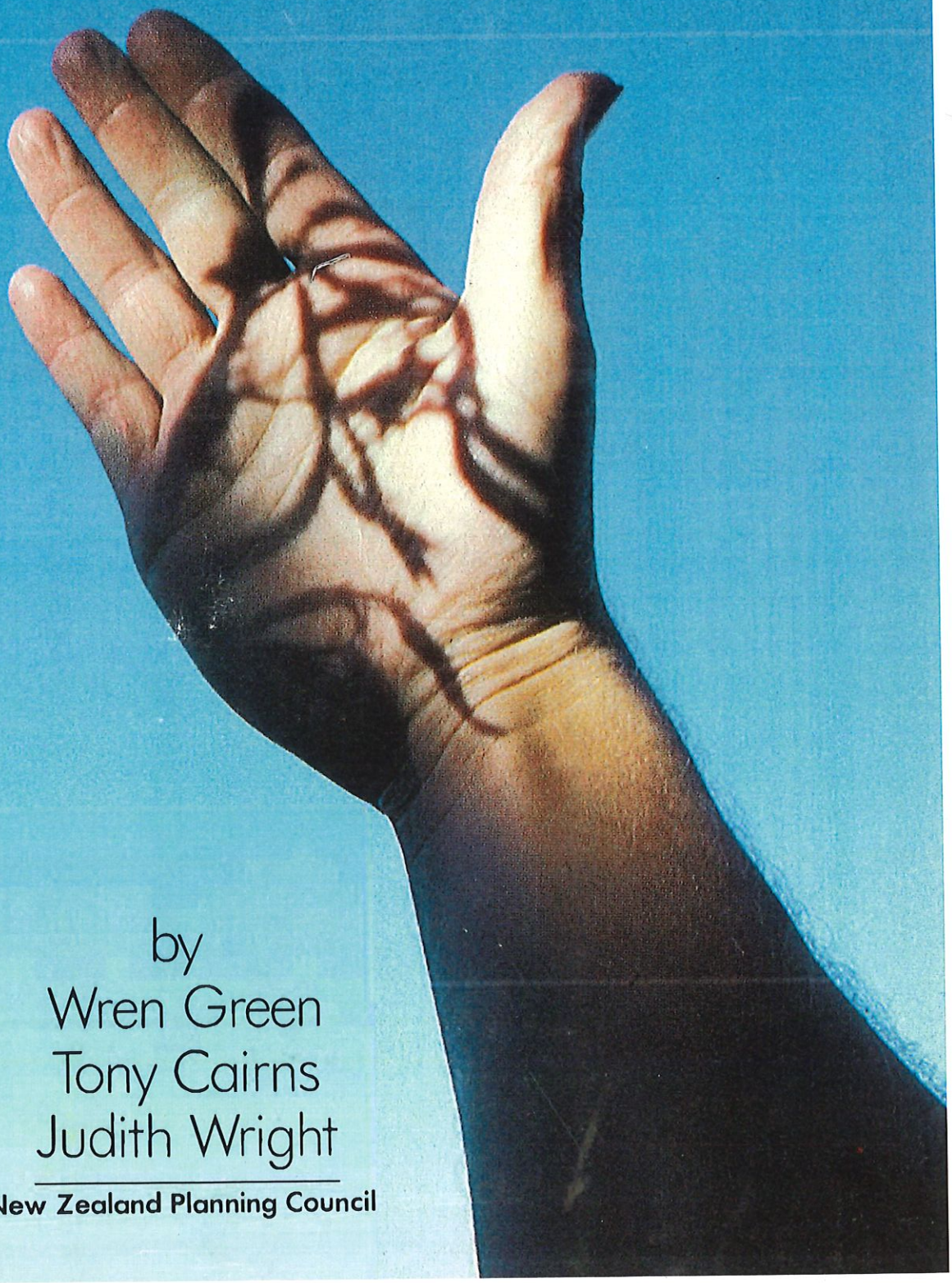
New Zealand AFTER NUCLEAR WAR



by
Wren Green
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New Zealand Planning Council

NEW ZEALAND AFTER NUCLEAR WAR

It is essential that not only governments but also the peoples of the world recognise and understand the dangers in the present situation.... Removing the threat of a world war – a nuclear war – is the most acute and urgent task of the present day.

United Nations General Assembly
First Special Session on Disarmament

Our representatives depend ultimately on the decisions made in the village square ... to the village square we must carry the facts.

Albert Einstein

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FOREWORD

NUCLEAR WAR IS A POSSIBILITY THAT MUST BE FACED, however horrifying the prospect might be. The Planning Council undertook this study of the impacts on New Zealand of a nuclear war because it felt the possibility should be examined rather than ignored. The outcome of the study justifies this judgement. The issues for New Zealand are very different from those most commonly perceived. Knowing what they are should encourage our efforts to prevent nuclear war and give us some basis for coping should prevention fail.

The project has been difficult and challenging. Information from many unrelated sources had to be assembled, assessed and assimilated. The task of the project team would have been impossible without the assistance of the many people in New Zealand and overseas who willingly gave their time and energy to it.

This was intended to be a preliminary study. The team has achieved much more than that. While no study of such a complex, hypothetical event can be definitive and more research and information is needed, the team has taken its work beyond the preliminaries to the point where proposals for action can be properly considered.

Readers will find this report useful for more than its designed purpose. In the course of exploring the impacts of a nuclear war, the authors have provided a valuable picture of the mechanics of New Zealand society and thrown light on the roles and interdependencies of its elements.

The report is only part of the result of the project. The background papers from which it is drawn and the Planning Council's recommendations for further study and action are also available from the Council.

Funds for the project came through the Ministry for the Environment. The Minister's forbearance in granting an extension of time to complete the study and in respecting the Planning Council's independence is appreciated.

To the authors Wren Green, Tony Cairns and Judith Wright, other members of the study team and the many contributors within and outside the Planning Council's secretariat I offer the Council's thanks.

GARY HAWKE
Chairperson

INTRODUCTION

THIS BOOK IS THE RESULT OF A STUDY of how New Zealand would be affected by a nuclear war. A team was set up under the auspices of the New Zealand Planning Council, after the government allocated $125,000 from reparations paid as a consequence of the sinking of the Rainbow Warrior in Auckland Harbour. The six month contract stated that the study should be a preliminary overview, looking at environmental, social and economic impacts on New Zealand of a major nuclear war in the Northern Hemisphere and identify important issues where further second-phase studies and actions are required. This study assumes New Zealand was *not* a direct target.

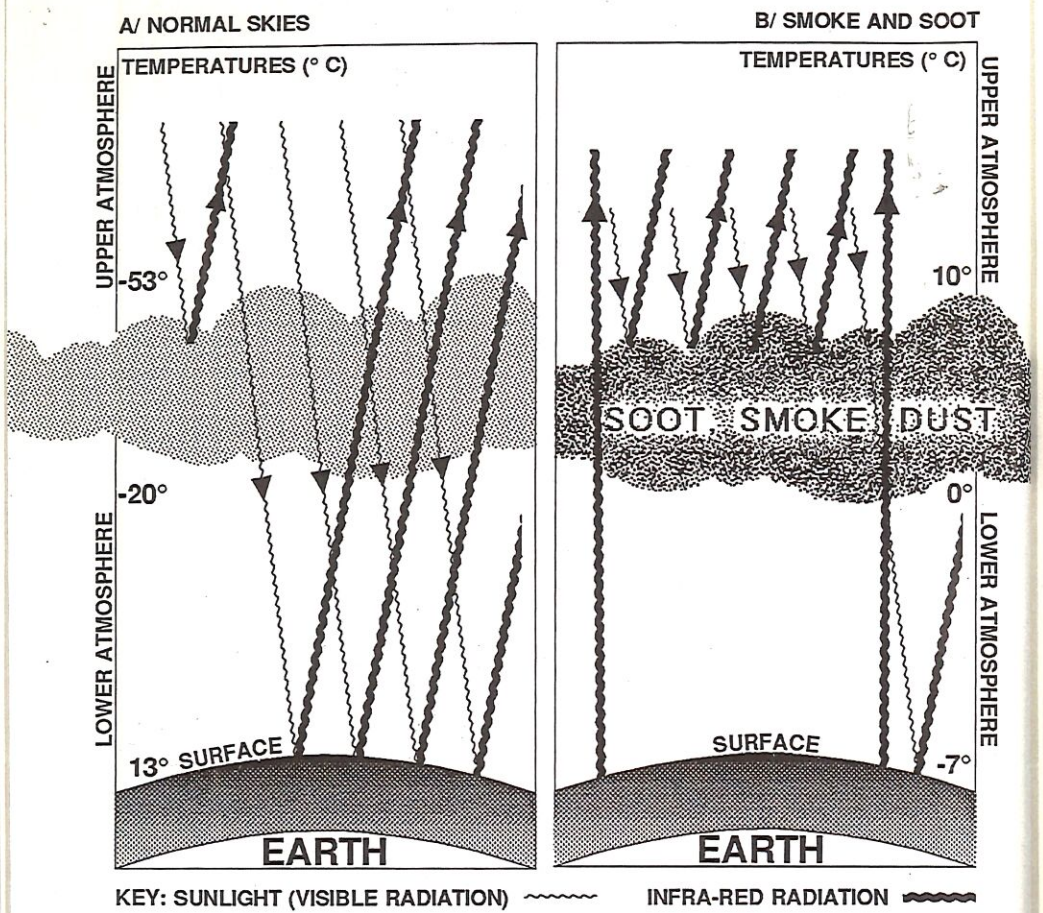
The time constraint meant that the material had to be gathered as quickly as possible. This, and the wide range of topics studied, has meant that there may be inaccuracies in the report, and there are most certainly omissions. However, it is the view of the authors that the order of any errors or omissions is not so great as to detract from the overall message, that catastrophic long-term impacts would be experienced in New Zealand, not from environmental effects, but from major social disruptions that would spread to every aspect of life in New Zealand.

It was discovered in the course of this study that public understanding of the issues reflects a Northern Hemisphere bias with fear of radioactive fallout being a major concern. Since the nuclear bombings of Hiroshima and Nagasaki, public understanding of the consequences of nuclear war has been largely limited to the direct effects of nuclear explosions. However, the indirect, long-term effects of nuclear war are now being recognised by scientists as being even more devastating, particularly for non-combatant countries.[1] For this reason considerable effort has been made to make this book useful to the general reader with the first four chapters answering some general questions about nuclear war, radiation, "nuclear winter", and the lesser known phenomenon, electromagnetic pulse (EMP).* Chapters 5-16 each give an overview of the main impacts on a

* *See Chapter 4 for detailed explanation of electromagnetic pulse and its effects*

Fig 2/

EFFECT OF SMOKE FROM FIRES ON ATMOSPHERIC TEMPERATURES



A/ Sunlight passes through clouds and warms the earth's surface. Heat radiates back into space as infra-red radiation, maintaining the overall heat balance.

B/ Soot and smoke clouds absorb sunlight and warm the upper atmosphere. However, sunlight does not reach the earth's surface. Infra-red radiation continues to leave through the smoke clouds and the resulting heat imbalance leads to cooler surface temperatures.

Source of temperature values: Nuclear Winter *O. Greene, I. Percival and I. Ridge 1985 Polity Press*

Although New Zealand might well escape being bombed in a nuclear war, it would not escape extreme disruption. Later chapters will examine the social and economic disruptions that would occur. This chapter continues with a description of "nuclear winter", and an analysis of how it might affect New Zealand.

WHAT IS NUCLEAR WINTER?

> *"Nuclear war-induced disturbances to the environment would include virtually every environmental problem of concern today – habitat destruction, species extinction, air pollutants, toxic chemicals, acid rain, ozone depletion – only on a scale of totally unprecedented extent and intensity."*[3]

The term "nuclear winter" is used in this report as a convenient metaphor for the multitude of environmental effects that could follow nuclear war. It thus includes effects such as disruptions to global agricultural systems, in addition to darkened skies and freezing temperatures. The trigger for the multiple environmental effects would be the thousands of fires started by nuclear explosions.

In a major nuclear war thousands of intense firestorms would be started in cities, industrial areas, forests and wildlands. About 70% of the populations of Europe, North America and USSR live in urban or suburban areas where fossil fuels, wood and paper products, plastics, rubber and many chemicals are heavily concentrated. The near total burnout of less than one hundred of the largest industrialised urban areas would consume 25-30% of the combustible materials in the developed world.[4]

This widespread burning of cities and industrial areas would produce enormous quantities of smoke mixed with dust from the explosions. From 25% to 35% of this smoke would be soot (carbon particles) which, being black, strongly absorbs the sunlight that normally warms the earth. Some soot and smoke would be quickly removed from the atmosphere by rain ("rainout"). The remainder (average estimates suggest 170 million tonnes) would be warmed by the absorbed sunlight and would rise above the lower altitudes in which rapid rainout occurs.

