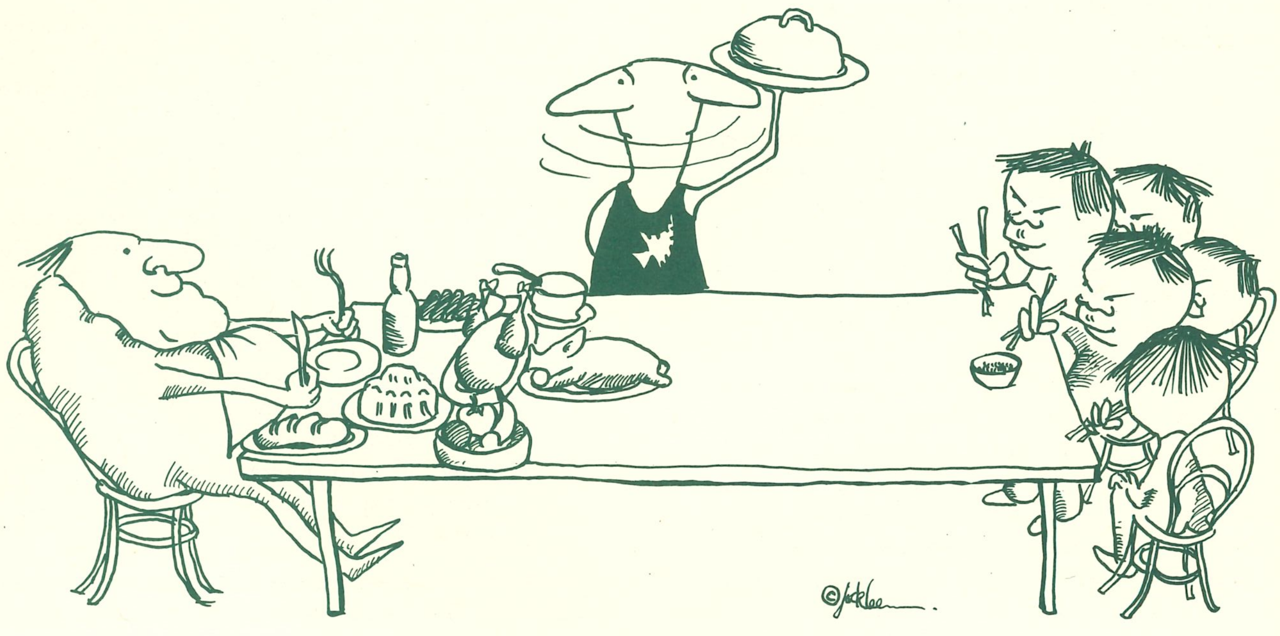
How should New Zealand respond to the problem of continuing world hunger? Although New Zealand's total food production may be small in world terms, more agricultural products could be exported to developing countries than at present. By importing handcrafts and other goods in which the poor countries have a comparative advantage, New Zealand could aid the development of those countries. New Zealand's ability to *give* food as aid is constrained by its own needs for overseas exchange. At the same time, as long as it sells much of its agricultural output to wealthy markets, New Zealand is in a stronger position than otherwise to give financial aid.

New Zealand could perhaps be of most help in the raising of food production in developing countries. In providing technical assistance, however, it is important that the technologies transferred are suitable for the recipient country. In particular, the small, resource-poor farmers, who cannot afford the fuels, fertilisers, and pesticides on which western-style agriculture depends, are most in need of help. By developing the following types of technology, New Zealand would not only be in a position to help those farmers, but would also be able to reduce the dependence of its own agriculture on non-renewable resources:

- biological methods of pest control (New Zealand has already achieved an integration of chemical and biological control in orchards);
- plant breeds which are more efficient in their use of fertilisers and water (New Zealand would benefit especially from more phosphate-efficient plants);
- simple, wind-powered irrigation pumps. (These are already being manufactured in Christchurch.)

By sending New Zealanders to the developing countries, New Zealand could also contribute to the on-site development of technologies which are compatible with the social and physical environments of the resource-poor farmers.

Finally, New Zealand should, if possible, use world forums to increase its pressure for freer international trade (so raising the export opportunities for poorer countries and for New Zealand), for more adaptation of agricultural research to the needs of poor countries and for the provision of necessary back-up services for new technologies.



# 3

# FISHERIES

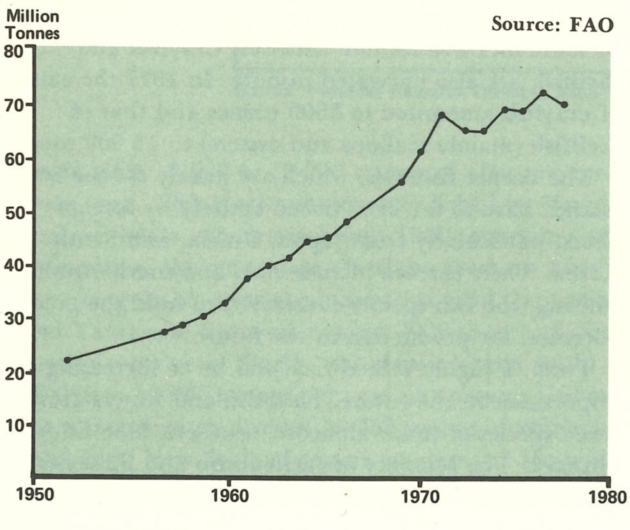
This section describes food production from the world's waters, outlines New Zealand's fishery resources, and makes some suggestions for their development.

### Potential Ocean Production

Man has always relied on the oceans for some of his food. Shells and fish bones unearthed by archaeologists suggest that as long as 10 000 years ago early man was gathering food from the sea.[1] Today seafoods provide almost one-fifth of the world's animal protein. Fish figures most prominently in the diets of the Japanese and the Russians. In Japan, for example, fish provides more than half the animal protein intake of the people.

Since World War II, man's capacity to exploit the ocean's fish populations has expanded rapidly. World fishing fleets have grown and the industry has adopted sophisticated fishing technologies such as sonar location. As fishing effort expanded, so the catches of fish increased. Between 1950 and 1970 the world catch climbed from 21 to 70 million tonnes of fish. Since 1970, however, the catch has fluctuated around 70 million tonnes (figure 3.1). Because world population has grown since 1970, static fish catch represents a decline in the catch per person per year, and real prices for almost every edible fish species have risen.[2]

FIGURE 3.1: WORLD FISH CATCH, 1950–77




Most biologists agree that the world will not again experience a dramatic growth in fish catch like that of 1950–1970.

The fish populations of the oceans will continue to provide us with food only if we pay attention to the concept of sustainability. If we catch fish faster than the population produces young to replace them, then that fish population will decline. Thus, there is an upper limited to the number of fish that can be caught every year without threatening the long-term survial of the population. This is called the maximum sustainable yield.

Unfortunately we do not know what the maximum sustainable yield is for many fish populations. The vastness of the oceans make population estimates very difficult. However, changes in the fish catch over time and with fishing effort serve as clues, showing us how close the catch is to the maximum sustainable yield. In the 1960s', for example, Peru's offshore anchovy fishery yielded 10 to 12 million tonnes of fish annually. In 1972 and 73, however, the catch dropped to a few million tonnes, because of a combination of both overfishing and a shift in the Humboldt current. This natural phenomenon of the shifting current caused fish production to fall, but this effect had not been adequately considered when fishing catches were set. A 1970 United Nations study estimated the maximum sustainable yield of the Peruvian anchovy fishery to be 9.5 million tonnes per year.[3] In the light of possible environmental changes, the long-term average yield may be even less.

There are, however, oceans where the potential for increasing fish catches is high. These are mainly in the southern hemisphere, and include New Zealand's fishing grounds. The pressure from northern nations to gain access to these fishing areas is already evident.

The seas could provide more food if man began to harvest the smaller sea creatures. There is, for example, interest in krill, a small shrimp which is especially abundant off the coast of Antarctica. It has been estimated that these krill swarms could yield up to 100 million tonnes per annum.[4] However, the maximum sustainable yield is not known with any certainty. Krill is an important food for fish, squid, birds, seals and whales, and the effect of krill harvesting on these animals is also unkown. On the one hand, any shift to catching small fish, or harvesting the tiny plants (plankton) of the oceans may reduce the populations of larger fish which depend on them for food, and which in turn are valued as human food. On the other hand, harvesting animals from lower down the food chain is more efficient in terms of total food energy.

Ocean pollution is another threat to sustainable fish catches. Thousands of tonnes of oil, for example, enter the sea every year, killing sea-birds and some fish and shellfish. In addition, the detergents used to "clean" oil spills are themselves toxic to many creatures. If man is to look to the oceans for food, then he must stop treating them as a limitless dump. The long-term effects of the pesticides, oil, and heavy metals (e.g., mercury, cadmium) which make their way to the sea are unknown.

### Aquaculture

"Aquaculture" is the farming and husbandry of marine and freshwater fish and shellfish. Some countries (particularly in Asia and the Pacific) rely on aquaculture for around 50 percent of their total fisheries production, and of this, about one-third is obtained from freshwaters. Worldwide, aquaculture provides almost 10 percent (5-6 million tonnes) of the world's water derived protein every year.[5]

The potential for aquaculture is, as yet, unexploited in many countries, including New Zealand. Swampland, mangroves and saltwater marshes are appropriate for aquaculture, which therefore need not compete closely with other productive land uses. Freshwater lakes and rivers are also suitable sites for fish farming.

Sea farming also holds potential for the future. It entails the rearing and release of young fish into oceans to supplement the catches of commercial fisheries.

### World Demand for Fish

A 1973 FAO study suggested that the worldwide demand for conventional fish food (both marine and freshwater) would increase to 61 million tonnes annually by 1980 and to 108 million tonnes by 2000. Although the 1980 figure has already been exceeded, a more recent study suggests that world demand for many fish species will outstrip the maximum world supply potential before 1985. The study concluded that demand would be curbed, and might approach 83.5 million tonnes by the year 2000.[6]

### Ocean Management

In the past, ocean fisheries have been free for all to exploit. Fishing nations have been unwilling to sacrifice short-term catch in the interests of sustaining catch in the longer-term. The resultant overfishing has shown the need for international agreements about catch limits, but these can be very difficult to achieve. The International Whaling Commission, for example, was set up to allocate remaining whale stocks among competing whale nations. Although it has found difficulty in establishing catch quotas in the face of certain selfish member countries, it has succeeded in maintaining some whale populations, while other populations have actually increased.

The United Nations Law of the Sea Conference was established to help control the exploitation of ocean resources (both fish and mineral). The conference has agreed that every coastal nation should declare an "exclusive economic zone" out to 200 miles from its coast. That nation will then be obliged to manage the resources within its zone.

### New Zealand's Fish Resources

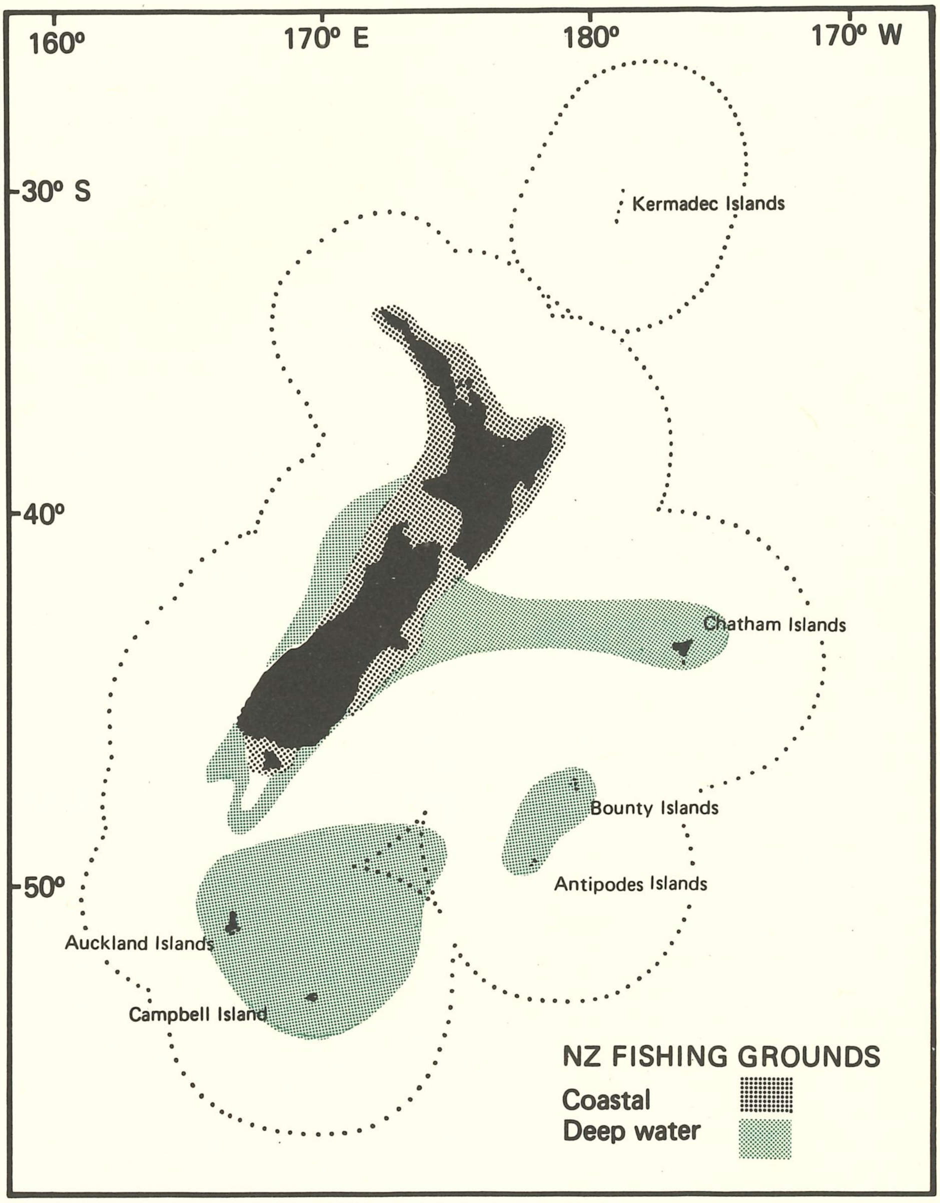
On 1 April 1978 New Zealand declared its right to control the 200-mile exclusive economic zone shown in figure 3.2. It is the fourth largest in the world. However, New Zealand's knowledge of the fish resources of that zone is far from complete.