Although soot particles block incoming sunlight they are transparent to the heat that is continually returning to space from the earth's atmosphere. As a result there would be a significant heat imbalance after nuclear war – less energy would be received at the earth's surface than would be lost back

to space. Consequently the earth would cool within a few days over those Northern Hemisphere countries that had been bombed. This is the phenomenon now known as "nuclear winter" – a severe loss of light and freezing temperatures (Fig 2). The smoke clouds would spread quickly over neighbouring countries covering much of the Northern Hemisphere in one to two weeks. Thickness of the clouds would be extremely variable. Under dense patches of smoke in some areas light would be reduced to 1% of normal – the equivalent of full moonlight – in the middle of the day. Over the Northern Hemisphere mid-latitudes (30-60°N), light levels could be reduced to 5-10% of normal for the first few weeks. Clearance would be slow and would depend on how long the smoke remained in the atmosphere.

Smoke and soot particles produced in a northern "summer war" (April to October) would be heated sufficiently by sunlight to rise above the lower atmosphere (where rain is generated) and into the upper atmosphere (stratosphere). Particles would remain suspended there for months or years because they would not be subjected to rain. In winter, when there is less solar heating, particles would be less likely to be lifted into the upper atmosphere and would be more likely to be rained out in the following months. Effects through the following spring and summer would depend on the amount of smoke remaining.

Under the dense smoke clouds temperatures would drop rapidly. For a war during April to October surface temperatures in continental interiors could drop to 20°C to 40°C below normal within a few days of nuclear war. Northern mid-latitudes would have autumn or winter-like conditions for weeks or more. Freezing air masses might spill over into coastal regions and into southerly, tropical regions that rarely or never experience frost. In winter, when temperatures would already be low, the initial temperature drops below normal would not be so large. Ordinary winters would become severe winters. Temperatures in the sub-tropics could still drop well below normal in any season.

Sudden temperature drops of 25-40°C below normal would have catastrophic effects on a whole range of ecosystems, from northern grasslands to tropical forests. Mortality of plants and animals would be greatest following a "summer war" when they would be totally unprepared for freezing conditions. Even long-term temperatures of 3-5°C below average would have serious impacts on many crops. The climatic disruptions could drastically affect rainfall throughout much of the Northern Hemisphere for several months to years. The warm, smoke-laden atmosphere and

cooler surface of the earth would reduce the normal temperature gradient between earth and atmosphere that produces mixing and results in rain (Fig 2). The result would be very stable weather patterns leading to little or no rain. The monsoons which are the critical source of water to Asian and African countries could be eliminated for one or two years. Rain could also be eliminated over combatant countries for many months following a nuclear war.

The natural systems most sensitive to the low temperatures are tropical and temperate forests, lakes, streams and estuaries. Very low light levels would have greatest impact on the northern oceans, through the mortality of phytoplankton – tiny plants that are the basic food source in ocean systems. Drought would most severely affect tropical forests, grasslands, lakes and stream life.

Other environmental consequences of nuclear war should be mentioned. Many missile silos are in forests and grasslands. Attacks on these high priority targets would ignite areas of grasslands and forest that would burn out of control. Vast areas of Northern Hemisphere forest and grassland could be destroyed by fire from the initial explosions. Recurring freezes, UV radiation, radioactive fallout and toxic pollutants would kill further areas of vegetation, and make the dry dead wood vulnerable to subsequent fires. Recovery of plant communities would be slow and unpredictable.

Local radioactive fallout levels in large areas between latitudes 30° to 60°N would be lethal not only to people but also to other mammals, birds, and some plant species. From 6-20% of the total land area of NATO and Warsaw Pact countries would receive levels of fallout in the first few days that would be lethal for unprotected humans. Since coniferous plants are as susceptible to radiation as humans, the extensive pine forests of Europe and the Soviet Union would be largely destroyed by radioactive fallout, fires, loss of rain, toxic chemicals and damaging levels of radiation. Many of the large and small mammals dependent on these forests and all but the hardiest birds, would be unlikely to survive.

The urban firestorms would be filled with toxic pollutants from the burning of chemicals, petroleum products and synthetic materials. The acidity of rain water, which is already killing European and North American freshwater species and forests, would be ten times worse, especially in areas near explosions. Runoff of pollutants into estuaries would seriously damage estuarine systems.

As the smoke clouds cleared, the incoming sunlight would carry higher levels of damaging ultraviolet rays (UV). These would particularly stress tropical forests, fresh water and marine systems as well as food crops. The maximum increases would occur after eight to twelve months and would take about ten years to return to normal. UV also causes physiological stress in humans, increasing their susceptibility to disease, skin cancer and cataracts.

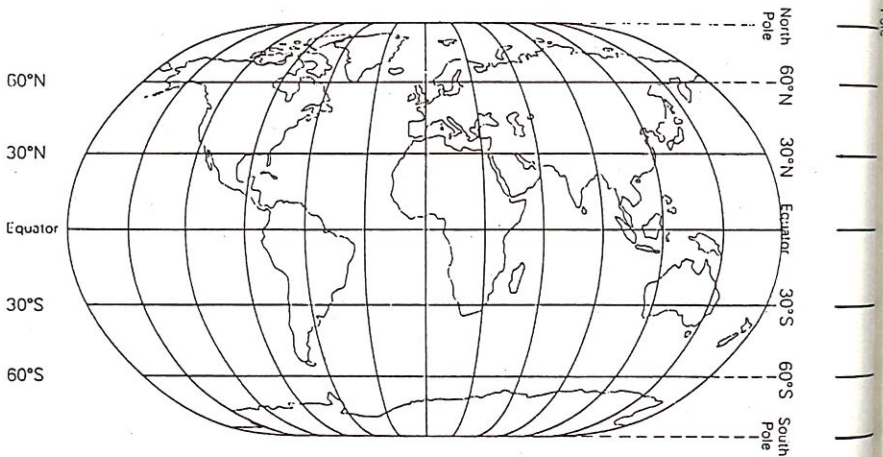
These environmental consequences are widely referred to as "nuclear winter" although the term now includes additional effects beyond drops in light levels and temperature. The initial research and much of the initial media interest centred on the *magnitude* of the likely temperature drops in the first few weeks. Whilst subsequent research[4] has shown that the immediate fall in temperature may not be as great as was first suggested, there is agreement on two critical points. First, that there will be major disruption to global climate following a nuclear war. Second, the impacts seem likely to continue for *longer* (perhaps years) than was first estimated. This is of greater significance than the actual degree to which the temperature would initially drop since it is the *long-term* temperature drops that would have the major impacts on agricultural production. In March 1987, new results from more complex and realistic computer models of atmospheric processes were evaluated at an international scientific conference in Thailand. The consensus was that likely climatic outcomes remain as outlined in the 1985 SCOPE report [4,5] and summarised in this chapter.

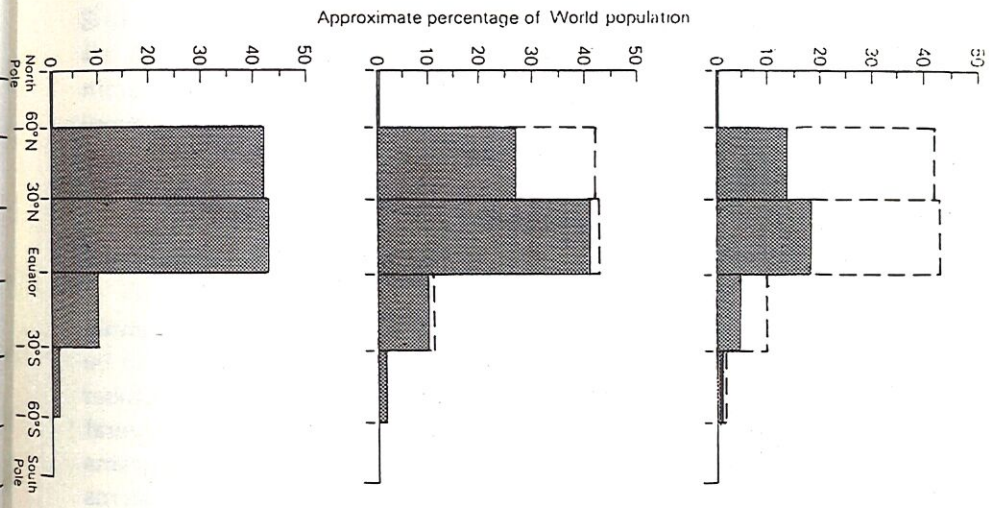
HOW MANY PEOPLE WOULD DIE?

A major nuclear war would directly kill enormous numbers of people in combatant countries. The estimates vary according to different targeting scenarios but range from 250 million to 1,000 million people, with addi-

Fig 3/
HUMAN POPULATION AT RISK FROM DIRECT AND INDIRECT EFFECTS OF NUCLEAR WAR

Source: *SCOPE 1985* vol 2 Chap 2, (ref 5)





tional millions suffering injuries.[6] The death of one billion people in probable combatant countries is shown in Fig 3. However, even greater numbers of people would be at risk of dying from starvation as the following explains.

The world's five thousand million people are heavily dependent on complex agricultural systems for their food since less than 5% of this number could be supported by natural ecosystems alone.[5] Food production is highly vulnerable to many of the environmental impacts of nuclear war as well as to the loss of modern machinery, energy, technology, and chemicals which make modern agriculture possible. Of particular significance is the effect of even minor drops in *average* temperature. On a daily and seasonal basis we are used to considerable variations in temperature, sometimes of 10-20°C. Yet over periods of several years average temperatures change very little, and it is these long-term temperature averages that are crucial. At the height of the last ice age in New Zealand, when the area under forest was severely reduced, the average temperature was about 5°C colder than at present.[7] Average Auckland temperatures were similar to those of present-day Invercargill.

Many of the world's major grain crops are sensitive to average temperature drops of much less than 5°C. For example, wheat production in Canada would probably be eliminated by a decrease of 3°C in average temperature.[5] Although the plants would grow, the reduced growing season and lack of heat would prevent the grain heads from ripening. Rice is the grain crop most sensitive to temperature drops. If temperatures fall below 15°C at critical growing periods rice grains do not form.

These, and similar analyses of many other crops, indicate that all grain production could be effectively eliminated in the Northern Hemisphere following a major nuclear war for at least one summer.[5] These conclusions would hold for the *very small* average temperature drops that are now predicted for the many months following a nuclear war. Greater temperature drops, e.g. over 5°C reduction, would far exceed the thresholds that eliminate grain crops.

These results were used in the SCOPE study to assess the potential impact on humans. From estimates of the amount of food likely to be available in a country for one year, calculations were made of the number of people that could be kept alive over that period.[5] However, several simplifying and conservative assumptions were made, such as all grains would be used to feed people not animals, and food distribution systems

would work as at present. Thus the outcome summarised in Fig 3 is not a worst case outcome.

In the vast majority of countries (excluding New Zealand, USA, Canada and Australia) there is less than one year's food supply available at any point during the year. Therefore, if international trade ceased the outcome of a nuclear war would be starvation, particularly for many of the 85% of the world's population who live north of the equator (Fig 3 C).

Nuclear war impacts would thus extend to non-combatant countries, not by blast but through starvation on an unprecedented scale. For example, Japan imports more grain then it produces annually and imports all its crude oil. Average food stores alone would be insufficient to feed the present population for a whole year. Agricultural production could be eliminated for a year or more following relatively mild climatic stresses. A 3-5°C average temperature drop would seriously reduce rice harvests, and larger decreases would eliminate Japanese rice production. Acute food shortage and large-scale mortality would be possible in such circumstances. Fatalities in India from starvation could eventually exceed the number of fatalities in the USSR and USA caused directly by nuclear explosions.

Since the likelihood of nuclear war is greater than zero and the consequences would be disastrous, there can be little doubt about the value of identifying the major consequences likely to face New Zealand.

HOW WOULD THE SOUTHERN HEMISPHERE BE AFFECTED?

If it were not a nuclear target New Zealand would not experience blast and high radiation effects of explosions. Nor would New Zealand experience rapid and substantial temperature drops given its distance from combatant countries. The perception that "nuclear winter" effects would be similar around the globe is false.

Misconceptions are inevitable when most information has tended to be from northern sources whose natural bias is to discuss global impacts from their own perspective. The catastrophic impacts felt in Switzerland or Great Britain, for example, would not be the same as those experienced in New Zealand. The effects south of the Equator would be less severe and would be different in some important respects.

The amount of smoke reaching the Southern Hemisphere would be

strongly influenced by what time of year the war occurred. A war beween April and October (i.e. northern summer) would result in the maximum amount of smoke reaching southern skies. There is normally a weak interchange of air across the Equator in the lower atmosphere. A large volume of warm smoky air could disrupt this pattern and consequently smoke would be *actively* carried into southern skies. This smoke would first arrive over New Zealand in three to four weeks, unlike the normally slow exchange via the upper atmosphere which takes a year or more.

Even so, the amount of smoke overhead after a northern summer war would be much less than that in northern skies. Compared to Northern Hemisphere light reductions of up to 95%, light levels in New Zealand could be reduced by about 20% for the first year. This would not cause freezing weather conditions although the resulting temperature drops (Chapter 1) would cut plant growth rates and have significant effects on some crops (Chapter 8). Temperature drops would be greater for southern continents. These are current estimates and further research may indicate greater amounts of smoke travelling south and thus greater temperature drops.

Changes in rainfall patterns are difficult to estimate for the Southern Hemisphere and for New Zealand. Nonetheless, general predictions from computer studies suggest a reduction in rainfall would be possible, which could produce drought conditions over Australia. Rainfall might be reduced by up to 50% over New Zealand although the effects would vary between regions.

The impact of radioactive fallout would be much less in New Zealand compared with the Northern Hemisphere. Global fallout levels in New Zealand (even if Australia were bombed) would be only 5% of average Northern Hemisphere levels. The effects of this amount of radiation are discussed in Chapter 3.

After a northern winter war (November to March) much less smoke would be sufficiently heated to rise into the upper atmosphere and disruption of the hemispheric circulation patterns is less likely. Northern Hemisphere countries would thus receive most of the smoke from a "winter" war although if sufficient smoke still remained into the spring, it could be carried south. Further research is required to evaluate these effects.

RADIOACTIVE FALLOUT

SINCE 1945 WHEN HIROSHIMA AND NAGASAKI WERE BOMBED, people have tended to think of nuclear war in terms of horrifying images of radiation illness and death. It is true that ionising radiation – or radioactive fallout – would kill millions of people in combatant countries. In a major nuclear war lethal levels of fallout could cover from 5% to 20% of the total land areas of Warsaw Pact and NATO countries within the first two days.[1] Much larger areas of the combatant countries would be covered by sub-lethal levels, causing widespread illness which might lead to death. Thus images of pervasive meaningless death and lingering pain are realistic fears for the many millions who live in the likely combatant zone of latitudes 30-60°N.

These consequences are not likely in Southern Hemisphere non-combatant countries and yet radioactive fallout is one of the main concerns New Zealanders have about nuclear war (Appendix 1). One reason for this is that most of our information about nuclear war comes from Northern Hemisphere sources. This chapter shows why radioactive fallout would not greatly affect New Zealand (assuming New Zealand is not a nuclear target) and outlines the likely impact that it would have.

WHAT IS RADIOACTIVE FALLOUT?

A fuller account of radiation terminology and effects is contained in Background Paper 9. Only the main concepts relevant to an understanding of the results are outlined here.

Nuclear explosions produce material with atoms that have unstable nuclei. These nuclei become stable by releasing bursts of energy called ionising radiation. Radiation causes damage to plants and animals when

its energy is absorbed by sensitive tissue. The term "rem" is used to measure how much radiation energy is absorbed. The process of unstable products releasing energy and becoming stable elements is called radioactive decay. Many radioactive products decay rapidly (within seconds) while others take years to decay.

The dose level of radiation that would kill 50% of fit healthy adults is 350 to 450 rem received over a two to three day period. The same dose received over a longer time, allows more chance of recovery and would kill fewer people. Thus the time over which the dose is received is an important factor. People stressed by other injuries, in shock, or without medical care could die from dose levels below 350 rem. A dose of 600 rem in a few days is almost certainly lethal. The various health effects of different levels of radiation are shown in Figure 5. Levels of 100 rem or greater would only be experienced in New Zealand if it was a nuclear target.

The radioactivity in material produced by nuclear explosions decreases rapidly with time. As a result, one hour after an explosion the radiation dose rate received from the material could be 1000 rem/hour, but after two hours the rate could have dropped to 400 rem/hour. After 10 hours the rate would drop to 63 rem/hour, and after two days to 10 rem/hour. After one month it would be about 0.4 rem/hour. Because of radioactive decay, 90% of the dose that an unprotected person would absorb would be accumulated within the first three days.

In the enormous heat and violence of nuclear fireballs (temperatures reach millions of degrees centigrade) over 300 radioactive products of some 36 different elements are produced. Four radioactive elements (iodine, cesium, strontium, plutonium) are particularly important because of their effects on humans. However their decay rates and behaviour vary enormously and they therefore pose differing threats.

Decay rates are measured as "half-lives" – the time taken for half of the original radioactivity to decay. Iodine-131 concentrates in the thyroid and has a half-life of eight days. Hence the radioactivity in a quantity of iodine-131 will be halved in eight days, and halved again in the next eight days and so on. Thus after two to three months iodine-131 is no longer emitting any significant amounts of damaging radiation. Cesium-137 has a half-life of 30 years. When taken into the body it spreads throughout most tissues, especially muscle, but is excreted in one to two years. Strontium-90 has a half-life of 28 years, resembles calcium in its biological activity, and so is absorbed into bone from which it is removed very slowly. Plutonium-239 has a half-life of 24,000 years and is very damaging if retained in the lung, liver or bone.

Radiation increases the risk of cancers of nearly all types and radiation-induced cancers are indistinguishable from "normal" cancers. Susceptibility varies enormously according to age, sex and which organ is exposed to radiation. The greater the dose of radiation, the higher the incidence of genetic diseases and cancers. Cancers from radiation associated with fallout take many years to appear. Leukemias and bone cancers appear from two to 25 years after exposure, while other cancers (including thyroid cancer) appear 10 to 40 years later. The number of extra genetic diseases is comparable to the extra cancers that would appear, but it would take several generations for all the genetic diseases to occur.

Types of fallout

Nuclear explosions lift radioactive particles various distances into the atmosphere depending on the size of the particles and the force and height of the explosion. The resulting fallout is called *early* or *local* if it returns to earth within 48 hours after the explosion. Early fallout (from radioactivity on larger particles) can cover a wide, but still restricted, area. For example, early fallout from a one megaton near-surface explosion could spread lethal radioactivity levels over about 100 x 40km (4,000 km^2) and put unprotected people at serious risk over an area of roughly 300 x 60km (18,000 km^2). Roughly 50% of all fallout from a nuclear weapon exploded at ground level (ground burst) would be early or local fallout. By contrast, an airburst (in which the fireball does not touch the ground but the explosion occurs within several kilometres of the surface) produces virtually no local fallout and all the radioactivity is delayed fallout. Only if New Zealand was a nuclear target would it receive local fallout.

Delayed fallout results from smaller radioactive particles being lifted higher into the atmosphere. Two sorts of delayed fallout can be distinguished. *Intermediate* fallout does not rise above the lower atmosphere (up to about 15 km – 1.5 times the height of Mt. Everest) and falls back to earth in rain or is pulled back by gravity within a few weeks. Intermediate fallout is deposited within the same hemisphere as its origin (Fig 4).

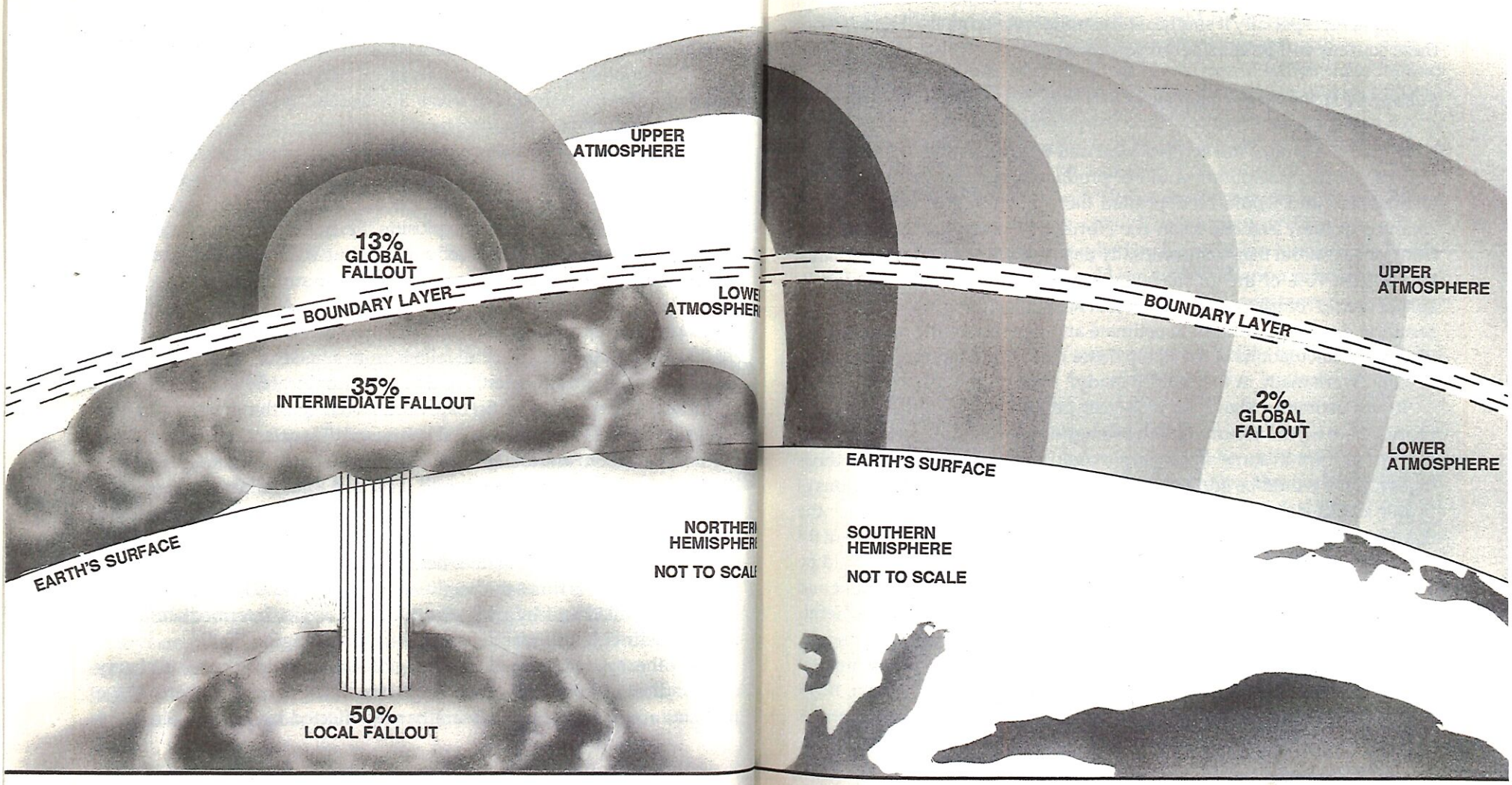
The other type of delayed fallout is *global* fallout which consists of very small radioactive particles carried high into the upper atmosphere. These particles are so light that they are hardly affected by gravity. Since the

Fig 4/

APPROXIMATE DISTRIBUTION OF RADIOACTIVE FALLOUT FROM NORTHERN HEMISPHERE EXPLOSIONS

Fig 4/

Diagram only shows groundburst explosions since airbursts contribute only to intermediate and glodal fallout. Size, number and height of explosions would all influence the resulting fallout patterns. For example, total local fallout might range between 30% and 50% of all fallout. Intermediate fallout is widely dispersed over some weeks but remains in the same hemisphere as the explosion. New Zealand would receive only the small amount of Northern Hemisphere fallout that was lifted high enough into the atmosphere to be carried south.



upper atmosphere is above the rainfall zone (confined to the lower atmosphere) these small particles remain suspended for several months or years and become truly global in their distribution. Eventually they sink in cold air masses when they are subjected to rainfall and return to the earth's surface.

NUCLEAR WAR IMPACTS

New Zealand would receive global fallout from explosions in the Northern Hemisphere and delayed fallout from explosions in the Southern Hemisphere, especially if southeast Australia were targeted. The effects of these sources will be considered separately.

Fallout from Northern Hemisphere

New Zealand would not receive local and intermediate fallout because both these classes of fallout would be produced primarily in the Northern Hemisphere and would be deposited there as well. The radiation dose received in New Zealand from the Northern Hemisphere would come from global fallout that was eventually deposited over a period of decades and at least 75% of the global fallout produced in the Northern Hemisphere would return to earth within that hemisphere (Fig. 4). Although the resulting doses are difficult to estimate and depend on the nature of the war, some calculations of the likely doses that would be received in New Zealand were made in the SCOPE study.[1]

It was estimated that over a 50-year period, people in the Northern Hemisphere would accumulate an average dose of about 12 to 15 rem from delayed fallout. In some areas people could receive doses up to 10 times higher. (This would be additional to doses from local fallout.) Millions of people could develop cancers as a result. The average dose over the Southern Hemisphere would be almost 20 times lower, a total of about 0.8 rem over 50 years in New Zealand, although half of this dose would be received in the first 10 to 15 years. This value assumes that some smoke and radioactive particles would be carried rapidly into the Southern Hemisphere in a disturbed atmosphere during the first months after nuclear war. Without this rapid mixing the dose for New Zealanders would be about 0.5 rem. The radioactive element cesium-137 would be the main source. A further dose of 1 rem would be accumulated from diet (mainly cesium-137 and strontium-90 incorporated in the food chain) over 50 years.

Thus a total dose of about 2 rem would be accumulated over 50 years by people in New Zealand from northern global fallout. This would be a *smaller* amount than the 10 rem received over the same period from natural background radiation that occurs naturally in rocks, soil and space (8 rem) and from technological sources (2 rem). In other words, people are all the time being exposed to naturally occurring and other radiation at an annual rate of accumulation of about 0.2 rem per person (Fig 5).