New Zealand's fisheries fall into two categories: the coastal (inshore) fishery and the deep-water (offshore) fishery. The inshore fish are caught primarily by New Zealand boats, and include the slow-growing, high-quality species such as snapper, tarakihi, and trevally. About 60 000 tonnes of fish is caught inshore every year, and of this well over one-half is exported. Current levels of fishing are considered to be placing heavy pressure on these inshore fisheries. Crayfish and shellfish are also harvested inshore. In 1977 the catch of crayfish amounted to 3500 tonnes and that of shellfish (mainly scallops and oysters) to 13 000 tonnes.[7]

The deeper fisheries, which are mostly off the South Island, have so far been fished entirely by foreign fleets, particularly from Japan, Russia, and South Korea. Their catches include hoki and southern blue whiting, the two species considered to hold the greatest potential for production in the future.[8]

Tuna, a highly valued fish, will be of increasing importance in the future. New Zealand waters carry three species of tuna: albacore, southern blue fin, and skipjack. The Ministry of Agriculture and Fisheries estimates that New Zealand's 200 mile economic zone

FIGURE 3.2: 200 MILES EXCLUSIVE ECONOMIC ZONE




Source: Fisheries Research Division, Ministry of Agriculture and Fisheries

could yield 10 000 to 15 000 tonnes of albacore tuna every year. This species is currently fished by New Zealand boats, which catch only 1500 tonnes per year. In contrast, the current catch of the southern blue fin tuna is probably near the maximum yield. Japanese and Taiwanese boats take about 7000 tonnes of this species every year. Finally, the skipjack tuna could yield 20 000 to 30 000 tonnes per year. At present United States boats catch around 10 000 tonnes of skipjack tuna from New Zealand waters every year.[9] However, these catches may only be sustainable if other countries in the migration pathways of tuna do not increase markedly their levels of tuna fishing.

There is also increasing interest, particularly from Japan, in New Zealand's squid fishery. In 1977, 84 000 tonnes of squid were taken.

In 1976 the total fish catch from New Zealand's offshore waters was 200 000 tonnes. The maximum sustainable yield of fish from these waters could be as much as a million tonnes a year.[10] However, fisheries scientists suggest that the total allowable catch should be in line with the lower "safe biological yield". Under this concept allowance is made for uncertainties in fish population estimates, and variations in fish growth.

With the declaration of New Zealand's 200 mile economic zone goes the responsibility to allow other nations to harvest that part of the total allowable catch which New Zealand's fishing fleets do not have the capacity to catch.

### New Zealand's Fishing Options

New Zealand's long-term options for fishing the offshore species range from allowing all the catch to be taken by foreign nations through to complete working of the area by New Zealand. The latter option would entail the cost of developing larger New Zealand fleets and bigger boats. A third option is to co-operate with nations who have greater capital, more experience in fishing, and better access to big markets. Joint fishing ventures are already under way with Japan, Korea, Russia, Taiwan, and West Germany.

As one of the closest countries to Antarctica, New Zealand may have an important role in assessing the potential of krill populations and then possibly in harvesting the krill.

At present New Zealand lacks a clear statement of the objectives for which its fisheries are to be developed. The maximisation of export earnings is probably the unwritten objective at present, although there are other possible objectives and these could alter fishing strategies. These objectives include maximum protein yield, maximum economic return to the individual fisherman, or maximum employment in the fishing industry (which reduces the return per fisherman).

Closer to shore are resources as yet largely unexploited: the shellfish populations of New Zealand's many sheltered bays and inlets are substantial. These resources can also be farmed, an especially suitable area for shellfish rafts being the Marlborough Sounds. Indeed, oyster and mussel farms are already supplying shellfish to local and export markets. Scallops, pauas, pipis, and tuatuas are as yet unfarmed.

The potential for freshwater aquaculture in New Zealand is also very substantial. Although trout fishing is a popular sport, trout farming is still an untried and controversial concept. However, salmon farming is now under investigation and may be a practical proposition. Young salmon are raised in hatcheries, released and subsequently caught as they return from the ocean. This is called "ocean ranching". Both salmon and trout are popular eating species and could be readily sold at home and overseas. New Zealand's current need to import tinned salmon could disappear! In Rotorua grass carp are being reared for release into lakes troubled with lake weed. Carp is a good eating fish and its encouragement could hence fill two roles.

Once the fish have been caught, New Zealand has further options. In particular New Zealand can choose the extent to which fish is processed before export either alone or in collaboration with overseas companies. Should New Zealand export frozen fish, tinned fish, fish cakes or some other fish product? The answer will depend partly on where New Zealand can develop markets for its fish and what price that fish will fetch.

# 4

# FORESTRY

Almost all the world's people depend on forests for one or more of their varied products. Firewood is the main energy source for many developing countries.[1] Timber for construction and wood pulp for newsprint and paper are essential to the developed countries. In the United States, for example, the tonnage of wood harvested is similar to the total production of steel, aluminium, cement, and plastics together.[2]

### Future Demand for Wood

The world currently uses about 2400 million cubic metres of wood every year.[3] Estimates of future need vary considerably, but all agree that demand will increase. In developing countries the needs of expanding village populations for firewood are growing so fast that the natural growth rates of the local forests cannot provide for this expansion.[4] The world demand for newsprint will also grow as the proportion of mankind that is literate expands, and as more people move to the cities in developing countries. In contrast to this trend, however, the electronics age will reduce the use of paper and printing as the means of storing and exchanging information.[5] The net effect of these two contrasting trends is difficult to predict.

The recent past has seen the progressive substitution of non-wood materials (steel, aluminium, concrete, plastics, etc.) for wood. However, the production of steel and aluminium is very energy-intensive compared with the sawing of logs, and as real energy costs rise, wood will become more attractive for construction purposes. In addition, there is a growing realisation that the substitutes for wood are based on non-renewable resources (iron-sands, fossil fuels, etc.), whereas forests can be renewed.

### World Production Outlook for Wood

Estimates of the world's total area of forest vary considerably. A recent assessment places the total area at 2800 million hectares, which represents a wood volume of 224 000 million cubic metres.[6] Table 4.1 illustrates how these forests are distributed around the world; most are found in three regions, namely North and South America and the USSR. A distinction is made between conifer (also called "softwood") and non-conifer (also called "hardwood") forests because they produce different types of wood suited to different end uses. The conifer forests are those of pines, firs, and

TABLE 4.1: WORLD'S TOTAL FOREST RESOURCE BY REGIONS AND SPECIES GROUPING[6]

| Region | Area (million ha) | | | Total volume (billion $m^3$) | | |
|---|---|---|---|---|---|---|
| | Conifer | Non-conifer | Total | Conifer | Non-conifer | Total |
| Europe | 75 | 50 | 140 | 8.0 | 4.0 | 12.0 |
| USSR | 553 | 175 | 765 | 61.3 | 12.0 | 73.3 |
| North America | 400 | 230 | 630 | 26.5 | 9.5 | 36.0 |
| Central America | 20 | 40 | 60 | 0.7 | 1.5 | 2.2 |
| South America | 10 | 550 | 560 | 0.5 | 59.5 | 60.0 |
| Africa | 2 | 188 | 190 | 0.05 | 5.1 | 5.2 |
| Asia | 65 | 335 | 400 | 5.5 | 28.5 | 34.0 |
| Pacific | 11 | 69 | 80 | 0.3 | 1.0 | 1.3 |
| World | 1140 | 1640 | 2800 | 102.8 | 121.1 | 224.0 |

similar coned trees. The non-conifers are the flowering trees such as oak, beech, and maple. Coniferous wood is preferred for almost all uses other than for fuel and decorative panelling. Hence in almost every country the natural coniferous forests have been felled in preference to non-conifers.[7] In New Zealand, for example, most coniferous kauri and podocarp forests have been felled. In the forests that remain, the non-coniferous tawa and beech trees dominate.

Will the forests of the world be able to supply the anticipated growth in demand for wood? After an extensive study of the world's forest resources, New Zealand forester W. Sutton concludes that there will be shortfalls in wood supply. He suggests that the only country with any potential for a large increase in wood exports is Canada. Many countries have recently reduced their estimates of future wood production (for example, Sweden, Britain, Japan, and Australia), while other countries have ambitious plans for expansion which seem unlikely to be realised. In the USSR for example much of the forest is in Siberia where the climate is severe with some of the soil permanently frozen.[8]

Quality of the world's wood supplies is as important as quantity. In almost all countries the best quality, oldest trees have already been felled. The trees which have grown to replace them are generally smaller and of lower timber quality.[9] These second-growth forests will produce wood which is excellent for fibreboard, particleboard, pulp (for paper production) and adequate for construction timber. However, they will not produce high quality timber without knots (called *clearwood*). Sutton concludes that there will therefore be a world shortage of clearwood in the future.

But need we be concerned about shortages of high quality timber? Reconstituted wood products (such as particleboard and fibreboard) have become increasingly popular and there has been some substitution of these for solid wood. Because reconstitution involves breaking wood down into small pieces or fibres, and then reforming it, high quality wood is not needed. However, this process is also energy-intensive, and the prices of both particleboard and fibreboard have been badly affected by rising energy costs.[10] In addition the wood wastes previously used in reconstitution are becoming more attractive as a possible fuel source. Because reconstituted wood products can only compete with solid wood if their wood raw material is cheap, growing trees solely for reconstitution will not be profitable. Finally, reconstituted wood is not as strong, as tough, or as attractive as solid timber. Hence solid timber is likely to remain in dominant demand.

Future supplies of pulpwood and paper seem to be of concern to some forecasters. A recent FAO report for example predicts that the world's total use of paper and paperboard could almost double by 1990, requiring a 2.9 percent annual growth in the capacity of the world to produce pulpwood. The report concludes this level of expansion will require "a major input of capital expenditure, manpower, forest land and raw materials."[11] Poor quality wood can be used for pulping, and hence pulpwood and high quality timber are not necessarily competing end-uses for trees.

**New Zealand's Forest Resources**

In 1913 a Royal Commission on Forestry reviewed future needs for wood in New Zealand and concluded that the native forests would not be able to meet this need, which was mainly for sawn timber. The commission recommended a large-scale tree-planting programme and the newly formed Forest Service set a target of 125 000 hectares to be planted in radiata pine. With the help of the labour force made available by the great depression, this target was reached by 1931 and it is these trees that are now supplying much of New Zealand's wood needs.

Between the mid-1930s and the mid-1960s rates of planting were very low. However, by 1970 the annual planting rate had risen to 18 000 hectares and by the mid-1970s to 40 000 hectares. Because radiata pine takes about 30 years to grow, the mature trees which we will be harvesting around the year 2000 are already planted. The increase in planting rates from the mid-1960s onwards will produce a rapid increase in wood available for harvesting from 1990 onwards (see table 4.2). Soon after the year 2000 New Zealand's forest industry could be producing nearly four times as much wood as now, with more than 70 percent of this likely to be available for export.[12] (This quantity would, however, be quite small in world terms.)

TABLE 4.2 NEW ZEALAND'S AVERAGE ANNUAL WOOD SUPPLY[12]
(Based on a 30-year Growth Period)

| Period | Supply (in million $m^3$) |
|---|---|
| 1976-80 | 9.5 |
| 1981-85 | 9.5 |
| 1986-90 | 9.5 |
| 1991-95 | 12.7 |
| 1996-2000 | 17.7 |
| 2001-05 | 24.4 |
| 2006-10 | 33.4 |

### New Zealand's Forestry Options

For New Zealand's radiata pine plantations, Sutton[13] has identified three management options.

(1) Grow trees for pulpwood and/or energy (liquid fuels or burning). The trees need no tending and would be felled as soon as the volume of wood was sufficient. Hence the trees might be quite young when felled because no particular size of trunk is needed.

(2) Grow trees to sufficient size to provide sawn timber for framing buildings or logs for export. The trees would be thinned to encourage increases in log diameter.

(3) Grow trees to produce a maximum volume of clearwood (i.e., high quality, defect-free wood). The trees will need to be pruned (to reduce the degrading effect of knots) and thinned (to allow maximum diameter growth on the pruned trees). Forests managed in this way will also produce substantial quantities of lower-grade wood suitable for uses such as pulping and energy production.

In the production of pulpwood and framing timber, New Zealand will face some competition with other wood exporters. Many other countries (e.g., Australia, Brazil, and Chile) are planning to expand pulpwood production in the face of rising world demand for pulp and paper. Similarly New Zealand's framing timber has no distinct advantage over that of other countries.[14] However, if a decision is made to commit substantial forest areas to the production of transport fuels for internal use, then the first management option could be appropriate for those forests. Substantial volumes of wood waste will also be available from sawlog forests. This will be a cheaper wood source for transport fuel production than wood from forests grown specifically for energy production.

Returning to export possibilities, New Zealand does have some comparative advantages over competitors in the production of clearwood. Radiata pine is a suitable, fast-growing species in New Zealand conditions. The knowledge, the money, and the human labour are available to prune and thin pine plantations at the right times. In other countries with large areas of radiata pine (Chile, Spain, and Australia) pruning has not taken place, and hence the option of producing clearwood from those particular forests is closed. Hence if the predicted world shortage of high quality timber eventuates, New Zealand would be in a favourable position. The price of clearwood on world markets is substantially more per cubic metre than is currently fetched for New Zealand's framing timber.[15] Even if a world clearwood shortage does not eventuate, the timber could still be used for log export, framing timber, or pulpwood. Pruning and thinning pine forests is therefore a way of keeping options open. Some New Zealand foresters do feel, however, that the risk of losing the investment represented by thinning and pruning is too high. There is also some disagreement among foresters about the desirability of severe thinning and about the use to which thinnings should be put.[16] On balance it would seem that some mis of the three options identified by Sutton is desirable.

So New Zealand has choices about the quality of timber produced. There are also choices about the extent to which timber is processed before export. New Zealand can either continue to sell logs to Japan, where they are fed into pulpmills, or process logs into pulp within the country and so export a higher value product. If the latter option were chosen, then joint ventures could provide the needed capital, expertise, and market access. The recently built Karioi pulpmill, for example, is a joint venture with Korea. Decisions about wood processing should therefore be made in the light of the wider issue of foreign investment in New Zealand.

New Zealand also has options about the use to which clearwood is put. A capability in producing high quality furniture for export could be developed, for example. Radiata pine is not the only New Zealand source of timber for this type of venture either. Eucalypt species have attractive finishing qualities, and interest is growing in trees such as black walnut. Developing an export furniture industry certainly entails risks, although there does seem to be a growing market for both furniture and joinery components. In addition to our existing outlets in Australia, there are new market opportunities in Taiwan, USA, and UK. Plywood, too, is in ready demand overseas at profitable prices.