There is an important uncertainty in the above estimates of fallout levels. Significant additional radiation could be released if the world's non-military nuclear power plants (about 300 at present), military reactors and weapons facilities were targeted. The extent to which these nuclear facilities would be targeted and how their radioactive material would be dispersed is uncertain. Some "worst case" assumptions suggest a two to sixfold increase in total accumulated doses for humans in mid-Northern Hemisphere latitudes over a 50-year period. The possible effect on southern latitudes is very speculative. "Worst case" estimates might double or triple the total dose of 2 rem for New Zealanders over 50 years.

The increase in radiation absorbed by New Zealanders due to a Northern Hemisphere nuclear war would not cause radiation sickness, nor lead to immediate deaths, but would contribute to a long-term rise in cancer levels.

The following estimates of cancers caused solely by northern global fallout have been provided by scientists at the Institute of Nuclear Sciences, DSIR. Such estimates cannot be made with great certainty, but are sufficient to show the scale of the risk involved. They are based on a value for cancer risk within the range quoted by authoritative overseas sources. Cancer incidence was estimated assuming that each increase of 1 rem in the New Zealand population (of 3.3 million) leads to about an extra 1,000 cancers. Presuming the availability of present medical care about one-third of these cancers would be fatal.

Thus a 2 rem rise would cause 2,000 extra cancers, which would develop over a 70 year period; and cause about 700 fatalities. Fatalities would rise if medical care fell. This figure would however, be outweighed by the normal occurrence of cancer cases, which is currently 9,000-10,000 each year. Over a normal 70-year period in a population of 3.3 million, there could be 700,000 cases of cancer of which 400,000 would be fatal. The

accumulation of natural background radiation of 10 rem per person over this period would be responsible for about 10,000 of the expected 700,000 cases. Thus 2,000 extra cancers caused by fallout from a nuclear war would be undetectable because of the high normal rate of cancer.

Extra genetic abnormalities are likely to be less than the number of extra cancers (2,000) and would be spread over several generations. The extra dose to pregnant women is unlikely to exceed 0.05 rem per pregnancy. This could lead to one extra health problem in each 10,000 births, compared with 600 similar problems expected normally in this number of births.

Fallout from Southern Hemisphere

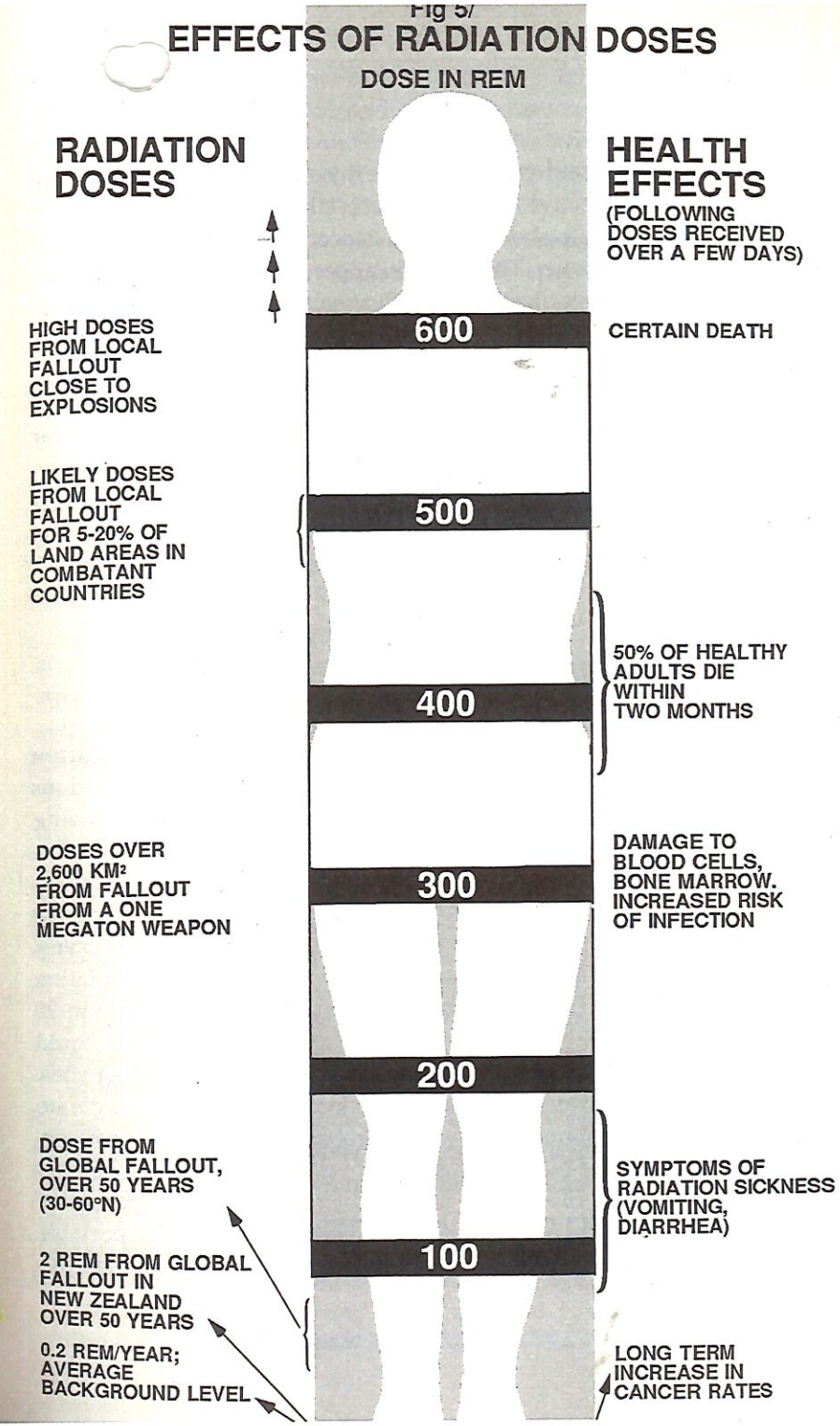
In addition to global fallout from Northern Hemisphere explosions, New Zealand would also be subjected to global fallout from Southern Hemisphere explosions. The impact would depend on the scale of the attacks. Taking the most pessimistic assumptions of the study a total amount of 15 megatons of warheads was assumed to have been exploded in the Southern Hemisphere. The extra fallout on New Zealand would provide a further dose of 0.2 to 0.6 rem over 50 years. Taking the 0.6 rem value over 50 years would add an extra 600 cancers (200 deaths) to the value for New Zealand cancers from Northern hemisphere global fallout. This would increase fallout-caused cancers by 30%.

Fallout from southeast Australia

Targeting southeastern Australia could cause intermediate fallout over New Zealand as well as global fallout. The additional radiation dose could require preventive action to reduce the health effects. The following assumes a likely worst case of 3 megatons dropped as ground-level explosions on southeast Australia. A maximum of 40% of intermediate fallout could head towards New Zealand. Some would settle by gravity over the Tasman. Assuming none is rained-out over the Tasman, the rest is available to be spread evenly by rain over the whole country. Non-iodine related doses from fallout would then total about 0.45 rem over 50 years and be responsible for about 450 extra cancers, 150 of which would be fatal. (In fact, all the fallout would not reach New Zealand as some fallout would drift on over the Pacific.)

Cancers caused by iodine-131 could be a greater problem. Iodine-131

Fig 57



is the dominant radioactive element for the first two months. It would fall on pasture, be eaten by cows, and would be a danger to people if they then consumed iodine-contaminated milk, butter and cheese. It localises in the thyroid and under these circumstances the thyroid dose could be as much as 15 rem. If no protective measures were taken the resulting thyroid disorders would include about 400 fatal cancers, 3,600 non-fatal cancers and 12,000 benign tumours. These would appear between 10 and 40 years after exposure. Since risks from iodine-131 arise mainly via dairy products, thyroid cancers would be substantially reduced if milk supplies were impounded for two to three months and pre-war stocks of dried milk powder and cheese used instead (by which time very little radioactive iodine-131 would remain). New Zealand would have ample pre-war stocks for its population though distribution could be a problem. Alternatively, distribution of potassium-iodate tablets would be an option. If taken before the fallout arrives, the iodate prevents iodine-131 from being taken into the thyroid. Present stocks are insufficient if there were a nationwide demand and, as all stocks are held in bulk store in Wellington, distribution problems would arise.

POST-WAR RESPONSES

Although the amount of fallout which might reach New Zealand might not have serious long-term impacts, fear of it is likely to provoke tremendous anxiety and a sense of helplessness amongst New Zealanders following news of nuclear war. Since radiation cannot be seen and is poorly understood by most people there would be a strong demand for frequent, accurate and clear information from qualified people. High priority should be given to providing accurate information on local fallout levels and on the implications for personal health. The National Radiation Laboratory is based in Christchurch and monitors fallout of strontium-90 and cesium-137 at three New Zealand sites. After a nuclear war they could also monitor iodine-131 and activate unused equipment at six other sites. With disruptions to transportation and telecommunications, accurate information on local fallout levels would probably require local monitoring independent of the National Radiation Laboratory. If there were an electromagnetic pulse (EMP) (see next chapter), regional independence would be essential, particularly given the likelihood that smaller, portable monitoring devices would sustain less damage from an EMP than the equipment in the Laboratory.

If southeast Australia were targeted, iodine-131 levels would require prompt action to detect levels of contamination in milk and milk products. If those were declared unsafe, essential needs for milk would have to be met from other sources, namely safe milk powder. The demand for potassium-iodate tablets could be high. The expected source of supply would be doctors and chemists but at present neither group stocks potassium-iodate tablets.

Monitoring programmes would identify areas of low fallout where milk supplies might be acceptable with respect to strontium-90, cesium-137 and iodine-131 levels. Other methods could be used to reduce the levels of radioactivity in foods, but may not significantly reduce overall radiation exposures. These include washing fruit and leafy vegetables, avoiding certain foods (dairy produce, freshwater fish), using pre-war stored food and water purifiers.

POLICY ISSUES

Planning options should focus on three main objectives. First, to ensure that accurate, comprehensive monitoring of fallout can be maintained after nuclear war. Second, to be able to maintain effective channels of information for policy-makers and the public despite the likely disruptions. Third, to improve significantly public understanding of radiation and radiation hazards.

Total reliance on the facilities of the National Radiation Laboratory for all specialised monitoring programmes after a nuclear war would be unwise. Major vulnerabilities in communication and transport could cause unacceptable delays or make it impossible to have samples sent to Christchurch.

Consideration should be given to:

- Establishment of a system that would allow independent and effective monitoring services at a regional level. Training and extra equipment would probably be needed. People in positions with appropriate skills (in universities, health services, DSIR, and the armed services) should be identified and given responsibilities in event of emergencies.
- Evaluation of the vulnerability of radiation-monitoring equipment to an EMP and a costing of necessary countermeasures.

- Establishment of procedures for transporting samples of contaminated material (soil, air, water, milk) to the National Radiation Laboratory in emergencies.
- Establishment of supplementary specialist facilities in the North Island, for example in Wellington at DSIR's Institute of Nuclear Sciences, and/or in Auckland.
- Clearly define the hazardous levels of radioactivity for different situations and make these known along with appropriate countermeasures. This would avoid the kind of confusion amongst officials, conflicting safety standards and contradictory actions which provoked understandable public exasperation and mistrust in Europe after the Chernobyl disaster.
- Evaluation of the merits of maintaining protected stocks of food, especially dried milk and animal feed.
- Evaluation of the merits of all health boards maintaining sufficient supplies of potassium-iodate tablets for emergency needs should they be necessary.
- Additional research into regional differences between soils as they relate to the retention of contamination by pastures and crops. Identification of pathways through food chains which may lead to higher than average doses of radiation for some communities.
- A public education programme to fully inform people of the nature of ionising radiation and its potential impacts.

THE DEVASTATING EFFECTS OF AN ELECTROMAGNETIC PULSE

THE PREVIOUS CHAPTER DISCUSSED radioactive fallout in some detail because the survey commissioned for this study (Appendix 1) revealed that radiation was believed to be the most serious consequence for New Zealand after a nuclear war. However, as that chapter showed, the amount of radioactive fallout likely to reach New Zealand is many times smaller than most people envisage.

Conversely, this study reveals that people are generally unaware of a consequence which could have a far more devastating effect than either the expected amount of radiation or a "nuclear winter".

This phenomenon is the electromagnetic pulse (EMP) produced by all nuclear explosions. The higher above the ground a nuclear explosion occurs, the greater the surface area covered by an EMP. The EMP produced by ground bursts or low-level airbursts would have minor effects within several kilometres radius. Only high altitude explosions produce significant EMP effects.

While it is generally considered unlikely that such a high altitude explosion would occur over or close to New Zealand, it is considered more likely to occur over Australia.[1] There are three important joint USA-Australian military communications facilities in Australia at Pine Gap, Nurrungar and North-West Cape. Whilst intelligence experts are confident that these facilities are directly targeted by Soviet missiles, this does not also preclude the additional use of EMP as a disabling act at the initiation of a nuclear war.

Less likely but still a possibility in a nuclear war is the use of EMP-generating explosions specifically to disable Australian ports and cities in the southeast and east. A further possibility is the targeting of French

economic and social problems, and the need for new decision-making processes would all demand attention. Currently New Zealand society has difficulty resolving problems which are minor by comparison, such as those associated with redundancies, re-structuring, unemployment and decline in export markets. It would take high levels of initiative, co-operation, adaptability and tolerance to facilitate a return to a relatively stable, open and democratic society after the shock of nuclear war.