What of New Zealand's native species? Can use be made of timbers like rimu, matai, kauri, and beech? Unfortunately these do not lend themselves to the type of plantation management for which pine trees are so suitable, although large areas of rimu in Westland may be suitable for some form of sustained yield management. Another native species of commercial interest is kauri, which has some potential for high quality wood production, although it takes 150 years to reach maturity. In general, however, the timber advantages of native trees over radiata pine (which only take 30 years to grow) are insufficient to outweigh the growth rate disadvantage. However, New Zealand's native forests have other values, as we will see in the next section.

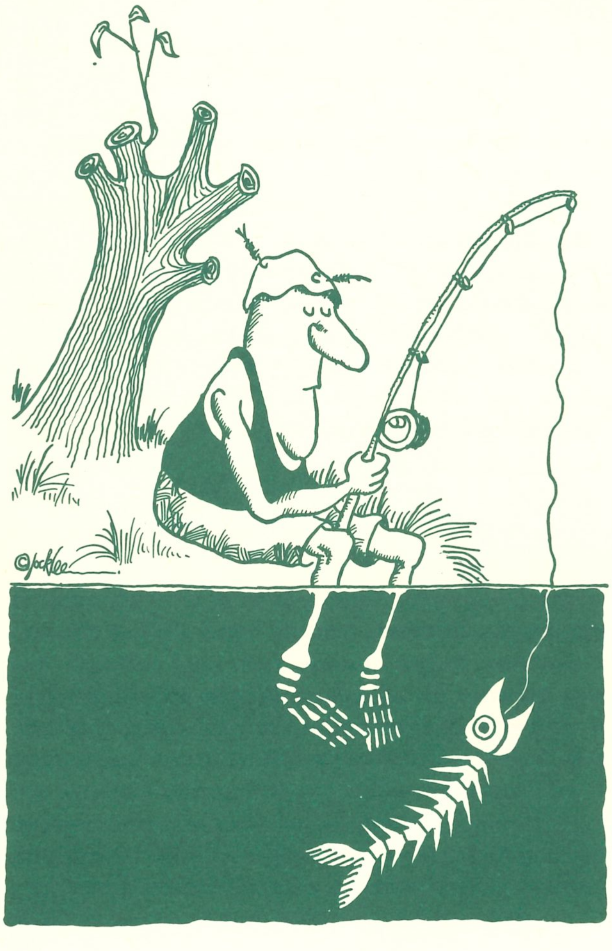
# 5

# NATURE CONSERVATION

### Why Conserve?

Much international attention is now focussed on preserving parts of the earth in their natural state, and on preventing animal species from becoming extinct. In this section some of the reasons for this concern are summarised.

Once a natural system or species is destroyed it can seldom be replaced, and one of the arguments for nature conservation is that many species or systems may have some economic value which is yet to be discovered. Previously unused plants, especially, may prove to be sources of food, chemicals, or fibres.



Similarly wild animals and plants provide genetic material which agricultural scientists can draw upon to breed new and more productive varieties.

Ecologists recognise the research value of unmodified natural systems. By understanding natural processes, man will be better equipped to manage natural resources in a way which can be sustained.

Aside from economic values, natural beauty is a source of artistic and emotional stimulation to man; natural landscapes also provide a sense of stability and peace in a world where man-made landscapes are changing.

Concern about the loss of natural diversity has motivated an international effort, co-ordinated by UNESCO's "Man and the Biosphere" (MAB) programme. Project 8 of this programme is called "conservation of natural areas and of the genetic material they contain". The aim of Project 8 is to ensure that examples of all types of natural system are preserved through the establishment of a world-wide network of "biosphere reserves".[1] Every country is asked to co-operate through their own national MAB committees; (New Zealand has one of these).

### New Zealand's Responses

New Zealand has many types of natural system, including some special areas of forest, tussock grassland, swamps, lake margins and sand dunes. Isolation from other land masses for thousands of years has resulted in the evolution of unique plants and animals. New Zealand podocarp, kauri, and beech forests survived ice ages 20 000 years ago, and are intrinsically valuable because of their great age. New Zealand has an important contribution to make to the MAB programme.

The expansion of productive agricultural land by European colonists reduced New Zealand's forest from 66 percent to 22 percent of total land cover. Consequently, an estimated 20 species of native birds have become extinct.[2] The loss of forest and swamp has been greatest in the lowland areas of the country, which are most suitable for farming. Most of the remaining lowland forest is on the West Coast of the South Island. However, much of New Zealand's mountainous land still carries its original cover of plants and animals (although somewhat modified by opossums and deer); most of the forest in national parks is of this high altitude type.

Competition between preservation and productive land use continues to characterise the debate over remaining forest areas, such as Pureora State Forest. Similarly, tussock swamplands are being drained to bring land into agricultural production and mineral exploration proceeds in areas proposed as national parks.

The future resolution of conflicts between production and preservation in New Zealand will be shaped partly by social value systems. If the enjoyment of natural beauty is considered essential to the individual's quality of life, then sacrificing some increases in national production in order to preserve natural areas will be justified. How national income is earned by New Zealand will also shape attitudes toward natural areas. If, for example, tourism becomes a major overseas funds earner the pressure to preserve areas of natural beauty will be greater because such areas have thereby acquired an economic value. The pressure to convert land to agriculture and forestry for export products would be accordingly lighter.

### Tourism

What are the chances of tourism becoming a major industry in New Zealand?

Tourism is at present the world's fastest growing industry. The current rate of growth is 10 percent per year, and if this were to continue to the year 2000, some writers suggest that the industry could be providing for more than 2000 million people.[3]

The growth of tourism particularly relevant to New Zealand is that expected in the Pacific Basin. In the ASEAN nations of Indonesia, Malaysia, the Philippines, Singapore, and Thailand the growth in national prosperity, the expansion of the middle classes, and urbanisation will increase the flows of tourists from those countries. Japan, China, Korea, and South American nations such as Brazil will also contribute to tourism in the Pacific. South Pacific tourism is growing at 12 percent per year, and by the year 2000 the annual traffic in and out of New Zealand may be several million.[4]

For what number of tourists can New Zealand cater? What level of tourism is considered desirable? While tourism may provide the economic justification for nature conservation, uncontrolled tourist access to natural attractions leads to overcrowding and may even destroy the lonely beauty which the tourists have come to see. Rapid growth in tourism will also place pressure on accommodation and transport facilities. Tourism in New Zealand should therefore be planned for in a co-ordinated manner, and the objective of that planning should not necessarily be the maximum growth rate possible.

# 6

# MINERALS

"Minerals" are non-living, naturally occurring materials useful to man. They include both metals (e.g., iron, copper and lead), and non-metals (e.g., clay, limestone and sand). Fossil fuel energy sources (coal, oil, and gas) are also minerals but they will be discussed separately in section 7.

Of the 2000 or so minerals known in the earth's crust, less than 100 provide the bulk of materials on which modern society depends.[1] The complexity of man's dependence, however, is well-illustrated by the telephone system, which uses 42 of nature's 92 elements, as constituents of 35 types of metals and alloys, 14 types of plastic, 12 varieties of adhesive and 20 different semi-conductor devices.[2]

## World Demand for Minerals

Every year the world uses the equivalent of 3.75 tonnes of minerals per person, and this rate is increasing at 7 percent each year. The highest rates of consumption are in industrialised countries; in the USA, for example, the annual figure is 15 tonnes per person.[3] These minerals generally flow from their natural source (a mine), to a processing plant, to a manufacturing industry, to a consumer, and lastly to the dump.

## World Supplies of Minerals

Is there any need for concern about the steady flow of minerals from mine to dump? Some would argue that the world's virgin mineral resources are running out, and that man must begin to regard wastes as the major source of valuable minerals.[4] In contrast, others note that past predictions of mineral scarcity have been unfounded, and that new reserves will be found as they are needed.[5] Because most countries estimate ore reserves sufficient only for the next 20-25 years production, currently quoted mineral supplies seldom represent the total quantity of each mineral that is ever likely to be found and extracted. Furthermore, technological advance allows us to extract minerals from lower and lower grades of ore, to develop cheaper substitutes, and to create hitherto unheard-of products.

Historically, a combination of technological advances and cheap energy has indeed expanded the reserves of minerals by pushing back the grade of ore which could be mined economically. However, to concentrate a mineral from its ore requires energy and, as real energy costs rise in the future, progressive shifting to lower grade ores will be increasingly expensive.[6]

Even though man's knowledge of mineral stocks is incomplete, there are clues to impending scarcity. If the effort put into exploring for new mineral ore bodies increases while the frequency of success decreases, then that mineral is probably becoming scarce. The following is an assessment of the world supply outlook for the main groups of minerals (excluding fossil fuels).

### *Metals*

Figure 6.1 summarises the current state of knowledge on the lifetime of metals. Mineral lifetimes increase with new discoveries and technological advances, but conversely lifetimes are decreased by increasing population and *per capita* use. Aluminium, iron (as steel and other alloys), magnesium, and titanium are widely used in industry. Most developed countries also depend on metals, such as lead, and zinc, which could be scarce by the year 2000.[7]

### *Non-metallic Industrial Minerals*

Most non-metallic industrial minerals should be in reasonable supply by the year 2000, with the exception of asbestos, graphite, and mica. Supplies of clay, crushed stone, gypsum, limestone, salt, sand, and gravel should be adequate.[8]

### *Non-metallic Construction Minerals*

These include aggregate rock, sand (silica for glass), clay (for ceramics), and other materials for cement. The quality of aggregate is determined by the type of rock near the construction site, which is a local rather than an international problem.

As energy becomes more expensive, so recycling and increased durability of materials becomes more attractive. Table 6.2 shows the energy saved by recycling materials. By producing raw steel from scrap the steel industry avoids using energy to mine and transport iron ore, coal and limestone, and to produce iron in a blast furnace. The energy-saving potential from recycling glass is less because glass production involves only one melting step and no energy-consuming chemical reactions. However, in both cases energy is saved by recycling.

### New Zealand's Mineral Resources

Table 6.3 summarises the current knowledge about New Zealand's mineral resources.

New Zealand currently imports more minerals than it exports. The major minerals on which New Zealand depends are fertiliser, coal, oil, and construction minerals. Of these, oil and fertilisers (phosphate and sulphur) are imported. Minor minerals imported include asbestos, barium, copper, lead, nickel, salt, silver, tin, and zinc.[15]

New Zealand is well-endowed with some minerals, especially coal, iron sands (used in steel production), and silica (used in glass manufacture). Supplies of these will last well into the 21st century, even allowing for increases in rates of production.[16] In addition, New Zealand produces many minor minerals which should still be in adequate supply by the year 2000. These include aggregate, clay, dolomite, limestone, serpentine, bentonite, diatomite, greenstone, magnesite, perlite, and pumice.[17]

### New Zealand's Options for Mineral Use

New Zealand has some choice in the degree of mineral self-sufficiency which is pursued. Reserves of coal and natural gas allow New Zealand to reduce its dependence on imported oil (see section 7), and present the option of developing petrochemical industries. These in turn would reduce the need to import many materials, including plastics.

The extent to which New Zealand minerals are processed in New Zealand will in general be shaped by policies on industrialisation and energy use. If diversification of industry is favoured, then it makes sense to process indigenous minerals into useful material commodities (e.g., iron sands into construction steel). An alternative option is to export raw materials and import finished goods. In the latter case the energy needs and pollution associated with processing is shifted to other countries. Such a policy would make New Zealand less self-sufficient.

New Zealand currently uses 2 percent of annual world fertiliser production, of which the highest proportion is phosphate. However, early next century New Zealand's present sources of phosphate imports will be exhausted, and other countries, such as Morocco, may provide imports. Although there is an estimated 20 million tonnes of undersea phosphate on New Zealand's Chatham Rise, this would be expensive to retrieve.[18] Once retrieved, however, it could be ground up and put directly onto the land, thus eliminating processing costs. Another option for New Zealand is the partial substitution of chemical fertilisers by organic fertilisers. Human and animal waste is currently pumped into rivers, estuaries, and out to sea. This not only creates pollution problems, but also represents a waste of phosphate and other nutrients. Future patterns of land use, especially agriculture, will also influence New Zealand's fertiliser use. A shift from pastoral agriculture to cropping and horticulture, for example, would entail a shift from phosphate to nitrogenous fertilisers. New Zealand can be more self-sufficient in the latter, with current patterns of legume growth and planned production of urea from natural gas.

Finally, New Zealand can also choose to do much better with what it has, by the recycling, re-use, and repair of material commodities. Scrap steel is already used as a raw material in New Zealand's steel industry, and the re-use of bottles (especially milk bottles) is not uncommon. However, there are further opportunities, especially in reducing unnecessary packaging and increasing commodity durability. The recycling of minerals will not only save energy and make supplies last longer, but will render New Zealand less vulnerable to potential world mineral cartels, and reduce the contribution of rising raw material prices to inflation.

TABLE 6.3: ABUNDANCE OF NEW ZEALAND MINERALS, EXCLUDING COAL AND NATURAL GAS

(*Source:* New Zealand Geological Survey)

| Mineral | 1977 Production (Tonnes Unless Otherwise Stated) | Estimate of Supply |
|---|---|---|
| **A. Minerals in Production** | | |
| Aggregate (excluding silica sand) | 26 372 738 | Extensive, variable distribution |
| Bentonite (a clay) | 2633 | Reasonable quantities in Hawke's Bay and Canterbury |
| Clay | 267 750 | High grade (for ceramics) in short supply. Extensive supplies of lower grades at the base of coal measures and in deeply weathered rocks |
| Diatomite | 1113 | Small, scattered deposits |
| Dolomite | 23 070 | 70 million tonnes at Mt Burnett, Collingwood |
| Gold<br>Silver | 222.96 Kg<br>235.53 Kg | Mineable quantities in the West Coast and Coromandel Peninsula |
| Granite, marble | 16 828 | Substantial amounts |
| Greenstone | 30.26 | Limited resource |
| Iron sand (concentrate of 46 to 58 percent soluble iron) | 2 954 394 (of which 2 771 312 exported) | Reserves: 750 million tonnes<br>Recoverable: 500 million tonnes |
| Limestone | 3 800 107 | |
| 99 percent grade | 3 800 107 | Small amounts proven. |
| 75 percent grade | | Large quantities in a few areas (e.g., Te Kuiti) |
| Magnesite | 557 | Cobb Valley, Nelson. Considerable quantity |
| Perlite | 1000 | Rotorua-Taupo. Large quantities |
| Pumice | 28 550 | Extensive deposits Rotorua -Taupo |
| Serpentine | 89 006 | Large volumes at Kerr Point, Nelson, Mossburn |
| Silica sand | 146 486 | Adequate volume at Parengarenga Harbour |
| Sulphur | 825 (1976) | Small quantities Rotorua -Taupo |
| Tungsten ore (scheelite) | 10.65 | Scattered occurrences in Otago |
| **B. Selected Minerals not in Production** | | |
| Copper | | Scattered prospects |
| Gypsum | | Very small amount on White Island |
| Lead, Zinc | | Small, economic quantities in Tui Mine, Te Aroha |
| Nickel | | Some small quantities, but low in grade |
| Phosphate | | |
| *Sea:* Chatham Rise | | 20 million tonnes |
| *Land:* Clarendon (Dunedin) | | Small amount, low quality |
| Platinum | | Reserves and prospects unknown |
| Tin | | Very small amounts on Stewart Island |

# 7

# ENERGY

## World Supplies of Energy

Energy entering the biosphere comes from three sources:

- solar radiation;
- thermal energy from inside the earth;
- tidal energy created by forces between the moon and the earth.