POLICY ISSUES

The relationship between public and government is considered in Chapter 16, but the importance of developing consultative processes and general principles for resource allocation needs to be stressed. Recovery would also depend on the resilience and ability of communities to cope co-operatively with social stresses. Identifying these positive, resilient qualities of communities and how they can be encouraged elsewhere would be of benefit in the advent of any kind of disaster. In the course of this study, it was found that New Zealanders have a poor understanding of likely impacts on New Zealand of a nuclear war. There is especially a lack of understanding of how extensive and pervasive the longer-term effects of losses of imports and export markets would be. This poor understanding reflects a lack of information, not an unwillingness to learn. The NRB Public Opinion Poll (1986) for the Defence Review[3], and responses to this study, indicate that people are receptive to accurate information and that they believe that there is a need for planning to reduce post-war problems. Improving that public understanding should be a primary objective in any planning. If people had a more realistic understanding of the likely consequences of nuclear war, they would be better able to enter into the debate on whether and how much to plan; understand the options open to government; understand why prevention is imperative; and if nuclear war were to occur, would react less destructively than they might if they were ill-informed. The following chapters are part of that process of education.

VULNERABILITY OF COMMUNICATIONS

WHAT PEOPLE DO IN A CRISIS depends largely on what information they have received upon which they can base their decisions. The flow of information depends on various systems of communication.

Today's society has developed a highly sophisticated network of communication systems including telephones, telex, computers, broadcasting and newspapers. New electronic technology is being incorporated into these systems very rapidly which is either fully imported or dependent on imported parts. Thus a loss of trade with the Northern Hemisphere would eventually cripple existing systems of communication. The development or restoration of systems which could be maintained from domestic resources would take a long time.

NUCLEAR WAR IMPACTS

Communications during crisis

During any crisis, accurate information and the ability to pass it on to the appropriate people is of paramount importance.

People are not passive receivers of information. They interpret it, judge if it is reliable, confirm it with other people, and then decide whether or not to take any action. Experience from natural disasters, and technological disasters such as Chernobyl, shows that people want to be told the truth of the situation and be given as much detail as is necessary to enable them to make decisions about what to do. Without information it is impossible to reduce uncertainty about what has happened, to find out the consequences, and take appropriate action. When the threat is invisible or distant, as it was for Europeans after Chernobyl or as it would be for New

Zealand after a distant nuclear war, the need for effective communications and accurate information is even greater.

Consequently the pressures on New Zealand's communication systems, would be intense. The telephone system would be overloaded, and unless there were alternative systems in place such as radio links, responses of officials, emergency services and government would be seriously hampered and could lead to serious delays in communications between government, officials and the public.

As long as the country was not affected by an electromagnetic pulse (EMP), government would have access to television, radio, newspapers and the wireservice. In the crisis period of the first month there is no technical reason why these communications systems should not be able to continue normal operations and they would be very important outlets for information.

Consequences of an EMP

If New Zealand suffered the direct effects of an EMP, the results for the communication systems would be disastrous, particularly considering that many of the computers and electronic communications systems of the Broadcasting Corporation, New Zealand Telecom, and most government departments (including Defence, Justice, Police and Foreign Affairs) are not protected against an EMP.

Unless protected, computers, which have become indispensable in speedy communication systems, would be damaged. Furthermore, unless copies of software or databases were stored on optical back-up disks, vital information could be lost.

The telephone system could be completely out of action because of damage to electronic telephones and to electronic exchange equipment attached to above-ground telephone wires. At present 25% of the telephone exchanges are electronic (expected to be 100% by 1990) – all of which would be damaged by an EMP. The network of fibre optic cables which carries some of the telecommunication signals would probably survive an EMP, despite their performance being degraded for the duration of the impulse and for up to an hour later, though the electronic boxes every 30-50 km along the length of the cable would be damaged. There would not be sufficient staff or electronic spares to repair the entire system immediately. Priority users (perhaps government and emergency services) would have to be decided on.

Most international communications are via orbiting geostationary satellites and undersea cables. Both are vulnerable to an EMP and could be targets for attack. Special purpose satellites such as those used for the direct broadcasting of local television by a non-combatant country might not be a direct target but could nevertheless be extensively damaged since they would seldom be located at a distance greater than about 1000 kms from other satellites in the geostationary orbit, which is within the range of an EMP.

International communications would therefore probably be reduced to high frequency (HF) radio signals. HF radio depends for its operation on reflections from the ionosphere that occurs above about 100 kms height. Nuclear explosions create short-lived ionospheric disturbances in their immediate vicinity but the ionosphere as a whole is extremely robust. If ground terminals are available (transmitters and receivers) then HF communications would survive.

Although microwave links and broadcasting systems are fairly robust, in that they are designed to operate with high voltages present, it is unlikely they could withstand a severe EMP. So the important media outlets for information would be crippled. Newspapers are now printed on electronically-controlled imported presses. They would be inoperative without electricity and their electronic components would probably have been damaged.

With the loss of radio, television and newspapers, people would know only what they could find out for themselves. Information about events in the rest of the country and overseas would be sketchy for at least two days for the majority of the people in New Zealand until electricity could be restored to the main centres, and communication networks could be established. Central or local government people would be unable to communicate with the public and might have very limited information themselves.

POST-WAR RESPONSES

If there were no EMP

Without an EMP, communications systems should be able to operate for some months without major problems. Newsprint is made in New Zealand. Existing stocks, including export orders, normally exceed 60,000

tonnes which would suffice for three to four years with careful use. More critical would be imported components, for example printing plates and ink supplies. If the pulp mill continued operating newsprint could be stockpiled pending the final failure of machinery such as heavy rollers, bearings, and other import-dependent items.

Existing spare parts should suffice to maintain radio services for two to five years before shortages had serious impacts. Eventually, an erratic electricity supply would increasingly affect radio and television receptions and could also affect transmission where stand-by diesel generators were absent or had inadequate fuel.

Many components in sophisticated telecommunication systems, such as integrated circuits, are imported and have no locally-produced alternatives. Long-term viability of nation-wide communications would depend on re-learning how to make mechanical telephone equipment based on 1930s technology. The older telegraphic service, now being superseded by telex and facsimile operations, would be a more robust long-term system providing it could be re-built.

If there were an EMP

Communications would not cease if there were an EMP, but at first they would be limited and erratic. The limited nature of reliable information would allow rumours and misinformation to spread rapidly leading to fear and anxiety which, at worst, could degenerate into panic and social breakdown.

Two-way radio would be the most important medium for receiving information (local and international), and transmitting it throughout the country in such a crisis period. Those systems which rely on Post Office land lines to connect users to a base (e.g. truck operators, taxi companies, council vehicles) would have limited communication between mobile radios, but not back to the base. However, the amateur radio network which operates without land lines and has access to the higher radio frequencies is less likely to be damaged by an EMP, and could be the source of a highly effective communications network. There are about 6000 such operators in New Zealand, many of whom belong to the Amateur Radio Emergency Corp (AREC), an established emergency network. Many of them have access to portable power generators, and are generally adept at repairing damaged equipment. A radio link has recently been established between Wellington and Auckland (which enables two-way radio coverage of two-thirds of the North Island) and there is one planned between Wellington and Dunedin. Therefore, the amateur radio operators could form a communications network throughout the country within hours.

The army would also have the ability to establish a network. The problem to solve would be how to relay information to the public, emergency services and government.

A radio station network for the major centres could be re-established within hours, though continued operation beyond a week would depend on availability of electricity, or diesel to run stand-by generators. Restoring television transmission would take considerably longer and might not be considered such a high priority since there are so few battery-operated televisions. Battery-operated radios and television sets are less likely to sustain damage from an EMP than equipment connected to the mains electricity. Once transmission was restored they would certainly be all that could be used to receive radio or television programmes until electricity was restored, which could take many months, or even years, for a significant proportion of household users. Batteries would become extremely valuable (see Chapter 9). The microwave link network, usually reserved for television transmission, could be adapted to provide voice communications and some data flow if required, as an alternative route to Post Office circuits, though with a lesser capacity.

In the longer term, newspapers might be able to adapt to manual printing machines. There could be a return to public meetings and hand posters as a way of making public announcements. Postal and courier services could continue, though they would be limited by whatever modes of transport were available. With communications thus reduced, the pace of transactions would be considerably slower and government, business and personal communications would be conducted differently.

POLICY ISSUES

New Zealand is becoming more and more dependent on imported technologies and techniques which are replacing the slow, mechanically-based systems that can be manufactured in New Zealand. After a nuclear war these technologies, which are becoming an integral part of many economic sectors, would be unavailable. The solution is not to return to a

1930s level of technology now, merely in anticipation of disaster. Neither is stockpiling a real option as it would probably be prohibitively expensive and would only buy time (although valuable time) until alternative technologies were available.

Probably the most economical and practicable course of action would be to build a degree of resilience into the communication system by encouraging the local manufacture of essential components and the shielding and hardening of vital installations. There is information available for the inexpensive shielding of radios such as those used by amateur radio enthusiasts,[1] though the economic feasibility of protecting an entire system (i.e. all telephone exchanges or computers) is questionable. It would also be desirable to retain knowledge of production, maintenance and repair techniques of superseded communication systems, for example manual telephone exchanges or pre-electronic printing presses.

Some protection of computers and software could reduce the massive disruptions that would be caused by an EMP. Critical data bases, information systems and software could be safely stored on optical disks or on hard disks kept in containers protected against EMP. Some obsolete computer systems (capable of reading the above data sources) might be protectively mothballed as "insurance", instead of being re-sold.

If earth resources satellites were unaffected by EMP they could be one of the few remaining sources of data about the changes to the environment. Their receiving systems and image-processing equipment could be hardened against an EMP, to ensure adequate reception from the satellites.

Increased use of optical fibres for communications would reduce EMP impacts as optical fibres do not act as antennae and hence do not channel EMP energy into equipment, although the electronic equipment used in conjunction with them would be vulnerable. Research into EMP effects and the vulnerability of different systems is difficult and costly. Wider dissemination of the results of published research would assist agencies and organisations involved in communications to evaluate the feasibility of protecting equipment or the need to rely on other approaches.

Besides retaining knowledge of older, more manual technologies and operating skills as a "technological insurance policy", there is a case for examining the costs of import-substitution now of key components and systems which would be unavailable after nuclear war. At the very least, an adequate knowledge of how to adapt existing manufacturing industries to pr[illegible]e such items, should it ever be necessary to do so, would be worth acquiring.

Government departments, emergency services and relevant private sector organisations could develop general guidelines and operational procedures for re-establishing communication networks after national disruption.

An effective communication system would play a vital role in the first few days after a nuclear war, but communications systems are very vulnerable to an EMP, and their repair depends on the availability of spare parts many of which are imported. A wider awareness of the vulnerability of communication systems would allow reasonable discussion and support for what could be expensive contingency plans.

IMPACTS ON HEALTH

FOR MANY PEOPLE the onset of sickness and disease, or even death is their main image of New Zealand after a nuclear war. This is usually linked with fears of radiation sickness. However, this chapter will show that whilst people's health would be drastically affected by a nuclear war, it is not radiation that would be the main problem.

In New Zealand's health care system the major funding and co-ordination of services is provided by central government. The high standard of health care is based on many interacting factors - a trained workforce, hospitals, health infrastructure, vaccinations, high living standards, unpolluted water supplies, effective sewerage systems and an uninterrupted flow of medicines and medical equipment from overseas. All of these factors would be disrupted by nuclear war, some catastrophically.

The result would be a marked change in the standard of life and expectations of health for many New Zealanders. Even the most common conditions (toothache, or minor chest infection) usually forgotten after a short period of discomfort and alleviated by a pain killer, or antibiotics, could have devastating results for New Zealanders after a nuclear war.

At present a large proportion of medical effort goes towards the diagnosis and treatment of degenerative diseases of old age, for example hypertension, cancer and arthritis. With limited resources society would have to accept that many of these conditions would run their natural course, with nursing care and support. Society might have to return to the standards of health which were the norm fifty years ago.

NUCLEAR WAR IMPACTS

Loss of imports

New Zealand's dependence on imports of medicinal supplies and pharmaceuticals is virtually 100%. Thus, the most serious long-term impact would follow from the loss of medicines and equipment from Northern Hemisphere imports. An estimated $491,900,000 was spent on pharmaceuticals in the 1986/87 year. Without these imports the present health system would have to undergo drastic changes within a year.

New Zealand's pharmaceutical industry, based largely in Auckland, imports all active ingredients from the Northern Hemisphere. The final products manufactured from these active ingredients have a shelf life of only about two years. Even the *one* medicine that is considered "made in New Zealand" (an anticoagulant produced from the lining of sheep guts) depends on an indigenous material being processed overseas.

The loss of pharmaceutical imports would be felt over different periods of time depending on stock levels and how rapidly they were used up. At present rates of usage most pharmaceuticals would last three to six months. Controlled drugs, e.g. morphine, would last for two months. Without antibiotics, infection (e.g. staphylococcal) could spread and lead to complications and death.