Of these, the sun's energy is the most important to man, even though a large proportion of solar energy is radiated back into space without being used. Solar energy evaporates water to create clouds, then rain and snow which feed lakes and rivers. Solar radiation also drives the wind and waves, further sources of energy. Solar energy stored in plants provides food energy; it can also be burned for heating or converted to liquid or gaseous fuels. Coal and oil represent stored solar energy because they are the products of plant photosynthesis millions of years ago.

With the discovery of coal and oil, man changed from sole reliance on energy income (renewable energy sources) to dependence on stored energy. To create a sustainable society man must eventually return to reliance on energy income only. This is undoubtedly a long-term goal, unlikely to be achieved within 30 years. The transition back to renewable resources will be influenced by the progress of nuclear fusion technology (dependent on very small amounts of heavy water, an abundant non-renewable resource) and by the social acceptability of nuclear power in general.

Table 7.1 lists estimates of the world's energy endowments. Of particular interest to the developed nations is oil, of which the total estimated resource may be as much as $2000 \times 10^9$ barrels. One-fifth of this has already been used.[1] Its lifetime will depend on the rate of production. The American geologist M. King Hubbert has produced two views of the future of oil production; these are presented in figure 7.1. If world demands for oil grow in the future as in the past, the production curve will rise and peak in the 1990s. Alternatively, if the world succeeds in stabilising oil consumption, production would follow the second curve, expanding the lifetime of oil considerably. Stabilisation or lowering of production rates would be prompted by the development of alternatives to oil. In addition, oil-producing nations may choose to limit production in order to conserve the resource. Oil-producing countries will probably want to add value to their product either by processing crude oil to gasoline or diesel, by developing a petrochemical industry, or by building fertiliser plants. The more imminent the end of the oil era, the greater may be the use of oil for high grade products, such as petrochemicals, rather than for energy.

Coal will become popular again as a source of energy, and because the stocks of world coal are much greater than those of oil, coal use may well continue through the 21st century. There are, however, possible constraints on the future use of coal. These include the cost and difficulty of mining coal, and growing concern about the climatic effects of carbon dioxide accumulation in the atmosphere (see section 2).

In the developing world, wood remains the most important energy source, supplying over 90 percent of energy needs. Even though wood is a renewable resource, forest use in many developing countries is not being matched by replanting, and severe firewood shortages may result.

## New Energy Technologies

As man becomes aware that the use of coal and oil is not indefinitely sustainable, so his attention turns increasingly to the technology of using renewable resources and to nuclear fusion power. Some of these technologies will now be described briefly.

### *Solar Technology*

The sun is a giant nuclear fusion reactor, safely sited 150 million kilometres from earth. The solar radiation reaching earth in one hour is roughly equal to the world's total energy use in one year.

TABLE 7.1: GLOBAL ENERGY SUPPLY
(PJ × $10^6$)

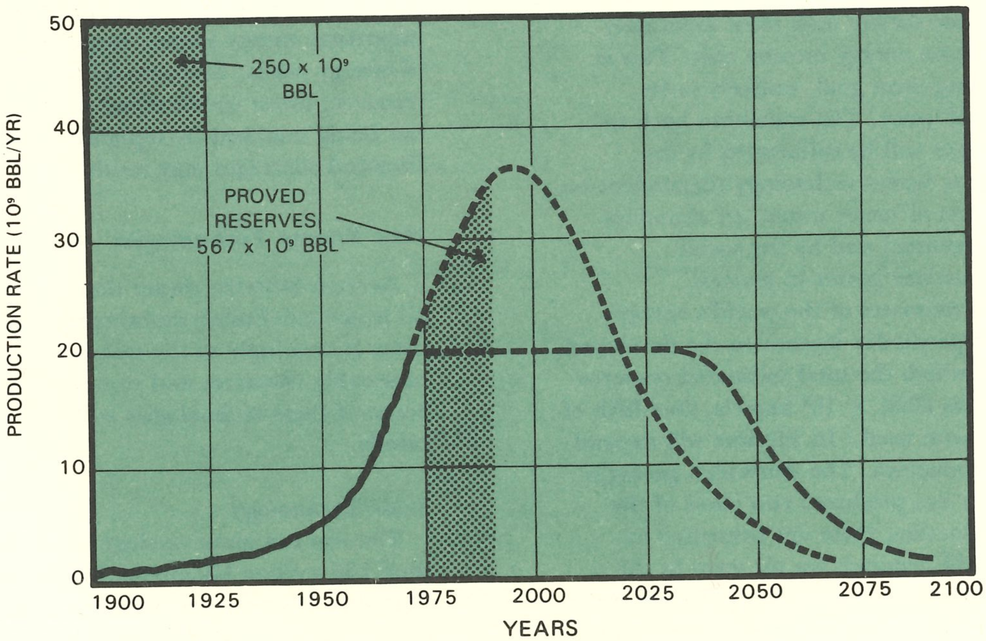
| Fossil Fuels | Proven | Potenial | Non-fossil Fuels | Potential |
|---|---|---|---|---|
| Oil | 4 | 15 | Uranium (U235) from oceans | 3000 |
| Natural gas | 1 | 16 | Uranium from the land | 5 |
| Coal | 100 | 170 | Solar | 30 per annum |
| Shale Oil | 20 | 2000 | Ocean energy (including ocean temperature differences) | 20 per annum |
| Tarsands | 2 | 2 | Fusion | Almost infinite |
| | | | Geothermal (includes the possibility of pumping water down into the earth's magnum) | Extensive |
| | | | Energy farming | Extensive |
| | | | Hydro-electric | .1 per annum |

1 PJ = 1 Petajoule = one thousand million million joules
= the energy in 22 000 tonnes of petrol
= one-quarter the annual energy output of the Wairakei geothermal power station.

World annual energy consumption is less than 1 million PJ

New Zealand's annual energy consumption is nearly 400 PJ

FIGURE 7.1: ESTIMATE OF COMPLETE CYCLE OF WORLD OIL PRODUCTION[1]
BBL = 1,000 million barrels



But the challenge to technology is how to collect and concentrate this radiation.

*Solar Water Heating*

The most widely used application of solar energy at present is for domestic water heating. A typical solar water heater employs dark glass-covered plates to absorb the sun's heat and transfer it to water pipes underneath. Although this application is economic in many parts of the world, problems still to be worked on are the lowering of installation costs and improved equipment durability. Solar water heaters could be used much more widely in the future, especially on the roofs of industrial plants for providing industrial processes with hot water.

*Solar Cells*

Solar energy can also be used to generate electricity through a range of devices. One is the solar cell, which converts incident light into electrical energy. The direct current so produced can be converted into an alternating current, or can be used to charge an electric storage battery. The solar cell is used now in remote sites, but is as yet too expensive for widespread use.

*Heliostat*

The heliostat uses mirrors to concentrate the sun's energy onto a boiler. This technology is already in use in the USA.

*Satellites*

A possibility for the 21st century is the use of satellites to intercept and concentrate solar energy, which could then be beamed to earth as microwaves for electicity generation. However, the heating effect of microwaves as they interact with the atmosphere is as yet unkown.

*Windpower*

Windpower can be used to sail ships, to pump water and to generate electricity. A small market for windmills has persisted through the centuries, and there are currently 15 to 20 manufacturers in several countries, including the USA, France, Australia, Switzerland, and New Zealand. Wind is widely available and renewable, and wind generators may soon become cheaper relative to fossil fuels.

Small wind generators allow the user to be independent of a national electricity network, and this independence is particularly valuable in remote areas. Although wind patterns are predictable on an annual basis, they are highly variable on a daily basis, and hence some form of energy storage device (for example, a battery) is needed.

Modern windmills employ high speed aerofoils, which will probably form the basis for future advances in the technology. Many countries, including Germany, Sweden, the USA, and New Zealand, are proceeding with windpower research. The world's largest windmill to date has a capacity of 2 MW (megawatts) and was built in Denmark by the teachers and students of Tvind College.[2]

*Ocean Energy*

Temperature differences within the oceans, wave energy, tidal currents, and the rise and fall of the tides are four potential sources of energy from the sea.

The ocean collects solar energy on the surface, while the depths remain cold. In 1975 the Japanese began investigating the use of this temperature difference. The system they are developing employs a liquid with a low boiling temperature. This liquid is turned to vapour at the ocean surface, the vapour used to drive a turbine generator, and then cooled (until it liquefies again) by the lower temperatures of deep water.[3] Similar work is being done in the USA.

The principle of tapping tidal power is similar to that of hydro-electricity. Rising water is captured behind a dam, and subsequently used to turn turbines as it flows back. In France, the River Rance supplies electricity in this manner.

Wave energy can be captured in a number of ways. In Britain research has been concentrated on the development of offshore rafts. One device, currently on trial in Loch Ness, consists of a row of "nodding ducks", which rotate around a hollow steel spine. The nodding movement drives a hydraulic pump, and hydraulic power is then converted into electric power.[4]

*Nuclear Fusion*

Nuclear fusion employs the energy released when two light atomic nuclei collide and fuse to form a heavier nucleus. The elements which can be used in the process are heavy hydrogen (deuterium, which is abundant in seawater) and lithium (which is recovered from ground deposits).

Nuclear fusion power is considered to have some advantages over nuclear fission for the large-scale, centralised generation of energy. The total quantity of radioactive material produced is less from fusion than from fission. However, fusion power still entails hazards, such as the need to replace and dispose of structural parts of the power station which become radioactive. The leakage of radioactive tritium, a by-product of normal operation, is also a potential hazard.[5]

Several estimates of the time and cost required to produce a demonstration fusion plant have been made in the USA. Times range from 15 years (a crash programme) to 45 years (still with an increase on the current rate of development) and the costs are very high.[6]

*Liquid Fuel Production*

During the next thirty years, coal may become increasingly important to take the place of oil (and natural gas) as a source of liquid fuels. Both coal and natural gas are raw materials for the production of methanol, gasoline, diesel, and aviation fuel. Compressed natural gas (CNG) and liquid petroleum gas (LPG) will also be important.

The renewable sources of transport fuels which may ultimately be very important are crops and trees. Ethanol and methane can both be produced from crops (and crop residues), while wood is a raw material for methanol, gasoline, and diesel. Countries without fossil fuels may move to these renewable sources quite rapidly. Brazil, for example, is already using ethanol produced from crops as a transport fuel.

Other possible energy sources for transport include hydrogen (which can be produced by the electrolysis of water) and electricity.

The processes entailed in producing liquid fuels from coal, natural gas, and plant material are well-described in a recent DSIR discussion paper.[7]

New energy technologies, such as those described above, should be discussed within the broader context of social, economic, and ecological structures. Some of the important issues are as follows:

- What are the capital and energy costs of developing the new technology?
- How long will it take for the technology to penetrate society?
- What are the ecological implications (for example, of carbon dioxide accumulation from the burning of coal)?
- How does the technology affect social structures? For example, does it contribute to greater centralisation, or does it encourage individual initiative?

**New Zealand's Energy Resources**

New Zealand is rich in energy (table 7.2). Coal and natural gas reserves are substantial, while an abundance of renewable resources allows New Zealand to create a society whose energy use is indefinitely sustainable.

*Hydropower*

Together, hydropower and geothermal power supply 90 percent of New Zealand's current electricity demand, and furthermore have an installed capacity which exceeds use by about 30 percent. The total potential of hydro-power in New Zealand is estimated to be 209 PJ per year. This is just over three times the output of the present hydro stations, which generate 63 PJ every year.[8] The full potential of hydro is unlikely to be realised because of other social needs, such as the desirability of leaving some rivers in their wild state.

*Geothermal*

At present New Zealand has one geothermal power station at Wairakei; its annual output is 4 PJ. A second is planned on the Broadlands geothermal field. The total potential for geothermal electricity production is estimated at 25 PJ per year, although developing all of this would be incompatible with maintaining scenic geothermal areas. Furthermore, geothermal steam is slowly regenerated from the earth's core, and if a field is used more rapidly than this regeneration rate, the output of that field may eventually fall.

Geothermal steam can be used directly for heating purposes, on both a large scale (as in the Tasman Company's pulp and paper mill at Kawerau) and a small scale (the domestic household level).

*Other renewable sources*

The potential solar energy available to New Zealand is several hundred times current total annual energy use (table 7.2).

New Zealand is also one of the windiest countries in the world. It has been estimated that 450 windmills (each with a capacity of 1 MW) could generate 10 percent of New Zealand's current electricity needs, if located at sites with an annual mean wind speed of 7 metres/second.[9] There are many such sites in New Zealand.

The wave energy available off the coast of New Zealand is large, but not as yet measured. However, one estimate suggests that a 63 kilometre length of wave power devices (with an overall conversion efficiency of only 20 percent) might produce 20 percent of New Zealand electricity demand.[10]

New Zealand's average tidal range is only about 3 m, compared with a world maximum of 10.8 m (in the Bay of Fundy, Canada). However, the Manukau and Kaipara harbours and Pelorus Sound do have tidal ranges sufficient for power generation. New Zealand's total tidal potential may be as high as 800 MW, with an annual generating capacity of 2.7 PJ. The use of this technology might be feasible within 20 years.[11]

The potential for using ocean temperature differences and tidal currents in New Zealand is uncertain as yet.

New Zealand has both the land resource and skills to grow trees and/or crops for energy production.

Finally New Zealand produces sufficient refuse annually to make feasible the production of steam, boiler fuel or fuel gas from refuse. In Auckland domestic refuse is already being pelleted for use as a fuel.

*Natural Gas*

New Zealand's known gas reserves total 8000 PJ, of which 7500 PJ are contained in the Maui field. The options for use of this resource are many, and will be discussed below.