Dental services would run out of equipment and expendable materials in about six months. Strict rationing would extend the life of these items to 12-18 months and then replacements would be unavailable for an extended period.

The consequences of running out of imported medicines, medical supplies and equipment are summarised for selected items in Tables 2 and 3 on pages 70 and 71.

Impacts on water supply and waste disposal

Clean water is an important factor for good health. Water supplies rely on electricity for pumping, chemicals for water treatment and spare parts for machinery. If there were no EMP, the first problem would probably be loss of chemicals for water treatment within one to six months. Chlorine supplies would be needed from local sources. Interruption of electricity supply would create pumping problems, especially for cities which rely on underground water (e.g. Christchurch).

Waste disposal in large cities relies on various types of engineering systems, transport, and a trained workforce. If refuse collection and sewerage systems were to break down, water contamination, pollution, and outbreaks of disease would result. In the longer-term, machinery at sewage treatment plants would break down if local substitutes for imported spare parts were not available.

TABLE 2: IMPACT OF LOSSES OF IMPORTED MEDICINES

IMPORTED MEDICINES	*CONSEQUENCES OF LOSS*
Antibiotics	No treatment for bacterial infection therefore complications more likely. Isolation for contagious diseases would assume greater importance. High rate of infection after surgery, more deaths. Increase in sexually-transmitted diseases.
Vaccines	Progressive return of infectious diseases (diphtheria, tetanus, whooping cough, measles, polio, tuberculosis) and increased deaths particularly among children. No protection against exotic diseases, such as cholera and plague, arriving later with refugees.
Medicines for chronic conditions	More illness and death for people with asthma, epilepsy and diabetes. Few medicines for patients with cancer and heart diseases. Some psychiatric disorders would increase in severity and consequences.
Anaesthetics	Operations limited to simpler shorter procedures using locally produced gases and ether.
Analgesics (painkillers)	Limited alleviation of pain after surgery or for acute and terminally ill people. Considerable suffering unless morphine is manufactured locally.
Oral contraceptives	Less reliable contraceptives would have to be used and the number of unwanted pregnancies would probably increase. If medical staff unable to meet the subsequent increased demand for abortions, more deaths or complications likely as a result of "back street abortions".

TABLE 3: IMPACT OF LOSSES OF IMPORTED SUPPLIES AND EQUIPMENT

IMPORTED MEDICAL SUPPLIES AND EQUIPMENT	*CONSEQUENCES OF LOSS*
X-ray film	Restrictions on many radiological examinations even with recycling of celluloid and X-ray emulsion.
Laboratory chemicals	Laboratory testing, which is a valuable aid to diagnosis, would be reduced to limited tests made with local materials and microscopes, for example haemoglobin estimation, blood count, urine examination and culture of bacteria.
Dental supplies	Present level of dental care impossible. More toothache would be experienced and tooth extraction by rudimentary methods more likely.
"High-tech" equipment	Equipment would be inoperative without replacement components over a six-months to three-year period. Without incubators many premature babies would die.
Needles and syringes	Need to recycle the limited number of old metal and glass syringes. More chance of infection from diseases transmitted by bodily fluids, e.g. AIDS and hepatitis.
Contraceptives	Dependence on sterilisation and less reliable contraceptive methods once the supplies of barrier contraceptives (condoms, diaphragm, spermicides, cervical caps) exhausted. The same possible increase of unwanted pregnancies, demands on medical staff, and risks of "back street abortions".

distribution of pharmaceuticals, especially to the South Island, from the main producers in Auckland. Effective rationing of scarce resources would depend on adequate security, communication, transport and would presuppose a shared trust in the fairness of the system.

If an EMP badly damaged the electricity grid there would be problems with sewage disposal. All urban sewerage systems depend on electric pumping equipment. Some systems have diesel pumps as a standby, but these would not cope with full sewage volumes and in any case, diesel would soon be in short supply, (see Chapter 9). Uncontrolled outflows would run into harbours and rivers. Unless power was restored quickly, people would have to resort to digging holes for outdoor toilets, but these would not necessarily be sanitary and so fly-borne diseases such as dysentery and gastro-enteritis could spread quickly.

POST-WAR RESPONSES

For several months the greatest need would be to eke out available medicines and supplies for as long as possible, to obtain more from Australia if that were feasible and make local production a very high priority. Systems for requisitioning all medicines in the country, and for rationing, would be required urgently to prevent panic buying and hoarding. These could be very difficult to establish and enforce, especially without pre-war planning and given the other traumas that medical people and administrators would be trying to cope with at the time. Determining priorities would be a major obstacle, and health workers might disagree over the guidelines. Treatment might be withheld from particular groups in cases of extreme shortages. In any case, very strict rationing would only extend existing supplies of pharmaceuticals one year, or two years at the very outside.

Alternative sources would be sought. Australia, for example, could supply some important medicines (antibiotics, morphine, codeine) if trade was possible and they were willing to share scarce resources. However, if attacked by nuclear weapons, Australia would be more likely to request medical assistance from New Zealand than to offer to sell medicines.

After a nuclear war there would be a period between the exhaustion of remaining stocks and limited local manufacture when New Zealand had few medicines. In these circumstances people would experience tremendous pain and suffering. Health care would be limited to the diagnostic and treatment methods that were used before modern drugs were developed.

Local production possibilities

Eventually, assuming that there was no EMP effect or that equipment damaged by an EMP could be restored, New Zealand would have the ability to set up small-scale local production of medicines. However, this could take some years to develop. Very few herbal remedies are as effective as modern pharmaceuticals and the cultivation of plants might not be feasible if excessive climatic changes occurred.

If any medicines were to be manufactured locally, priority would have to be given to essential medicines such as antibiotics and vaccines, as these have life-saving capacity and are the medicines most needed to deal with infectious diseases.

Without pre-war planning, it would take at least two years to establish an effective pharmaceutical industry in New Zealand. In the shorter-term, priority drugs such as morphine and penicillin could probably be produced. Co-operation between existing pharmaceutical companies, people with technical know-how (pharmacists, engineers etc), and the dairy and brewing industries which have some useful equipment for large-scale pharmaceutical manufacture would be necessary. Indigenous raw materials (hydrocarbons from oil, plant extracts and animal by-products) could be used for production of some antibiotics, vaccines, and anaesthetics (e.g. ether, chloroform and nitrous oxide). Extracts from plants could be used for producing other medicines, for example, aspirin from willow bark, and morphine and codeine from opium poppy, although it could take several seasons to produce adequate quantities of the latter.

Insulin can be produced from the pancreas of cattle, pigs, or sheep but any local production would be hampered by shortages of chemicals, and would result in a low-quality product. However, even this might save the lives of many people with severe diabetes. Without pre-planning, the time necessary to establish an adequate local supply of insulin after a nuclear war might be too long to save the lives of up to 6000 insulin-dependent New Zealanders.

Some specific problems

Pregnancy rates would rise as less reliable methods of contraception would be the only ones available. Coitus interruptus, the rhythm method, natural sea sponges, locally produced spermicides, and condoms made from lamb

Infectious diseases

While the scarcity of medicines (and disinfectants) would make it difficult to control "ordinary" health hazards, several other factors would be increasing the likelihood of outbreaks of infectious and communicable diseases.

Infectious diseases spread when people are poorly nourished and under stress, when water supplies are contaminated through ineffective waste disposal or inadequate sewage treatment, and when hygiene standards decline. Vitamin deficiencies or protein malnutrition would lower resistance to disease. Shortages of soaps and disinfectants would allow skin infection to spread and infections like hepatitis would increase in incidence especially when people are in close proximity.

If the sewerage system failed, poor sanitation and sewage treatment could lead to increased cases of viral gastroenteritis (stomach upsets). Food poisoning from the bacteria salmonella, shigella or campylobacter could also lead to typhoid or excessive vomiting and diarrhea which, if not controlled, could lead to dehydration. The frail, newborn and elderly would be most at risk.

Chronic diseases arising out of untreated streptococcal infection in childhood, for example, rheumatic fever, kidney damage and rheumatic heart disease have become uncommon but these problems would probably return in the absence of penicillin. Skin infection (staphylococcal) could likewise spread and lead to septicaemia and death.

If animals were no longer being vaccinated there would be an increase in the risk of leptospirosis and tuberculosis spreading from cattle to people. Both diseases cause chronic illness.

Other factors would increase the spread of diseases. Insects and rodents (mice and rats) are disease carriers. Their numbers would increase if domestic rubbish built up and pest control became more difficult. An influx of refugees could significantly increase the risk of epidemics. Some could bring diseases not normally present in New Zealand, for example plague or cholera, which could arrive with refugees from any of the Northern Hemisphere continents many months after the war. (Contrary to people's perceptions of plague as a medieval disease, over 12 million deaths have been attributed to plague worldwide in the 20th century alone.) The necessary vaccines are not likely to be available so quarantine of infected refugees would be of the utmost importance.

The problems caused by higher incidences of all these diseases would

be exacerbated by a lack of medicines and antibiotics; thus, conditions in New Zealand could resemble those found in pre-industrialised Europe.

Estimates of the number of deaths in New Zealand from diseases after nuclear war are necessarily uncertain since non-medical factors (nutrition, sanitation, hygiene) would be critical. It has been estimated that in the United States 20% to 25% of survivors could die from communicable diseases.[1] These people would be far weaker, more susceptible to disease, and would have little of the social infrastructure that would be functioning in New Zealand, so this figure would only apply here if there were a total collapse of society, if deadly diseases arrived unchecked with refugees, and if little effort was made to overcome the dangers of food and water contamination. The death of one person in five could thus be the extreme price of social disintegration after a nuclear war, bringing additional fear and grief to families and communities.

Effect of increase in ultraviolet (UV) light

A 50% increase in ultraviolet light, caused by destruction of the ozone layer, would cause an increase in cancers (especially of the skin) and cataracts.

Additional impacts from an EMP

An EMP would cause immediate problems for the continued operation of hospitals and increase the likelihood of infectious diseases through disruption of water and sewerage systems, especially in cities which rely on underground water. Standby generators (without solid state components) in hospitals would alleviate general electricity failure after an EMP, providing voltage regulators were unaffected and diesel supplies could be maintained. For example, even Wellington Hospital's Total Energy Centre, which is one of the few using gas, requires a tonne of diesel a day. Any long-term power failures to hospitals would kill patients reliant on respirators, incubators (about 1000 per year) and dialysis machines (about 400 per year at present). Heating, cooking, lighting and laundry service all rely on electricity. "High-tech" equipment reliant on electronics would probably be permanently inoperative. Dental services would be unavailable until power supply was restored.

Supply of pharmaceuticals already in the country could be disrupted, since the packaging and processing industry might have to revert to manual methods. Fuel shortages or transportation difficulties would slow

could be achieved. A related question is the degree of stockpiling that would be possible and feasible. Some medicines last in storage for many years. Others, such as modern pharmaceuticals, last on average only about two years as finished products. On the other hand, the active ingredients will last in storage almost indefinitely. Since New Zealand already produces pharmaceuticals from imported active ingredients, stockpiling these ingredients in sufficient quantities to last, say, five years could ensure an adequate supply of essential medicines while local manufacturing capacity was being established. The cost of stockpiling should be compared with the potential cost in suffering, death and social breakdown that might otherwise occur.

The stockpiling option would be of less importance if local, self-reliant industries were to be established as commercial ventures before nuclear war. The ability to do so exists now albeit on a small scale. The hurdles involve patent restrictions and the commercial interests of overseas pharmaceutical companies. Such options would require detailed costing and may be appropriate only for crucial medicines. (See Background Paper 10 for proposed list of essential pharmaceuticals.)

Preparation of a list of essential medical equipment, inventories of such supplies, and evaluation of the feasibility of stockpiling equipment and spare parts would be of critical importance. The potential for local manufacture and recycling (e.g. silver for x-ray plates) should be studied. Plans for handling the health issues associated with nuclear war refugees, and strategies for reducing the vulnerability of the health sector in the face of the likely social problems, should be developed.

Consideration could be given to the merits of educating health personnel now as to what might be required for health care in a post-nuclear war New Zealand; and to the merits of setting in place contingency plans for requisitioning and rationing drugs and equipment; and for quarantine regulations.

The health consequences after nuclear war would depend to a large extent upon the social structure of the post-war society. The presence of a large number of medical workers and the availability of extensive medical and technological literature would make it possible for there to be worthwhile health care, however standards of health care would sharply decline.

MEETING NEW ZEALAND'S FOOD NEEDS

PRODUCING SUFFICIENT FOOD to meet local needs would be of prime importance for any country in the aftermath of nuclear war, and New Zealand would be better placed than most countries in this respect. The mass starvation predicted for many[1] would not occur in New Zealand. However, feeding the nation after a nuclear war would depend on more than just the ability to grow food. This chapter looks at how the present ability to produce food surpluses could be eroded by "nuclear winter" effects, by loss of energy and chemical inputs (such as diesel fuel, fertilisers and animal vaccines) and discusses problems associated with processing and distribution. It considers how the agricultural sector would be affected and how it might adjust to concentrating on feeding the local population. The dairy industry is used as a case study for many of these issues.