*Coal*

New Zealand's known coal reserves currently stand at approximately 90 000 PJ, having been increased greatly in 1978 by the proving of 4400 million tonnes of lignite in Southland. The energy content of this coal is still uncertain, although it may be the energy equivalent of 10 Maui fields. However, the water content of the coal is known to be high (40-60 percent). Current use of coal in New Zealand is only 54 PJ annually.

Further information on New Zealand's energy resources is presented in "Goals and Guidelines".[12]

### New Zealand's Energy Options

New Zealand's energy future cannot be discussed in isolation from the broader debate on New Zealand's social and economic goals. Energy is simply a means toward achieving particular lifestyles and standards of living. Individual and national choices about mobility, work patterns, leisure activities, land use, and industrial development all shape energy demand. For each option particular quantities and forms of energy will be appropriate.

*Scale of Energy Generation*

A characteristic of many of New Zealand's renewable energy sources is that they are appropriate for small-scale energy generation at the local community or individual level (for example, wind, solar, plant material, and hydro). One of the choices facing New Zealand is the extent to which decentralised energy generation should be encouraged in the future. Centralised systems would continue to be needed for meeting peak demand, and the demands of large energy users (for example, in industry).

TABLE 7.2: NEW ZEALAND'S ENERGY RESOURCES

| Resource | Nature | Current Annual Use | Known Potential |
|---|---|---|---|
| Oil condensate from gas fields | Non-renewable | 30 PJ | 1340 PJ |
| Natural gas | Non-renewable | 64 PJ | 8000 PJ |
| Coal | Non-renewable | 54 PJ | ? 90,000 PJ |
| Hydro | Renewable | 63 PJ (generating capacity) | 209 PJ/year |
| Geothermal | Renewable | 4 PJ | 25 PJ/year |
| Solar | Renewable | — | At least 100,000 PJ/year |
| Wind | Renewable | — | At least 7 PJ/year |
| Wave | Renewable | — | Extensive |
| Tidal range | Renewable | — | 2.7 PJ/year |
| Tidal current | Renewable | — | ? |
| Ocean temperature difference | Renewable | — | ? |
| Recycling refuse | | | Extensive |
| | | Total use = 385 PJ (includes imported oil) | |

Although small-scale energy generation at the local level might make a minor contribution to total energy supplies, it may make a major contribution to meeting the diverse social objectives of individuals and communities. It would allow individuals freedom of choice of the energy system thought to be most suitable for their needs, and it may strengthen community self-reliance.

This issue of scale illustrates the importance of discussing energy generation within the broader context of individual and community aspirations.

*Transport fuels*

At present New Zealand is in a vulnerable position because of uncertainties surrounding the supply and price of imported oil. To decrease that vulnerability immediately, the following fuel options are available.

1 Use of oil condensate from the Kapuni, and then Maui, natural gas fields;
2 Use of liquid petroleum gas (LPG);
3 Use of compressed natural gas (CNG).

CNG and LPG will probably be most popular for petrol-driven vehicles using large quantities of fuel annually in urban travel (for example, taxis and delivery vans). The cost of converting a vehicle to LPG use is about $700, whereas the conversion cost for CNG is around $1,000.[13]

These short-term options will help bridge the gap between current supply problems and longer-term options based on New Zealand resources. Short- and long-term options are, however, closely inter-related. For example, increasing the gas draw-off from the Kapuni field (in order to recover condensate) may result in the irrevocable loss of carbon dioxide, which would be a valuable input to a future methanol plant based on Maui gas.

New Zealand's broad long-term transport options are:

1 to manufacture synthetic gasoline from natural gas and/or coal;
2 to switch to alcohol fuels (methanol or ethanol);
3 to electrify road and rail transport.

The production of synthetic gasoline and diesel would eliminate any need to modify engine design, and would probably keep New Zealand in line with transport changes in the rest of the world. Coal, natural gas, and wood can all be converted to conventional fuels,

including aviation fuel as well as fuel for land transport. Given sufficient capital, a synthetic gasoline plant could be operating in New Zealand within about 10 years.

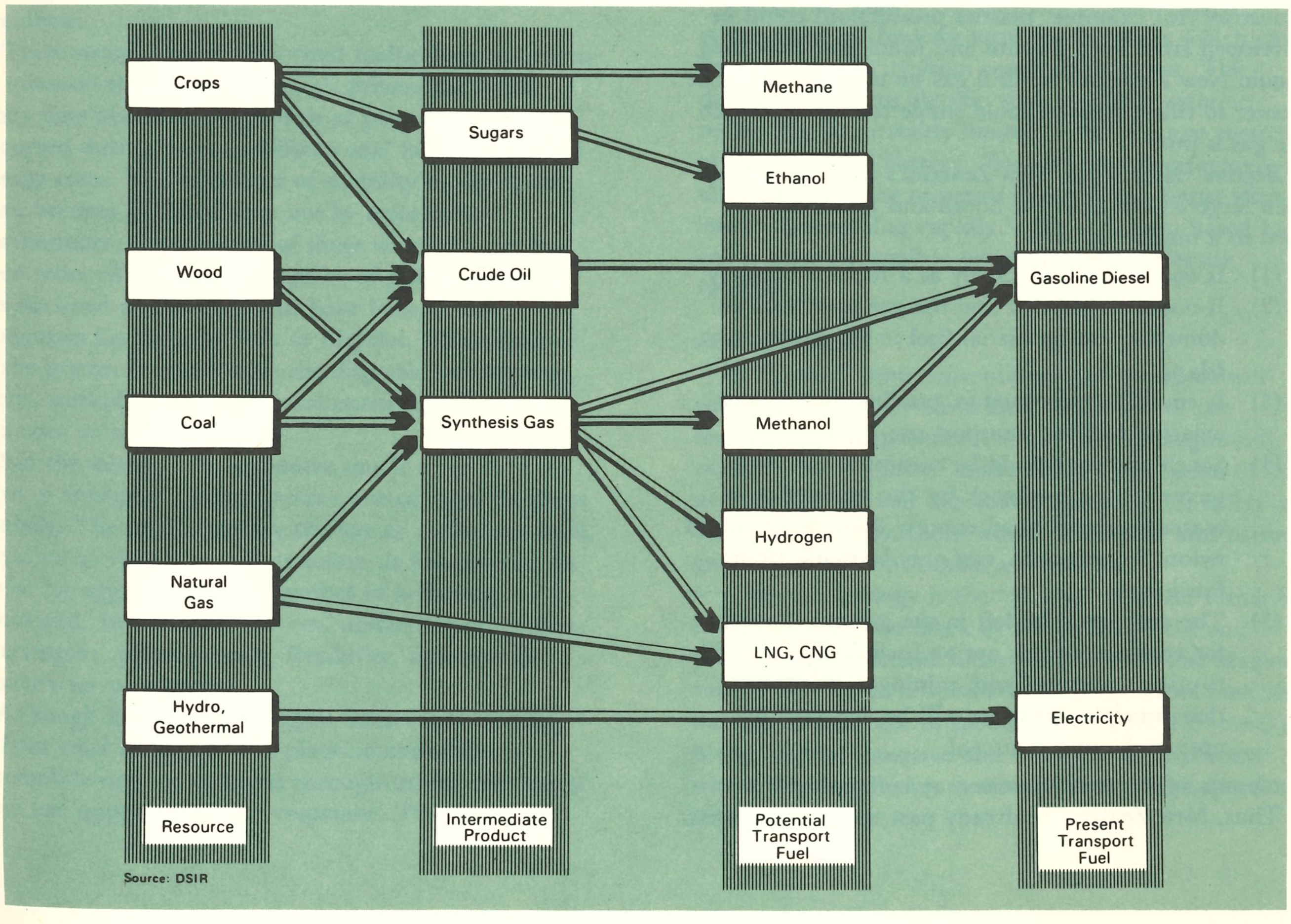
Methanol can be produced from New Zealand's coal and/or natural gas. Once these non-renewable resources have been depleted, the technology exists to produce methanol from wood, without major changes in the processing plant being required. Methanol-petrol mixes can be used in existing car engines with only minor engine modification required. Once the percentage of methanol climbs above about 15 percent major engine modifications must be made. The problems associated with high methanol blends (over 70 percent) have not yet been fully evaluated. By making a switch to methanol New Zealand would be following a path not as yet chosen anywhere else in the world.

The other possible alcohol fuel is ethanol, which can be manufactured from wood and from crops, such as fodder beet. It cannot, however, be manufactured from either coal or natural gas, and requires quite a different type of processing plant. Whereas the production of methanol implies large, centralised plants and the need for imported capital and expertise, ethanol production implies smaller plants which could be based solely on New Zealand capital and expertise.[14] Hence a switch to ethanol could be achieved by a progressive build-up of capability, whereas methanol would require larger steps.

Finally, New Zealand is well-endowed with renewable energy sources with which to generate electricity. Much of this electricity could well be available for the transport industry in the future. New types of battery storage are being developed, and the use of electric cars may be widespread (on the world basis) in 30 years' time. This option would require some of New Zealand's car fleet to be changed. However, New Zealand currently imports 50 000 new cars annually and hence it would be feasible to change much of the fleet within 30 years. Electrification of rail is also an option for New Zealand.

Figure 7.2 summarises the possible pathways for converting New Zealand's resources to transport fuels.

FIGURE 7.2: PROCESSES AND PATHWAYS FOR CONVERSION OF NEW ZEALAND'S RESOURCES TO TRANSPORT FUELS



*Fossil Fuels*

In the context of New Zealand's present liquid fuel crisis it is hard to imagine that the future beyond 5 to 10 years may be very different. By world standards New Zealand's coal and gas reserves are large; in terms of New Zealand's needs they are huge.

From the Maui gas field the country is committed to take or pay for 170 PJ per annum, although that output will not be reached for several years. Some idea of the size of the Maui field can be gained by comparing this figure of 170 PJ with the total transport fleet energy use in New Zealand of 130 PJ per annum. To supply all of New Zealand's road transport fuels from Maui gas would, however, consume 200 PJ of gas annually because of conversion losses. At this rate of usage Maui gas would last for 35 years. At present, however, only 65 percent of Maui gas is "labelled" as available for transport fuel production. A further 15 percent is set aside for direct reticulation as a gas.

Hence New Zealand's natural gas reserves are sufficiently large to last to the end of this century and beyond if used for transport fuel production and/or reticulation. Another option is to use some or all of the gas as a source of materials rather than energy. Some Kapuni gas is already committed to the production of nitrogenous fertilisers, while further petrochemical industries (for example, plastics production) could be developed from both Kapuni and Maui gas. How long should New Zealand's natural gas be made to last? The answer to this question should shape the uses to which the gas is put.

Beyond natural gas, New Zealand's coal reserves are even larger. Coal from the Southland field could be used in a number of ways.

(1) It could be used directly as a fuel for industry.
(2) It could be gasified and the gas used both as domestic and industrial fuel in the South Island.
(3) It could be converted to gasoline, diesel, and aviation fuel for transport use.
(4) Southland coal could be committed to long-term use as a feedstock for the production of materials rather than energy. Many plastics and nylon, for example, can only be made from fossil fuels.
(5) The coal could be left in the ground. Reasons for considering this option include the land disruption associated with mining and concern that future generations will be deprived the option of using that coal.

Some mix of all these options may be feasible.

Thus, New Zealand is already past the point where it needs to be concerned on the grounds of security of future energy supplies, including liquid fuel. The central energy question is now one of how to make the best use of New Zealand's abundant fossil fuels. Not only could New Zealand satisfy its own needs for synthetic gasoline within 10 years or less but industrialisation of the economy and/or substantial export of liquid fuel now become options. Fossil energy has now the power to become a major driving force in changing the entire structure of New Zealand's economy and with it, the current balance of payments problem. New Zealanders need to think hard about the social implications of such a change. As the price of conventional oil supplies rises and further supply interruptions occur, short-term decisions may propel New Zealand into high investment and industrialisation based on fossil fuel. But if that is to happen, it should first be proposed as an option, debated, and its trade-offs understood. This would be preferable to New Zealand finding itself in the midst of industrialisation with little knowledge of its true costs or benefits and little choice from among other and, possibly, more attractive longer-term options.

# 8

# TRANSPORT

This section examines some of the ways in which people and goods might be moved by land, sea, and air.

**Land Transport**

*Road Transport*

The automobile is one of the most resource-intensive habits of modern man. Valuable energy and metals are used in its construction (and destined to become scrap), precious oil is burnt to fuel it, and large areas of land are devoted to roads and car parks. In addition, the automobile emits poisons such as carbon monoxide and lead which people in the cities breathe. The congestion created by peak-hour traffic is a source of stress for drivers, and may reduce speed to a walking pace. But by far the greatest cost of the automobile is the death and injury of thousands of people every year in accidents.

These social costs of motorised traffic have led many to question the wisdom of man's private car habit. They note also that the growth of private mobility occurred during an era of cheap and falling transport energy costs. The high level of mobility to which we have become addicted may not be sustainable. Furthermore, the mobility of those without a car has been reduced because the quality of public transport has declined and many roads have become too dangerous for those on foot or bicycles. The existence of the motorcar encourages the dispersion of housing, shops, workplaces, and entertainment, which in turn increases its indispensability.[1]

But the automobile represents much more than a form of transport. It has become one of society's status symbols. The media portray the car as a glamour item, a symbol of virility as well as status. It has become an outlet for aggression and a symbol of achieving adulthood. In addition, the car, unlike any other form of transport, offers privacy, flexibility, and storage capacity for possessions.

Although it is hard to imagine future society doing without road transport, the place accorded the automobile may be changed through the interaction of these two opposing human responses. The first is a growing reaction against the rising social and resource costs imposed by the car; the second is the individual's addication to the freedom, status, mobility, privacy, and security it offers.

As oil becomes increasingly expensive, new ways of powering road transport come under study. Many countries are already planning to produce petrol substitutes from indigenous resources. Brazil is currently producing large quantities of ethanol from plants. Both methanol and ethanol can be used in existing types of engine once minor modifications have been made. Alternatively, methanol can be converted to synthetic gasoline, which can be directly substituted for petrol. Similar fuels can be used to power the Stirling (external combustion) engine. Commercial production of a Stirling car is now under investigation by General Motors.

Electrified road transport may be particularly appropriate in the long-term for countries which can generate electricity from renewable sources. The distance which an electric vehicle travels without recharging is currently limited by the storage capacity of the lead acid battery. However, the development of alternatives (using minerals cheaper and ligher than lead) is proceeding rapidly.[2] The hydrogen-based fuel-cell is another possible power source for electric vehicles.

*Rail Transport*

In 30 years' time conventional rail transport will probably be largely electrified, and some of the technological improvements may include improved performance of power units, tilting suspensions to raise average speeds, and automatic operation for safety and better service.[3] Synthetic diesel (from coal and natural gas) may also be available as a rail fuel.