THE IMPACT OF NUCLEAR WAR ON FOOD PRODUCTION

Loss of export markets

The loss of major export markets would have a profound effect on the agricultural sector and would remove the reason for farmers and horticulturalists to produce at pre-war levels. A significant proportion of the capacity of the food processing industries (freezing works, dairy factories, canneries) would be surplus to local demand. Existing stocks of frozen meat (New Zealand exports over 40 million sheep and lambs each year), wool, dairy and horticultural products would meet local demand for months or years so long as they could be kept from spoiling, and could be distributed.

Loss of imports

Food production depends on more than conducive growing conditions and an adequate climate. New Zealand's present high level of agricultural production is sustained by a variety of imports. Without many of them the process of growing, harvesting, preserving, packaging and transporting food from farmer to consumer would be seriously affected.

Impacts of "nuclear winter" on the growing season and crops

It can be assumed that the severe nuclear winter effects expected in Northern Hemisphere countries would not occur in New Zealand. However even an average drop of only a few degrees, which may well occur (Chapter 2), would reduce the amount of food grown in New Zealand.

Knowledge of atmospheric processes is still not sufficiently advanced to predict how long "nuclear winter" effects might persist in New Zealand. And although a war during the Northern Hemisphere winter would mean there would be less effect on New Zealand, it is not known to what extent. Further computer modelling studies, based on a better understanding of the properties of smoke and atmospheric processes, are needed to reduce these uncertainties. It is possible that temperature reductions in New Zealand after nuclear war could be greater or indeed less than those upon which this study is based.

Frosts, cool temperatures and lack of water are the main factors that slow plant development and delay the maturation of crops. If crops do not get a minimum amount of heat energy over the growing season they fail to mature. Crops vary in their heat requirements for complete development.

The maximum temperature drops that a nuclear war would be likely to cause (3°C average drop in spring, 2°C drop in summer, 1°C drop for the subsequent 18 months) could increase the frost period significantly. A 1°C drop in the average minimum temperature (overnight low temperature) could add 40 to 50 days to the period when frosts could occur in warmer North Island locations. Each 1°C drop could add 15-30 days to the frost period of cooler South Island locations. (Calculations by New Zealand Meteorological Service staff.)

These predicted increases in frost periods would be significant for agriculture, since even brief periods of chilling or freezing temperatures during the growing season can kill certain crops. The following crops are frost-sensitive and could be destroyed by unseasonal frosts: green beans, courgettes, cucumbers, kumara, melons, potatoes, pumpkin, maize, tomatoes and wheat. Although the parent plant would survive, repeated frosts could eliminate crops of apples, asparagus, citrus and stone fruit, grapes and kiwifruit.

All these crops could fail during the first year in any region if frosts occurred in spring and summer.

There are historical precedents for small temperature changes destroying crops through frost damage. In 1816 the average summer temperatures dropped by 1-2°C in the North Eastern USA, Canada and Western Europe as a result of vast dust clouds emitted into the atmosphere by Indonesia's Mt Tambora. Frosts in May, June and August of 1816 eliminated nearly all maize production and much of the Canadian wheat crop. Famine occurred in urban France and Switzerland with the failure of frost-sensitive crops. Earlier a 1°C average temperature drop from the late 16th century to around 1700 reduced growing seasons by up to a month, and grain yields fell by up to 75% in parts of Europe as a consequence.[2]

Crops that require a lot of heat energy to mature, would be at risk from the overall loss in heat energy. With the assumed temperature drops during the first year after a nuclear war, kiwifruit and citrus fruit would mature only in the far north of New Zealand. Maize yields would be reduced and wheat would fail in Southland. Canterbury wheat crops would be delayed several weeks and would be marginal, especially if hit by spring frosts which forced a late second sowing. Since grains are grown primarily in Canterbury and further south (57% of wheat, 91% of oats, 83% of barley), supplies could be insufficient for national needs. The major problem would be loss of wheat for flour, since other grains are less significant for human consumption. Potatoes would be less affected by drops in temperature (70% of potatoes are grown in the North Island), but Southland potatoes could have small yields.

Pasture growth occurs at all temperatures above 5.5°C and is not subject to frost damage so grass would continue growing through the first year of low temperatures, although the amount produced would decrease, especially in colder climates such as Southland. A Ministry of Agriculture and Fisheries computer model was used to estimate drops in pasture production for Waikato, Canterbury and Southland if the temperature were to drop as described above. The loss in pasture production over the whole first year was 19%, 29% and 36% for these three regions respectively. In the warmer second year with an average drop of 1°C, production was reduced

by 11-17%. The model predicted heavier losses in spring associated with the 3°C drop (Waikato down 34%, Canterbury 54%, Southland 66%). If the spring temperature drop was 5°C, corresponding to a more severe nuclear winter, the declines for the three spring months would be: Waikato 58%, Canterbury 78% and Southland 90%. Pastoral farmers would have management problems if such low levels of pasture growth occurred in spring.

In summary, even relatively small drops in temperature would reduce food production in New Zealand. However, the magnitude of these reductions would be extremely unlikely to put people at risk of starvation given the huge surplus of production over levels of local consumption. Livestock would not be at direct risk since pasture growth should still be sufficient for stock to survive. Important vegetable crops would still grow in most regions, although some crops could be reduced significantly by unseasonal frosts. Loss of wheat crops could be the most serious shortage, since even at times of full production New Zealand imports about one-fifth of wheat consumed annually. Loss of grain and vegetable production would be heaviest in cooler southern regions.

Radiation concerns

Contamination of food by radiation would not be a major problem in New Zealand unless southeastern Australia was targeted. In that case, milk and milk products could be a health risk leading to a rise in thyroid cancers (see Chapter 3).

Whatever the level of targeting, there would be wide concern over the amount and effects of radioactive fallout and people would require information as to what could be safely eaten. Dairy farmers in particular would need guidance about the safety of milk and, if it was necessary, the best way of dumping milk without causing environmental and public health problems. Widespread demand for local monitoring of radioactive levels would probably exceed the capacity of the present monitoring system. Fish, particularly shellfish, would require monitoring, and the degree to which they were contaminated, if at all, would be an indication of general levels of radioactive fallout.

Other problems affecting food production

Many vegetables are grown from imported seeds, particularly carrots, broccoli, cabbages, tomatoes, courgettes and lettuce. Depending on the season in which war occurred seed stocks could be low and this would mean that future stocks could be in jeopardy. Extra crops, specifically for seed production, might need to be grown in warmer northern New Zealand to minimise effects of lowered temperature.

Crops, pasture and animals all rely on a range of imported fertilisers and trace elements to boost New Zealand's poor quality soils. Many fertiliser requirements and trace elements come from the Northern Hemisphere and alternative sources could be difficult to find. Loss of fertilisers (phosphorus, sulphur, potassium) would have minor impacts on pasture production for two years and then loss of production would be more rapid if alternative systems had not been developed. If the ammonia-urea plant continued production (Chapter 9) all local nitrogenous fertiliser needs would be met.

Serious animal diseases would re-appear after about five years as trace elements were depleted from the soils. Half of New Zealand's pastures are deficient in selenium (currently imported from Canada and Sweden), cobalt (from Zaire and central Africa) or copper and continued shortage of these trace elements could force farmers to retire about 3.4 million ha or 16% of the total area being farmed.

Without imported antibiotics there would be increased cases of animal diseases, including those caused by internal and external parasites (flystrike, lice, keds) and scabby mouth, all of which can be transmitted to humans. Although New Zealand makes animal vaccines, local production depends on the import of essential amino acids and vitamins. Present stocks would last about six months. Without strict vaccination programmes there is a high probability of cross infection of diseases from animals to people, particularly tetanus, pulpy kidney, blackleg, tuberculosis (TB) and leptospirosis.

Refugees could bring animals infected with such serious new diseases as foot and mouth, rabies, swine fever or anthrax. Without strict quarantine, or drugs, control of diseases would be difficult.

The horticulture sector would also lose imported pesticides, herbicides and fungicides which would reduce by 20-30% (see Background Paper 4) the quantity and quality of a range of fruit and vegetables. Fuel shortages would affect horticulture and cereal cropping much more than pasture farming. Harvesting would also be difficult, since most harvesting equipment relies on imported parts and fuel.

The New Zealand fishing industry would be seriously affected by lack

of imports since almost all gear, boats and machinery are imported (including fish nets, hooks and other equipment). However, only 1% of New Zealanders' food needs are presently met by this industry.

IMPACT ON FOOD PROCESSING

If problems of growing and harvesting food could be overcome, problems in preserving, processing and packaging food for transportation would be encountered.

Food is preserved to ensure supplies outside a limited growing season and to enable food to be transported to areas where it is not grown. Besides the imported spare parts for most machinery, the loss of particular items would affect the canning industry; for example, tin plate (presently imported from Japan in twice-yearly shipments) and the rubber sealant used in the manufacture of tins. Chlorine is also essential for sterilising the cans.

Oil, coal and natural gas are the main sources of energy used in the food processing industry, with electricity supplying only 12% of direct energy needs. This diversity of energy sources makes the whole sector less vulnerable to the sudden loss of a single energy source.

PROBLEMS OF DISTRIBUTION AND ACCESS TO FOOD

Few, if any, New Zealanders are self-sufficient in food. Most go to shops to buy supplies which have been through complex storage, processing and distribution systems since leaving the farm gate. Disruptions in supply could occur immediately, particularly if banks were closed, or if there was widespread panic-buying or looting. Transportation and storage of food for urban dwellers would be a major problem unless home growing was established. For example, fresh vegetable supplies for the main urban centres mostly arrive by truck and stocks are sufficient for only 2-3 days. Wellington has the longest supply lines, but Auckland's vegetable supplies are closer with 50% grown less than 50km from central Auckland.

If there were an EMP, the loss of communications and electricity and the social disruption, would affect equally people who distribute food and those who sell it. Food transport trucks might not be operating and supermarkets might not open (although fresh and frozen food would be spoiling). Without a prompt restoration of financial systems, electricity supply and communications, the number of people without work or access to savings would grow rapidly. Scarce food would then go to those who could pay for it or take it by force. Maintaining food supplies would be an essential priority for urban areas, but even with pre-planning the problems would be formidable.

RURAL CONSEQUENCES OF AN EMP

The instant disabling of electricity and communications by an EMP would have severe consequences for the rural sector. Equipment reliant on electricity mains would be inoperative – milking machines, electric fences, irrigation pumps, deep freezers, shearing machines, heated hen batteries, electrically-heated glass houses and domestic appliances. How long supply would be lost would vary considerably between regions. Without an immediate increase in farm labour, dairy farmers would be unable to milk large herds by hand and many cows would be dried off. Production could fall by as much as 80% without a five- to sixfold increase in farm labour.

After several weeks without electricity, assuming no backup generators, food products in large industrial cool stores (frozen meat, fruit, dairy products) would spoil. Piles of rotten meat and other foods would become a public health hazard unless they were promptly disposed of.

An EMP would leave rural people with longer-term practical difficulties as well. Electricity-driven irrigation systems needed for fruit, vegetable and wheat production would be lost. Repair and replacement of farm machinery would become more difficult. Before that point was reached, rapidly dwindling supplies of petrol and diesel would have severely hampered use of farm equipment, tractors, milk tankers, and trucks taking vegetables to city markets. A switch to alternative fuels, such an CNG, ethanol, or biogas would be a long-term solution, but such fuels would be difficult to produce given all the problems caused by an EMP.

POST-WAR RESPONSES

The nature of post-war changes would vary greatly depending on whether or not there was an EMP, although both cases would impose major reorganisation on the entire agricultural sector. Everyone involved in food production – the growers, processors and distributors – would have to adapt to producing food solely for local demand, and under adverse conditions.

Despite the local needs to be met, large cuts in production would still follow from loss of export markets, and through increased stock mortality as diseases spread. If stock numbers were reduced by 75% from pre-nuclear war levels, whether through disease or deliberate policy, the millions of sheep, beef cattle and dairy cows that would have been the basis for much of the pre-war export revenue would have largely gone.

Re-orientation of production to suit local as opposed to export needs would be a difficult process. Some foods would have value as raw materials for alternative products, for example the production of various useful chemicals from dairy waste products, but such long-term solutions would not alleviate short-term disruptions.

Even if export food markets were eventually re-established, rebuilding stock numbers would only be possible with a supply of vaccines, fertilisers, trace elements and an infrastructure that met other farming requirements such as machinery, fuels and processing industries. Although the stock would have strategic value as food reserves, they would represent drastic loss of income to producers and processors unless bought by some central agency, pending later sales.

In the meantime, farming patterns would be forced to change and land would have to be put to more diverse uses as stocking rates decreased. Some sheep farming could well revert to more wool production than meat production. Some marginal hill country might be abandoned, reverting to scrub and habitat more suited to wild pig and goats. If transport became difficult, farms distant from processing industries might be used more to maintain local self-sufficient groups than to supply national needs. There could be a greater application of organic farming methods in order to overcome the loss of fertilisers.