A new technology is the "Maglev" vehicle, which is levitated above the track by a magnetic field and propelled by a "linear induction" motor. The Maglev vehicle can travel at speeds in excess of those possible on conventional trains (about 350 km/h). However, it is very capital intensive and will only be important where there is a heavy demand for very high speed transport.[4]

electrification is a particularly favourable option for the railways and for urban public transport systems. Modern versions of the tram could easily replace the bus in medium density uses. In contrast, the development of personal rapid transit systems in New Zealand would be an expensive option because the investment needed to cover New Zealand's cities with a sufficiently dense network would be very high.

Transport strategies must necessarily follow decisions about lifestyles, mobility, and social structure. While rapid changes in urban form are unlikely in New Zealand, a feasible option is the development of stronger communities within existing cities. This would be fostered by providing people with jobs, schools, shops and other amenities closer to home. A reduction in commuting needs would then follow. Decisions about the location and scale of industry will shape the transport infrastructure required for the movement of goods. Such decisions will in turn be shaped by the goals of regions and by policies on decentralisation.

The future pattern of New Zealand's dependence on shipping will be shaped by the country's trading policies and the location of export markets. Rising transport costs may encourage New Zealand to look closer to home for trading partners. New Zealand has some choice in the degree to which exports are transported by New Zealand-owned ships or by foreign vessels. With some experience in yacht design, New Zealand could choose to develop expertise in wind-powered shipping. Alternatively, indigenous coal reserves could provide shipping fuel in the medium term.

New Zealand's aircraft use is shaped very much by overseas developments in technology and fuel use. Because servicing and refuelling facilities must be compatible world-wide, New Zealand has little freedom of choice, for example, in the development of new aircraft fuels.

# 9
# THE ELECTRONICS AGE

Electronics technology has revolutionised both the range and nature of human communication (through radio, television, telephones), and the processing and storage of information (through computers). In this section we examine some of the applications of these developments, their costs and benefits to society, and New Zealand's possible responses to the electronics revolution.

## Computers

Thirty-five years ago electronic computers were unknown; today their impact is widespread. Thirty years hence computer technology will influence our lives in many ways.

The most significant contribution to the modern electronics revolution has been the development of the silicon chip. The tiny silicon chip is a mass of minute circuitry, with the calculating power of a room-size computer of only 25 years ago. It is responsible for the miniaturisation of computer components and the increased speeds of electronic processing. Between 1960 and today the cost of computer calculation has fallen by a factor of 100, while basic computer speeds have increased by a similar factor.

By the year 2000 electronics technology may well have achieved the following:

- processing speeds increased by at least 100 times, the faster computers achieving 1000 million operations a second;
- mass information storage systems holding more than 100 million characters, from which information can be retrieved in less than 1 ten-thousandth of a second;
- silicon chips which hold 1 million bits of information forming the basis of micro-computers which will be used not only for computing but as controls for devices ranging from the trivial (e.g., electronic games) to the critical (e.g., medical applications).[1]

## Telecommunications

A telecommunications system has three parts. The first is the transmission system, which consists of the wires, wave medium, and satellites through which the messages pass. The second is the switching system, which enables the messages to reach their desired address. The third is the equipment at the end of the communication process — the telephones, teleprinters, and televisions.

Costs of the transmission stage of the system have fallen dramatically, and will continue to fall. A development which has greatly increased transmission possibilities is the "optical fibre", a hair-thin glass "wire" of extremely high purity. One fibre can carry 1800 to 2000 telephone calls or equivalent signals.[2]

The most promising developments, however, are taking place in the communications satellite which collects and relays signals from thousands of miles above earth. The cost of signal-receiving stations has dropped to the point where some developing countries (e.g., India, Indonesia) are locating ground stations in otherwise inaccessible villages, which can now have access to medical and educational programmes. The potential of the direct broadcast satellite is particularly promising. Japan launched such a satellite in 1978; it now broadcasts colour TV programmes directly to home antennae in remote villages and island communities.[3]

Transmitting information via satellite rather than via television cable or telephone wire has many advantages. Firstly, the cost of sending the message is independent of distance, an important advantage for isolated countries like New Zealand. Secondly, beamed signals can reach inaccessible or mobile locations. Thirdly, satellites have greater "bandwidth" which means they can convey a greater number and range of messages at once.[4]

Increases in man's capacity to send messages are being matched by electronic systems of storing and switching those messages. Many future telephone exchanges, for example, will consist of a mass of computer circuitry responsible for routing calls to their correct address.

## Applications of Computers and Telecommunications

### *Television*

In a variety of ways the TV viewer is progressively being offered greater scope and flexibility in the use of the television set. There is already, in wealthier countries, a proliferation of video tape-recorders for taping TV programmes on an opposite channel, or when the set is unattended.

The linking of household television with computerised information banks has also begun. The British Post Office, for example, has developed a system called VIEWDATA, which links the individual into a "library" of recipes, cricket scores, weather forecasts, etc. The user simply phones for the information required and this is displayed on the home TV set. By teaming up household communication equipment with computerised selecting devices in this way it will be possible to address material to much narrower, special-purpose, minority-group audiences.

The next step is to allow the viewer to feed information back via the television system; VIEWDATA already has this facility. More active viewer participation may be on the horizon, allowing banking, shopping and voting to be telecommunication functions.

For many people these prospects are exciting, for others they are seen as increasing man's unhealthy dependence on the "plug-in drug". The long-term effects of television watching on social behaviour and the capabilities of the human brain are still largely unknown. However, a recent American writer feels that the evidence against television is sufficiently strong to argue for its elimination. He concludes that television is not a technology that can be used for good or evil, but that its very nature predetermines how it will be used and what effect it will have on our lives.[5]

### *Public Safety and Privacy*

Law enforcement can become much more pervasive with the help of electronics technology. General surveillance (e.g., of streets at night), home intruder detection, and rapid communication between law enforcement agencies all become easier. Conversely, the growing availability of communications equipment represents a mechanism for increased control over the everyday life of citizens. The ready availability of large capacity computers at low cost will make it practicable to store ever increasing volumes of information about individuals and organisations. This becomes threatening to individual rights when all information is, in effect, stored in the one data bank. A complete re-think of the ethics of information handling may be necessary, and the response could well be the enactment of laws to control and monitor the holding of personal and sensitive information on computer files.

### *Banking*

Electronics technology brings the possibility of a "cash-less" society. It is a short step from the present elementary computer banking system to one in which any monetary transaction could be handled. A purchase at a local store could be directly debited to the purchaser's account and credited to the store via a computer terminal at the shop. Automatic cash dispensers (already in use overseas) can supply pocket money.

### *Medicine*

In addition to the computerisation of medical records, electronic monitoring of a patient's condition may become routine, and in some cases it will not be necessary for the patient to be kept in hospital for this purpose. (Needs for home nursing would increase accordingly.)

Computer programs which assist doctors in taking initial case histories and providing a tentative diagnosis are already in the experimental stage. Two-way television may even allow patient-doctor consultation at a distance. Despite these advances, however, human contact is undoubtedly an essential component in medicine, and must remain so.

Electronic devices may supplement or replace damaged nerve tissues. As well as better cardiac pacemakers, doctors are forecasting an implantable electronic ear for the deaf and similar applications. These advances are possible because modern circuits now approach the size, power consumption, and logical capacity of the natural tissues themselves.[6]

### *Education*

By the 21st century computer assisted learning, with each pupil progressing at his own pace, will be much more common. A computer terminal with a visual display unit can take the role of an individual tutor, presenting a concept, developing the skills necessary for its use, and interacting with the student. However, knowledge about human learning processes and the nature of teacher-pupil interaction is yet far from complete. As in medicine, the human element in teaching is likely to prove indispensible.

Access to library facilities will be greatly enhanced by the development of electronic library storage, allowing information to be retrieved at will from anywhere in the world. As the amount of accessible information increases, more sophisticated indexing and searching procedures will be developed.

### *Weather Prediction*

The factors that produce weather are governed by natural laws and therefore, in theory, capable of prediction. At present it is the complexity of the weather patterns that defeats man. However, as computers become more powerful, so the ability to predict weather may improve. Weather control may even be a possibility in the future.[7]

### *Office Work*

Electronics technology is already changing the way information is handled in offices. "Electronic mail" employs a machine which can transmit copies of documents, including letters, through any telephone line for display on a similar receiving machine. This is now in use in many countries, including New Zealand. Word processing machines are also in widespread use. The word-processor consists of a typewriter keyboard, video screen, a memory bank and a printer which together significantly reduce the time needed to produce finished documents.

These and similar developments suggest a substantial reduction in the amount of paper associated with the office. Letters, files, reports, and books could all be replaced by their electronic equivalent. Similarly, the number of clerks and typists needed to handle information will be reduced. One word-processor and its operator are expected to replace 2–5 typists. Already this machine is estimated to be abolishing 8000 office jobs a year in Australia.[8]

### *Commute or Communicate?*

Business travel includes commuting to work, meeting in conference, and the movement of goods. The first of these offers the greatest possibility for lowering travel costs by allowing people to work at home using telecommunication technology. This would be possible for those employed in the storage, transfer, or manipulation of information (as in insurance companies, accountants' firms, and many government agencies) and for those involved in management and policy-making.

Working from home becomes more attractive as the costs of electronic technology fall and the energy costs of transportation rise. It has been estimated that the energy consumption of travelling to work or a meeting by private car can be 29 times as great as the corresponding energy costs of telecommunication. Even if the private car were replaced with a mass transit system which was then used fully (100 percent loading), the energy consumption ratio would still be 2 to 1 in favour of telecommunication.[9]

For many people, however, the opportunity to meet with others is an important feature of the workplace. Furthermore, many would be reluctant to forego the opportunities for promotion which come from knowing the boss! One possible way of maintaining social interaction is to disperse a large firm to a number of small, neighbourhood work locations throughout a city or region. The employee would then report to the location nearest his home, irrespective of his role in the firm. Telecommunication and computer technology would be used to transfer information between work locations.[10]

Conferencing with others is a second type of business travel which might be replaced by telecommunication. In the next decade, videophone calls and two-way television might substitute for out-of-town meetings and conferences. By 2010 it may be possible to telecommunicate a moving "hologram" (a three-dimensional real image) of a person to any location. In this way a meeting might consist of one human and a number of holographic "ghosts" seated around a conference table.

The relationships between work, travel, status, and social interaction are, however, complex. There may prove to be sound social reasons for not replacing commuting with telecommuting, despite the energy advantages.

### *Computers in Industry*

The computer is assuming an ever-increasing role in manufacturing. In the late 1950s the control of industrial processes by computers first began. Today the microprocessor, a tiny process controller made possible by the silicon chip, is cheap enough to make feasible the automation of very small steps in an industrial process.[11]

This progressive replacement of human labour by computers may eventually produce fully-automated industry. One can imagine a computer hierarchy in which micro-processors are used to control individual pieces of equipment; mini-computers collect and process management information from the micro-processors of an entire factory; and large central computers use that information to compile corporate financial reports.[12] Already Japan is close to having fully-automated machine-tool and car factories, and

Western European car manufacturers are putting robot welding arms on the assembly line.[13]

The impact of this trend on employment patterns will be substantial. The need for trained people to design, oversee, and install computer systems will increase, but at the same time the need for semi-skilled industrial workers and for office workers will be reduced. The challenge facing society will be to provide the necessary retraining opportunities.

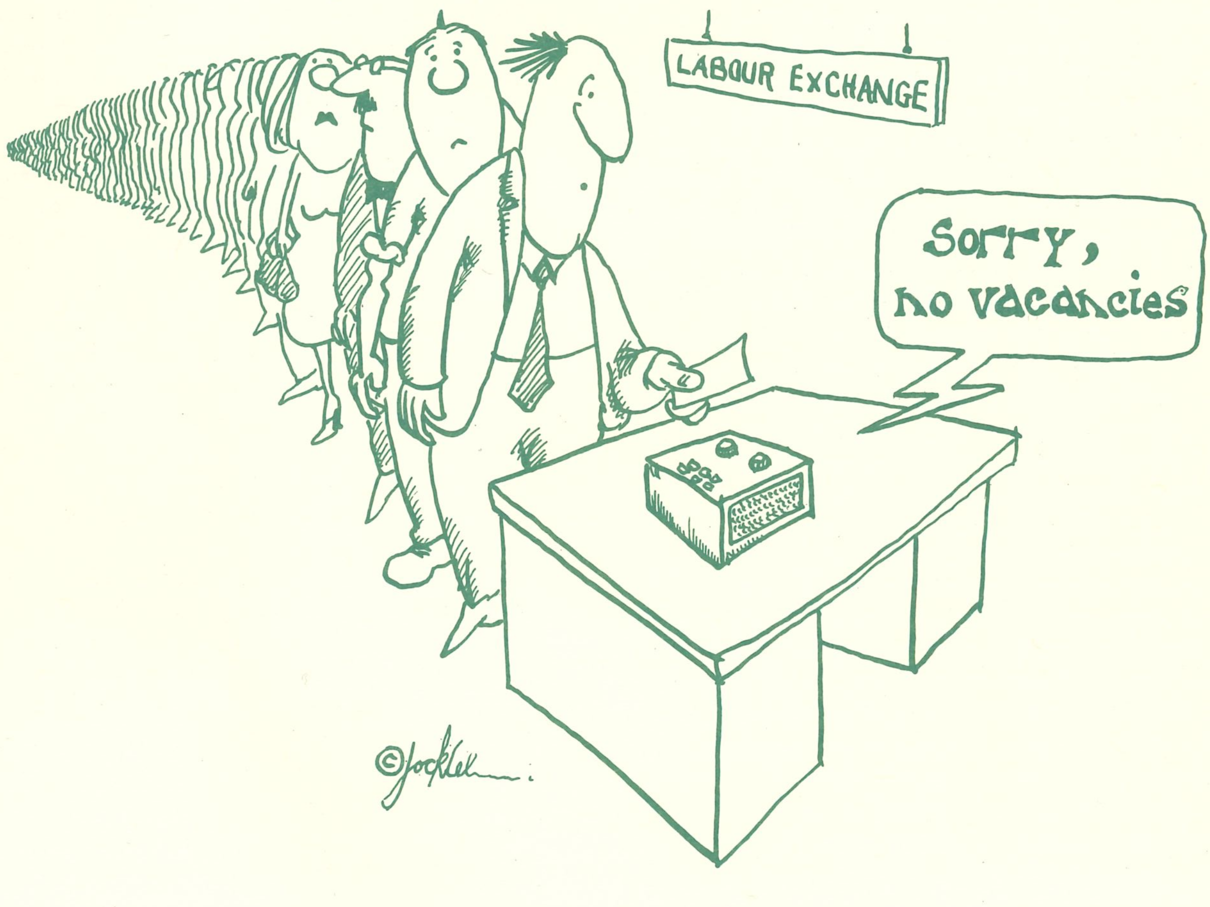
Some argue that the trend toward complete replacement of human labour by machines should be reversed. Others suggest a shorter working week for all, and increased leisure time, in which people can pursue the arts, travel, higher education, and other forms of self-expression. Indeed, the best of both these worlds may be possible if the high productivity of mass production industry is used to support other activities, such as craft-based manufacturing, which can be small in scale, and meet individual needs for self-expression. It can also meet the growing demand for custom-made and unique goods.

### New Zealand Options in the Electronics Age

The electronics age has potential applications to many aspects of society. However, the mere existence of a particular technology is not sufficient justification for its use. The financial and social costs of these applications of computers and telecommunications may be considerable. Such costs must influence whether, and in what order, new technologies are introduced into New Zealand.

*Telecommunication*

An era of unprecedented global communication is just beginning. New Zealand can choose the degree to which it participates in this development, which offers a number of exciting possibilities. One of the most promising for a geographically isolated country like New Zealand is the communications satellite. By placing high power transmitters in orbit, it will be possible to bring a wide range of services to the individual New Zealander. The home television set can be connected, via satellite, into a global system of data,



television programming, and commercial services. The spectrum available to carry signals becomes very congested in continental areas, but if the techniques developed to cope with this are adopted in New Zealand, then the spectrum available to New Zealand may be very wide indeed. Hence geographical isolation becomes a distinct advantage. By planning for the use of direct broadcast satellites, New Zealand could leapfrog the need for reticulated cable systems of television transmission.

The promise of direct broadcast satellites also includes two-way service. A wristwatch-sized satellite transceiver, which could be developed for personal use, would provide telephone, navigation, and emergency locator services for every individual in a country such as New Zealand. The cost: approximately $10 per unit.[14]

The introduction of a system like Britain's VIEWDATA is currently being investigated for New Zealand, and may be introduced in the 1990s.

*Computers*

Approximately 10 000 New Zealanders are currently employed in data preparation, systems analysis, and the programming, operation, and management of computer systems. Of these, 4500 are analysts and programmers. The demand for people trained in this area is expected to grow at around 10 percent per year, and in the near future there may be a shortage of trained data processing staff. Many other job opportunities will arise from the expected impacts of telecommunications and computing, and new training facilities will be needed if full advantage is to be taken of these opportunities.

New Zealand might choose to develop human skills in data processing and computer programming ("software") as a new source of export earnings. The potential for selling generalised computer programs (or "packages") overseas seems considerable, and one "package" sold widely might earn New Zealand over $1 million.[15] Areas in which New Zealand could develop particular programming skills include farm accounting and management, production control in primary industries, banking, health, and the development of hydro-electricity and geothermal power.

The introduction of the microprocessor to New Zealand's existing manufacturing industries and the word processor to offices could make many existing jobs redundant. Therefore the *speed* at which automation takes place should be adjusted to fit with the rate at which New Zealand can retrain and create new job opportunities. Rejecting computer technology altogether, in the interest of maintaining existing jobs, is an option. However, to choose this option while other countries automated export industries would make New Zealand exports less competitive, and New Zealand's industries would therefore require increased protection.

Conversely, the introduction of the microprocessor to New Zealand's manufacturing industries may improve the country's competitive position. The microprocessor makes small production runs, New Zealand's traditional disadvantage, economically attractive. Switching the output of the industrial process from one product to another is much cheaper and easier if the switch can be made simply by programming the microprocessor.

Another choice facing New Zealand is the degree to which computers are used to store and correlate information about the individual. How New Zealand chooses on this and other matters should reflect a desire to make electronics technology "a good servant" and not "a bad master". This can be achieved by the continual vigilance of an informed public, aware of New Zealand's options.

- To what type of lifestyles do we, as New Zealanders, aspire?

### Interdependence

Inherent in the first question is the issue of industrialisation. New Zealand could remain dependent on primary production and export its renewable resources (fish, trees, and agricultural products) in relatively unprocessed form, in order to import industrial products. Alternatively, we could pursue greater industrialisation, which might develop in a number of ways. Traditionally, many new industries in New Zealand have been based on the processing of imported materials (for example, in car assembly). We could in the future place greater emphasis on industries based on our own natural resources. Within this option we could concentrate on greater processing of primary products (fuelled by our energy resources). Alternatively, we could use our fossil fuels (and other non-renewable resources) as the basis for industrialisation.

Large-scale industrialisation based on our own resources could make us less dependent on imported materials and hence on trade. By contrast our dependence on inputs of overseas capital and expertise could well increase. Already the pulping of our wood and the development of our fisheries are characterised by joint ventures with other countries. The wealth of New Zealand's energy endowment attracts overseas companies to invest in industry based on that energy. To what extent are we willing to encourage further foreign investment in New Zealand?

Or do we wish for greater independence from trade and foreign investors? Our goal might be to rely as far as possible on our own resources and our own skills in developing them. Hence we would choose to emphasise those industries which can be based on New Zealand expertise and capability, such as the production of clearwood and the development of computer software. Pursuing greater independence might allow us to avoid some of the costs associated with growth based on expanding trade and/or heavy industrialisation. Complete independence from overseas trade and investment may only be achievable if we changed our lifestyle to a simpler, more labour-intensive, land-based one.

### Lifestyle

New Zealand's tradition has been to follow the lifestyle pursued by other western nations. Pursuit of a rising "standard of living" and an expanding range of goods and services has also brought centralisation, which entails urban spread, rural depopulation, the growth of central government, and the development of industry and energy production on a large scale.

While we in New Zealand now contemplate the option of industrialisation, other industrialised countries are looking to the development of a "post-industrial" society. This term refers to changes in the structure of a society, rather than changes in its industrial base. In a post-industrial society industries may still produce the goods which people need, but computer control of those industries leads to a transformation of work patterns. Hence New Zealand could industrialise and develop a "post-industrial" society at the same time. The many opportunities which the post-industrial concept presents for New Zealand will be discussed in the second booklet of this series.

Some futurists (for example Hazel Henderson[2]) believe that a post-industrial society should be characterised by a decentralisation of power, the strengthening of small communities, and the development of technologies which are resource-conserving and environmentally benign. Similarly, in New Zealand, some people now question the desirability of pursuing further growth in rates of resource consumption.* They also call for decentralisation, and a return to communities on a scale where caring and sharing can reduce the need for centralised welfare services and handouts from government. Some suggest that people should be given more opportunity to produce for themselves many of the things they need, especially food and energy. Such changes in lifestyle would also change our patterns of resource use.

How should people's need for employment affect the way we introduce technology into New Zealand? Continued interdependence with the rest of the world implies that as other countries automate productive industries, we may need to do so too in order to maintain competitiveness on world markets. But at what speed should we move toward automation? The introduction of the microprocessor, in particular, into manufacturing and service industries, could make thousands of present jobs no longer necessary. Many people would then be available for retraining, and we should think about the possible patterns of employment which might best suit people's lifestyle needs. Should we, for example, encourage the small-scale, high-value industries where human skills are the vital resource,

*Workshops on Goals for New Zealand. Report available from CFF, P.O. Box 5053, Wellington.

and the working environment more co-operative than in large firms? Associated with this question is the degree to which we use the electronics revolution as an opportunity to employ many people in the design of computer systems, and other aspects of computer use.

How New Zealanders view employment in the future will also influence resource use decisions. Should we choose those resource-development options which are more labour-intensive in nature? Or should we develop a more leisured society, with a shorter working week? Some of our resources might then be used for activities which may not contribute to export earnings, but which are important in the development of individual skills and self-esteem. Examples might be craft-work based on clay, wool and leather.

How might our attitudes toward interdependence and lifestyle affect the following resource use issues:

- land use patterns;
- use of non-renewable resources;
- energy and transport?

**Land use**

If New Zealand pursues a rising standard of living through increases in traditional land-based exports, then competition between different uses of productive land will intensify. An appropriate criterion for allocating land between competing uses might be "maximum sustainable economic return to the country", which in turn would be shaped by the availability of export markets for our various land-based products. Diversity may be our best protection against fluctuating markets, and this could be achieved by developing new exports, such as deer, rabbit, and goat products, and a greater diversity of horticultural products (wines, seeds, fruits, and nuts).

Conflicts between nature conservation and productive land use will increase if we pursue growth in land-based industries. Many remaining areas of native landscape will be lost, unless we decide that the pursuit of a higher gross national product can be curbed by other objectives, such as nature conservation.

Greater processing of primary products before export might be encouraged by rising freight costs, although this might be offset by increasing protectionism among countries which currently process our bulk agricultural products. Some of these countries may, however, be keen to shift processing to New Zealand, especially as their energy costs and pollution problems rise. For example, Japan may choose to invest in New Zealand pulp mills rather than import our logs. Again our attitude toward this type of development will depend on our willingness to accept foreign capital into New Zealand. If we wish to rely more on our own skills (while keeping in mind market access problems), then we might concentrate on processing our land-based resources into "distinctively New Zealand" products, such as lambswool rugs or high quality furniture. The challenge to our design skills will be to produce sought-after products. The market need to which we direct our land-based products will, in turn, affect resource management strategies (for example, the extent to which we prune trees to produce clearwood). Another option for the processing of our primary products is to become investors ourselves in overseas industries. New Zealand manufacturers of carpet have, for example, considered investing capital in overseas carpet manufacturing firms, and so ensuring a market for their yarn, and for the finished carpets.

A lifestyle based on decentralisation of our social structure would increase the strength of rural communities, and this in turn would affect land use patterns. There might be many smaller farming and forestry units, and hence more intensive use of land. Horticulture, in particular, could be developed. Decentralisation might also require the development of small, regional processing enterprises. Foreign investment, which tends to be in large-scale industry, might then be less welcome.

The pursuit of increased self-sufficiency for New Zealand would reduce the need to expand land-based exports. Conflicts between competing land uses, and the pressure to convert unmodified landscape into productive land, would be accordingly lighter. Growing trees or crops for liquid fuel production would then be a more favourable land-use option because it would not so readily take land away from export production. For a decentralised society, the production of ethanol from crops might be a sensible fuel strategy because the process is more amenable to small-scale operations than is the production of methanol from trees. It is also less dependent on imported technology, and large capital inputs. However, this option does raise the ethical question of whether, in a hungry world, land which could be growing food should be used for producing liquid fuels.

Our attitudes toward encouraging tourism in New Zealand will also affect land-use patterns. The decision to maximise overseas funds from tourism would reduce the drive for exports of land-based products. The consequent reduction in competition between productive land uses, together with the development of tourism, would both encourage the preservation of natural landscapes. Within the tourism option, New Zealand might choose to cater for several different tourist markets. Mass tourism, with its requirement for large-scale accommodation facilities, would need to be carefully controlled so that New Zealand's attractions for that market were not diminished. We could also make a feature of personalised accommodation at the guest-house and farmhouse level. This might provide employment for some in a decentralised society.

**Non-renewable resources**

We could continue to meet New Zealand's shortfall in minerals by exporting land-based products and importing minerals and their products. If, however, we chose greater industrialisation, then we might use our resources to manufacture substitutes here for what we now import. The latter option has already been chosen for our non-renewable energy resources. An ammonia-urea plant will manufacture nitrogenous fertiliser (currently imported) from our natural gas. Both coal and natural gas could form the basis of industries to manufacture liquid fuels, if we are willing to encourage overseas investors in these developments. If we produce fuel from Southland coal, economies of scale will suggest an industrial plant with a capacity greater than that required to meet New Zealand's needs (in the immediate future). We would then be able to export the products of our non-renewable energy sources. How would New Zealanders feel about this? Do we wish to keep our non-renewable resources for ourselves (and future generations)? How long should we make them last?

If we chose to be less dependent on trade, we could use our land to grow trees or crops for transport fuel production, and use our coal as a source of materials, rather than energy. Many materials which we currently import (for example, plastics and nylon) could be made from our fossil fuels. We could also choose to leave some of our non-renewable resources undeveloped in the meantime. They are unlikely to lose value, and by being left in the ground, options for their future use remain open.

An attempt to be more self-sufficient in minerals may require a greater effort to explore and mine those minerals that we do have. (This would intensify existing conflicts between national park preservation and mining.) Greater industrialisation in New Zealand might imply the expansion of our steel, iron, and cement works, so that we export fewer raw materials (such as iron sand) and more finished products.

However, should we export our minerals in any form? Should we try to use them more slowly? If an attempt to be more self-sufficient were coupled with changes in our life-style, we could be less dependent on imported minerals by adopting the principles of re-use, recycling and greater durability.

**Energy and transport**

The energy needs of New Zealand will be shaped by the lifestyle we pursue and our degree of industrialisation. Greater processing of our land-based resources (and our fish) before export, and/or a policy of expanded industry based on non-renewable resources, will all increase total energy usage in New Zealand. This, in turn, would encourage the development of more of our hydro and geothermal resources, and may therefore be inconsistent with the development of tourism based on New Zealand's "unspoilt loveliness". Continuing to export unprocessed agricultural products, as at present, would be less energy-intensive than processing.

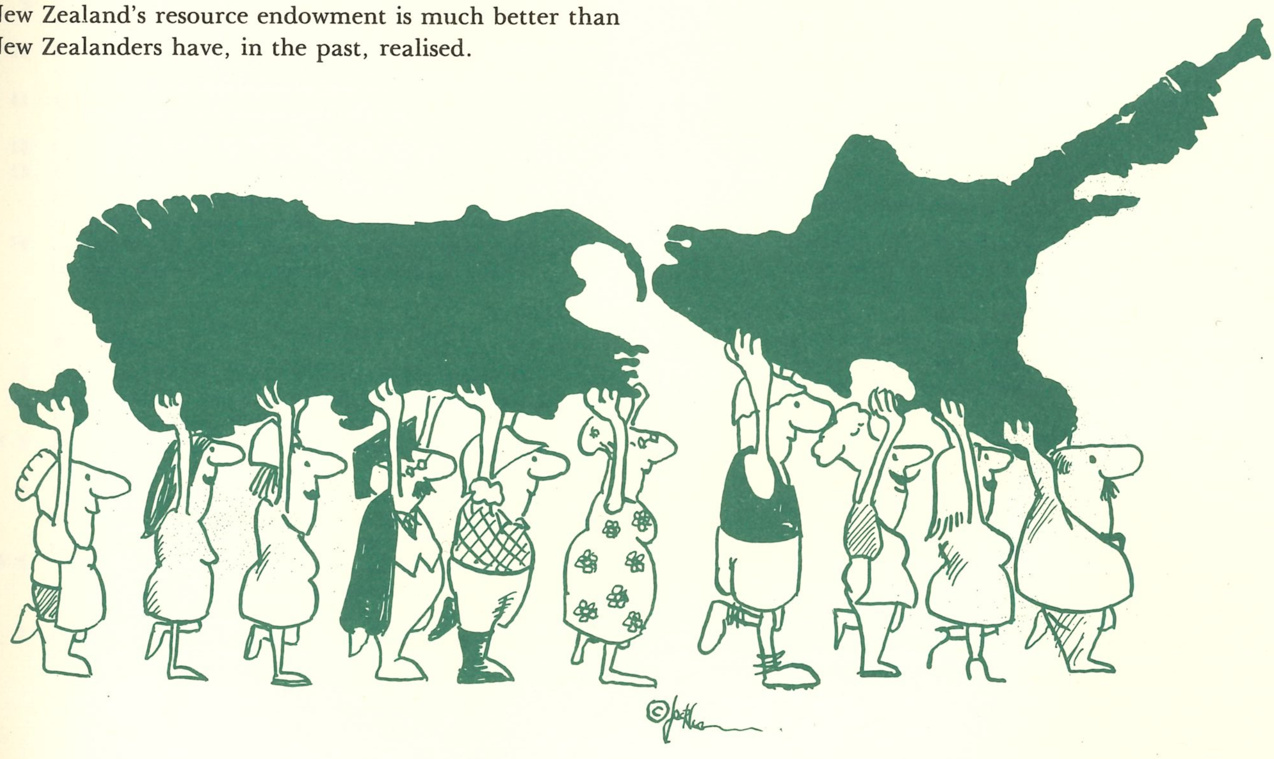
The lifestyle of New Zealanders is also reflected in our energy demands. Domestic energy demand will rise if we continue to pursue an increased standard of living and ever-more consumer goods. Alternatively, changes in lifestyle might modify the development of our energy resources. If we believe that people and communities should have the option of being more self-reliant, then the development (and/or importing) of technologies for small-scale electricity generation from the wind, the sun, and small rivers, is important. Although decentralised energy production might contribute little to total energy needs, it may serve to meet the social objective of greater community self-reliance. Decentralisation and the encouragement of community identity might also entail the provision of schools and jobs close to home, and hence reduce the need for transport fuels.

How can we make the wisest use of our non-renewable and renewable transport energy resources? The option of producing synthetic gasoline from natural gas and/or coal is one which may well entail foreign investment, industrialisation, and/or the export of some of our energy. If, however, we wish to constrain our dependence on overseas investment and expertise, it may make sense to electrify much of our transport. We have both expertise and renewable energy resources for electricity generation. Our third main option is to switch to alcohol fuels, which can be produced from trees and crops. Methanol can also be produced from natural gas in the shorter-term.

Whereas methanol production requires large capital inputs and overseas expertise, ethanol production is less capital-intensive and we have the expertise ourselves. On the other hand, ethanol production requires high quality land for crops, whereas methanol can be made from tree wastes.

Whichever choice we make now, eventually our gas and coal resources will not be available for liquid fuel production. The greatest value of these fossil fuels is the time they give us to transfer our energy demand and supply to a renewable and therefore sustainable option. If we are to avoid the disruption currently faced as oil runs out, then it is essential that we plan our rate of fossil fuel use no higher than the maximum sustainable rate possible with renewable resources.

Decisions about the development of New Zealand's resources are being made now, and more must be made in the near future. But to what purpose are we developing our resources? Is it simply to pursue an ever higher standard of living, or are we keen to create our own particular type of lifestyle, where material wealth may be just one of a number of criteria of resource use? Are we keen to see further overseas investment in the development of our resources, or do we wish to rely more on our own skills and perhaps the slower use of our resources? Are we willing to embrace the concept of sustainability now, or will we argue that a future generation must meet that challenge when it arises? Whichever way we answer these questions, we can face the future with confidence because we are in an extremely favourable resource position. In world terms, New Zealand's resource endowment is much better than New Zealanders have, in the past, realised.



# REFERENCES


**Principles of Resource Use**

1 Ray, G. F., 1977, *Industrial materials: past, present and future,* unpublished manuscript.
2 Kahn, H., W. Brown, and L. Martel, 1976, *The next 200 years — a scenario for America and the world,* William Morrow and Company, New York.
3 Henderson, H., 1978, *Creating alternative futures,* Berkley Publishing Corporation, New York.
4 Mishan, E. J., 1967, *The costs of economic growth,* Pelican Books.
5 Hardesty, J., N. C. Clement & C. E. Jencks, 1971, "The political economy of environmental destruction", in: Johnson, W. A. & J. Hardesty (eds), *Economic Growth vs the Environment,* :85-106 Wadsworth, California.

**Food and Agriculture**

1 Marstrand, P. K. & H. Rush, 1978, "Food and agriculture", in: *World futures — the great debate,* C. Freeman & M. Jahoda (eds): 79-112, Martin Robinson & Co., London.
2-3 George, S., 1976, *How the other half dies (The real reasons for world hunger),* Penguin Books, England.
4 Ojala, E. M., 1978, unpublished contribution to the CFF.
5 Marstrand, P. K. and H. Rush, 1978, op. cit.
6-7 Brown, L. R., 1978, *The worldwide loss of cropland,* Worldwatch Paper 24, Worldwatch Institute, New York.
8 Brown, L. R., 1978, *The twenty-ninth day,* Worldwatch Institute, New York.
9 Declaration of the World Climate Conference 12-23 February 1979, Geneva, Switzerland.
10 Brown, L. R., 1978, *The worldwide loss of cropland,* Worldwatch Paper 24, Worldwatch Institute, New York.
11 *Report of the Working Party on Novel Genetic Techniques,* 1978, Government Printer, Wellington.
12 Ojala, E. M., 1978, op. cit.
13 Brougham, R. W., 1978, "Maximising animal production from temperate grassland", *International Grasslands Meeting Proceedings,* Dublin, June 1977: 140-146.
14 Leamy, M. L., 1974, "Resources of highly productive land in New Zealand", *N.Z. Agricultural Science,* 8 (4).

**Fisheries**

1 Chapman, W. M., 1974, "Fisheries of the world", in *Oceanography,* Vetter, R. C. (ed.): 323-336. Forum Series, Voice of America, Washington D.C.
2-3 Brown, L. R., 1978, *The twenty-ninth day,* Worldwatch Institute, New York.
4 Knox, G. A., 1979, *New Zealand and the resources of the southern ocean.* Paper presented to the 49th ANZAAS Congress, 22-26 January 1979, Auckland, N.Z.
5-6 Bell, F. W., 1978, *Food from the sea: the economics and politics of ocean fisheries,* Westview Press, Boulder, Colorado.
7 Ministry of Agriculture & Fisheries, 1978, *Annual report to Parliament,* Wellington, N.Z.
8 Francis, R., 1978, "MAF scientists' calculations point to vast deepwater resource", *Catch '78,* 5(6): 22-24
9 Waugh, G. D., 1979, personal communication.
10 Francis, R., 1978, op. cit.

**Forestry**

1 Brown, L. R., (1978), *The twenty-ninth day,* Worldwatch Institute, New York.
2 Hillis, W. E., 1972, "Review of current situation of research into wood quality", *CSIRO Forest Product Newsletter,* 388: 3-5.
3 FAO, 1976, *Yearbook of Forest Products 1963-1974,* Food and Agriculture Organisation of the United Nations, Rome.
4 Brown, L., 1978, *The twenty-ninth day,* Worldwatch Institute, New York.
5 Williams, W. R., 1978, unpublished contribution to the CFF.
6 Persson, R., 1974, "World forest resources: review of the world's forest resources in the early 1970's". Cited in Sutton, 1975.
7-10 Sutton, W. R. J., 1975, "An evaluation of New Zealand's forestry export potential", D. Phil thesis, Oxford (unpublished).
11 FAO, 1977, *Demand, supply and trade in pulp and paper: trends and prospects to 1990,* Food and Agriculture Organisation of the United Nations, Rome.
12-15 Sutton, W. R. J., 1978, "Some export marketing implications of New Zealand's current planting programme", *New Zealand Journal of Forestry,* 23 (1): 85-94.
16 Fry, G., A. W. Grayburn & W. D. Sewell, 1978, "Management options for wood production in New Zealand". Unpublished paper to Appita Mini-Conference, Mount Gambier, South Australia. November 1978.

**Nature Conservation**

1 UNESCO, 1973, Programme on Man and the Biosphere. Expert panel on project 8: *Conservation of natural areas and of the genetic material they contain,* MAB report No. 12.
2 Fleming, C. A., 1975, "Scientific planning of reserves", *Forest and Bird,* 196: 15-18.
3 Turner, L. & J. Ash, 1975, *The Golden Hordes, International Tourism and the Pleasure Periphery,* Constable, London.
4 Henderson, J., 1978, unpublished paper to the CFF.

**Minerals**

1 Thompson, B. N., 1978, unpublished paper to the CFF.
2 Chynoweth, A. G., 1976, "Electronic materials: functional substitutions", in P. Abelson & A. Hammond (eds), *Materials: Renewable and Nonrenewable Resources,* American Association for the Advancement of Science, Washington D.C. Cited in Hayes, D., 1978.

3-4 Hayes, D., 1978, *Repairs, reuse, recycling — first steps toward a sustainable society.* Worldwatch Paper 23, Worldwatch Institute, New York.
5 Beckerman, W., 1975, "The fallacy of finite resources", *Bank of New South Wales Review,* No. 4: 10-15.
6 Carlsen, E., 1974, "The link between metals availability and the energy crisis", *Environmental Affairs* 3 (3): 447-458.
7-8 Thompson, B. N., 1978, op. cit.
9 Anon, 1978, *World Mineral Supplies.* Report of the Chemistry 305 class. Chemistry Department, Victoria University, Wellington, N.Z.
10-11 Wertenbaker, W., 1978, "Mining the wealth of the ocean", *Horizons USA,* 26: 2-6.
12 Gould, H. R., 1974, "Minerals from the sea", in *Oceanography,* Vetter R. C. (ed): p. 153-168. Forum Series, Voice of America, Washington D.C.
13 Thompson, B. N., 1978, op. cit.
14 Fried, E. R., 1976, "International trade in raw materials: myths and realities", *Science.* Cited in Hayes, D., 1978, op. cit.
15 Thompson, B. N., 1978, op. cit.
16 Anon., 1978, op. cit.
17 Thompson, B. N., 1978, op. cit.
18 Anon., 1978, op. cit.

### Energy

1 Anon., 1977, *Project Interdependence: US and world energy outlook through 1990,* Congressional Research Service, Library of Congress Publication No. 95-31, Washington D.C., U.S.A.
2 Dornberg, J., 1979, "Learning by doing: schools set a 2000-kilowatt example for wind-rich Denmark", *Popular Science,* January 1979: 81-84.
3 Anon., 1979, "Electric power from the ocean", *New Zealand Energy Journal,* 52 (2): 18.
4 Anon., 1979, "Wave power sinks into the doldrums", *NCE International,* January 1979: 28-29.
5-6 International Fusion Research Council, 1978, "Status report on fusion", *Atom 260:* 150-184.
7 New Zealand Department of Scientific and Industrial Research, 1978, *Transport Fuels for New Zealand,* Discussion paper number 1, 183 pp. DSIR, Wellington, New Zealand.
8 Minister of Energy, 1978, *Goals and Guidelines — an energy strategy for New Zealand,* 102 pp. Wellington, New Zealand.
9-11 New Zealand Energy Research and Development Committee, 1978, *Data appendix of New Zealand* (draft) for an initial multi-national study of future energy systems and impacts of some evolving technologies.
12 Minister of Energy, 1978, op. cit.
13 West, J. P. & L. G. Brown, 1979, *Compressed natural gas,* N.Z. Energy Research and Development Committee Publication No. 14, April 1979.
14 Arnoux, L., 1979, personal communication.

### Transport

1 Henderson, H., 1978, *Creating alternative futures,* Berkley Publishing Corporation, New York.
2 Byers, D. J., 1978, *Indigenous transport fuels — electricity.* Paper presented to "Transport Fuels in New Zealand — Guidelines for the Future", Wellington, N.Z., October 6-7, 1978.
3-4 King, M. A., 1978, unpublished paper to the CFF.
5 Ross, H. R., 1971, *Future developments in personal transit,* The Open University Press, Great Britain.
6 Turner, D. L., 1971, *High-speed moving pav... some of the human problems,* The Open Univ... Great Britain.
7 King, M. A., 1978, op. cit.
8 Hurst, R., 1978, unpublished paper to the CF...
9 Murray, M. E., 1978, *Impacts on aviation.* P... to "Transport 1984", Wellington, N.Z., May ...
10-12 Vance, D. J., 1978, unpublished paper to the...

### The Electronics Age

1 Williams, W. R., 1978, unpublished paper to...
2 Hall, P. (ed.), 1977, *Europe 2000,* Duckworth...
3-4 Van Valkenburg, G. L., 1978, unpublished p... CFF.
5 Mander, J., 1978, *Four arguments for the eli... television,* William Morrow and Company, In...
6-7 Williams, W. R., 1978, op. cit.
8 Carr, B., 1978, "Are *you* about to be replace... computer?" *The Bulletin,* September 1978: 54...
9-10 Nilles, J. M., F. R. Carlsen, P. Gray & G. J. ... 1976, *The telecommunications-transportation...* John Wiley and Sons Ltd, New York.
11-12 Abelson, P. H. & A. L. Hammond, 1977, "T... revolution", *Science 195:* 1087-1091.
13 Carr, B., 1978, op. cit.
14 Van Valkenburg, G. L., 1978, op. cit.
15 New Zealand Computer Society, 1978, unpub... sion to New Zealand Planning Council.

### Conclusions

1 New Zealand Environmental Council, 1978, *F... Perspective,* New Zealand Environmental Cou... Wellington.
2 Henderson, H., 1978, *Creating alternative fut...* Publishing Corporation, New York.

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New Zealand
is very well endowed
with natural resources, particularly
energy. These give us a wide range of options for the future, although we should keep in mind the goal of a sustainable society when planning for their use. Our natural gas and coal reserves, for example, give us the options of self-sufficiency in transport fuels, industrialisation and/or the export of energy. However, coal and gas will eventually run out, and ultimately our society must be sustained on our abundant renewable resources, which include land, water, fisheries and forests, together with the human skills needed to use them wisely.