After the initial supplies of surplus export meat and dairy products were consumed, and the surplus flocks and herds culled, vegetables would become a more important part of diet and urban areas would need to become more self-sufficient in vegetable production. In order to compensate for the lack of imported seeds, it might be necessary to build up local seed stocks during the first growing season. Regional specialisation in food types would be replaced by local diversification of crops and pastoral farming. Foods which are easy to store and which have high food value, such as the root crops potato and kumara, would be favoured, as would fruit with good keeping qualities (apples, kiwifruit). Extra plantings could compensate for losses of vegetables.

If the major food processing factories were unable to adapt to the loss of imports, and if lack of transport made supplies less available around the country, smaller food processing units might operate in the regions, and information about how to do home preserving would become valuable. The food that would be available would probably be packaged very simply, and uniformly, since brown paper bags and cartons could probably be manufactured, but not an extensive range of coloured plastic containers.

All those involved in food production, from growers to processors and distributors, would have to adapt to fuel shortages until petrol and diesel alternatives were more widely available (Chapter 9). Although some shortages could be met by increasing farm labour, both human and horses, a horse-drawn economy would not be a prompt alternative. Since it takes three to four years to rear a good working horse it would take many years to build up numbers to anywhere near the 200,000 (or 1 for every 3 people) found in New Zealand in 1901.

Diesel stocks would probably be diverted from fishing vessels to more essential industries and transport needs. In the longer-term, the fishing industry would require drastic changes if it were to be re-established. Adaption to earlier technologies, passive fishing methods and considerable re-training would be needed. By that time fishing grounds that are now overfished might have recovered to more abundant levels, although concern over radiation contamination might deter people from fishing.

Substitutes might be found for some of the imported foods that would be missed – tea, coffee, cocoa, sugar, tropical fruits and Pacific Island vegetables such as taro. Sugar substitutes such as sugar beet would take some years to establish on a large scale if raw sugar from Fiji or Australia was not available. Herbal teas can be grown in New Zealand and tea has been grown successfully in trials, but unless production levels were greatly expanded only a tiny percentage of requirements would be met.

These responses would be plausible where there was no EMP and a minority continued producing food for distribution and sale to the whole population. Collapse of transport, the market economy, and central government, as might occur if there were an EMP, would force more radical changes in New Zealand's food system. These changes would be slow to implement and the transition from pre-nuclear war New Zealand society would be very unpleasant.

Technologies in use would be a mix of old and new, with much greater

emphasis on recycling and "do-it-yourself" techniques. An extreme shortage of transport fuel would necessitate either the development of communities and cities that were largely self-reliant and which had a high degree of self-sufficiency in food production, processing and packaging, or large-scale relocation of urban populations to rural areas. Households would become more self-sufficient in growing and preserving food and, if necessary, rainwater could be collected.

While farming communities are often perceived as being better placed to cope with the upheavals that nuclear war would bring, the longer-term changes would affect them as deeply as urban dwellers.

Rural problems would be exacerbated if fears of being bombed, of running out of food, or of becoming victims of social breakdown prompted a massive urban migration to rural areas after nuclear war. Rural towns have little surplus accommodation and urban people without rural connections would quickly overload that which was available. Rural marae could provide accommodation for many urban Maori. Schools and halls might be taken for temporary shelter and the potential for conflict between urban migrants and rural residents could be high. Pressure on local retailers would be considerable, as both local customers and new arrivals sought to stock up on supplies. Replenishment of stock might become erratic, adding to the problems of rural retailers. Large influxes of people would create problems for disposal of wastes and sewage, thus putting a strain on maintaining supplies of clean water and preventing disease outbreaks.

In summary there would not be mass starvation, but people would have to adapt to much less variation and an erratic supply of foods. Since only 5% of the population presently live in 2-unit flats or multi-storied blocks of flats, a high proportion of New Zealanders would have access to a small garden section that would be able to sustain some food production. However, this would take some considerable time to establish, given, among other things, the shortage of seeds and the need for people to acquire the necessary knowledge.

IMPACTS AND OPTIONS FOR THE DAIRY INDUSTRY

The dairy industry was examined in detail as a representative example of the sorts of problems and changes that would occur throughout the whole rural sector. This case study exposes a number of issues common to other industries.

The continued operation of dairy factories would depend on sufficient staff reporting to work despite concern for their families and uncertainty over the continuation of employment and wages. Drops in diesel supplies would make the collection of milk from some farms impracticable, and those most distant from factories might have to be dropped from milk collection. Concern over radioactive fallout could lead to people demanding dried milk products from storage locations, with the possibility of looting.

Loss of exports and shortages of transport fuel would force many dairy farmers out of business and put many factory staff out of work. Reduction of throughput would produce "scale-down" problems for some factories forced to run below their design capacity. Existing stocks of dairy products would compound the economic problems. Usual stocks of cheese in the country would supply New Zealand needs for just over 2 years, milk powders for 1½ to 2 years and butter for 2½ years. Funding to keep dairy factories operational while at least some of these stocks were used locally would be uncertain without pre-planning.

Longer-term loss of electricity supply after an EMP would seriously affect the dairy processing industry, perhaps taking it back to older technologies. There could be a return to many small, labour-intensive factories making a few products, mostly for local or regional consumption. On-farm production of butter, cheese and cream might reappear. Open vat cheese-making and rotary churn butter-making would be the most viable technologies after either a sudden or a longer-term breakdown of important machinery. Little of the equipment needed for this has been saved in New Zealand. Knowledge of the technology of open vat cheese-making still exists amongst older cheese-makers and new small-scale cheese-makers. Recycling and local alternatives would be needed to replace imported items such as plastic milk-powder bags and cheese wrappers. Whether there would be enough dairy products to meet overall requirements is difficult to estimate.

Loss of animal vaccines, and a general decline of animal health would increase the likelihood of milk-related diseases such as leptospirosis, brucellosis and tuberculosis (TB) becoming widespread. Possums transmit TB to cattle and the likely rise in possum numbers if pest control ceased would put more cattle at risk in TB-prone areas such as the King Country, Wairarapa and Westland. If milk was not adequately pasteurised due to more on-farm processing, TB could easily spread to people. Leptospirosis

spreads to people in contact with urine from infected cows. If intensive vaccination programmes were not continued, New Zealand (which already has the highest level of leptospirosis in the world) could face a serious problem.

Planning and research could help the dairy industry cope with some of the disruptions of nuclear war, including the huge downturn following loss of export markets. An industry-wide plan for maintaining supply to the New Zealand population in the face of reduced transport could be developed. Factories capable of running on local energy supplies and those that can be adapted to make other products should be favoured. Procedural plans to mothball some butter and milk powder factories immediately following nuclear war, for possible later re-opening, could be developed and agreed to by staff. Piecemeal closures or abandonment could make it more difficult to maintain equipment and re-start at a later date.

Detailed knowledge of how to construct, use and maintain older technologies could be compiled and widely dispersed for local use. Failure of the electricity supply and loss of stored dairy products would mean the transition to the older technologies would have to be swift. Dairy-waste products such as whey can be used to produce a wide range of useful chemicals, including some antibiotics, nisin (a preservative), lactic and citric acids, methanol, ethanol, propanol, butanol and acetone. Acrylonitrile could also be made and might provide the basic feedstock for a plastics industry. Documentation would be required, as would the identification of necessary facilities and materials.

POLICY ISSUES

Food security is an essential element in any country's total security needs. Despite New Zealand's likely ability to meet its food requirements, there are some vulnerabilities which could be largely overcome with small investment of capital and labour. These include establishing seed-stocks for all important crops (at least one year's reserve should be held by the seed trade) and establishing gene banks to preserve genetic material of value for plant breeding programmes. Stocks of essential trace elements that would be very difficult to obtain after a nuclear war should be steadily increased well beyond annual requirements and the location of indigenous deposits, currently considered uneconomic, should be identified.

Local production of a few key ingredients would allow the local animal vaccine industry to continue independently of overseas trade, thus allowing much greater control over stock numbers. The feasibility of total self-reliance in animal vaccines and other animal remedies particularly antibiotics, should be investigated and would have value in the production of human vaccines as well. Similarly, the critical imports needed in food processing industries should be identified, and the feasibility of stockpiling, or developing local substitutes, should be evaluated. The vulnerabilities of the meat industry and of food processing companies needs further study.

Developments in "nuclear winter" research should be closely monitored. A better understanding of the potential long-term impacts in the Southern Hemisphere is needed given the severe loss of crops that would follow average temperature drops of, say, 3-6°C. Joint research programmes between Australia and New Zealand into regional impacts on climatic and atmospheric processes would be of mutual benefit.

There is considerable literature on alternative farming practices, new crops and older technologies for small-scale food processing, that would be of wide benefit given the constraints that would follow a nuclear war. Assembling and then distributing such material through farming organisations would be a practical way to assist farmers and communities to cope with the difficult task of adapting to post-nuclear war conditions.

CHAPTER NINE

IMPACTS ON ENERGY SYSTEMS

IN A MODERN, WESTERN SOCIETY SUCH AS NEW ZEALAND the fulfilment of every human need, including food, urban water supply and sewage disposal, shelter, health care, and contact with family and friends depends on energy; whether it is gas heating or diesel to power ships, or electric power to run computers. New Zealand's early reliance on wood, muscle and wind has shifted to electricity, gas, oil and coal as sources of energy. The impact of nuclear war on energy systems is, therefore, central to how New Zealand would be affected.

New Zealand's electricity is supplied primarily by hydro-generation (75%), and by thermal stations (20%) which rely on gas and coal. All thermal stations are in the North Island, as is one-third of hydro capacity. Excess demand over supply in the more populous North Island is rectified by the transfer of power from the South Island via a direct current (DC) cable across Cook Strait. Electricity is used mostly by domestic consumers (about 40%), the aluminium smelter (about 18%) and wood, pulp and paper industries (about 30%).

Natural gas comes mainly from the large Maui field, 34 km off the coast of Taranaki (90%), with a further 8% from the older and smaller Kapuni field (on-shore). The balance is from McKee, Kaimiro, and associated on-shore fields. Thirty-three percent of gas is used to generate electricity, 25% travels via pipeline to domestic, industrial and CNG (compressed natural gas) users, and the balance goes to three petro-chemical plants that produce synthetic petrol, methanol and ammonia-urea.

At present, processing of all New Zealand's liquid fuels (which for convenience will be taken to include transport fuels) occurs at the country's single refinery at Marsden Point, Whangarei. The refinery processes imported crude oils, indigenous light oils from gas fields (condensate), and also blends and adds lead to the synthetic petrol from the Motunui Synthetic Petrol plant. Without this further processing, Motunui petrol could probably be used directly as low octane, unleaded petrol for low compression engines.

New Zealand's self-sufficiency in liquid fuels will peak in 1987-1988 at about 55% of demand. Thereafter it will decline under present policies to only 27% by 2004-2005. By assuming a nuclear war "soon" this study coincides with the most favourable circumstances for levels of indigenous liquid fuels.

Coal is mined primarily (about 66%) in the North Island, around the Waikato. Two-thirds of this production is open-cast. The main consumers of coal are steel manufacturing, electricity generation, dairy factories, hospitals, freezing works and cement works.

Figure 6 emphasises the interdependence of different energy systems. Electricity is essential to control systems everywhere, especially at the refinery and synthetic petrol plant. Transport fuel, mainly diesel, is essential to the inspection and maintenance of distribution networks such as the electricity grid or pipeline system. These are primary dependencies. Others shown in the diagram may be considered secondary – the lack of coal for electricity generation would reduce output by only a few percent, although it would disproportionately affect peak demand in the North Island.

Although several different energy forms may be used to perform the same task, the ability to change from one to the other is limited by the energy-using equipment that has been installed. Over the last decade there has been a steady move to substitute natural gas for other fuels. This has involved capital investment in domestic stoves and water heaters, industrial boilers, and CNG/LPG vehicle conversions to replace equipment designed for electricity, diesel, fuel oil, coal and petrol.

NUCLEAR WAR IMPACTS

Changes in the demand for energy

Since the Northern Hemisphere is the source of over 75% of imports and the destination for nearly 80% of exports there would be a reduction in demand for energy with the cessation of many export and import-related

extensive social breakdown which hindered productive economic recovery. This would be more likely following the disruptions caused by an EMP. If there was no stable future to look forward to, people would find little incentive to save and invest, thereby diminishing the need for many of the existing financial institutions. "Adjustments" in this case would occur by painfully slow steps, possibly through the development of effective barter systems and then back to some form of monetary system.

POLICY ISSUES

In consultation with the financial institutions government might be in a position to moderate the adjustment processes. Pre-war planning among financial institutions, including government and the Reserve Bank, to formulate some co-ordinated measures for the initial crisis period might well be worthwhile. Measures to consider include: an orderly closure of financial institutions for some days while records and operating systems were sorted out; development of stand-by manual procedures; agreement that all deposit liabilities would be jointly guaranteed by the institutions and the government; the feasibility of replenishing banks with "sufficient" cash; agreed procedures for the orderly adjustment of assets and liabilities in balance sheets, development of EMP-protected storage and computer systems.

ECONOMIC DISRUPTIONS FOLLOWING LOSS OF TRADE

THE PREVIOUS CHAPTERS HAVE SHOWN that much of New Zealand's economy is directly, or indirectly, dependent on trade, predominantly with the Northern Hemisphere. Imports, whether of raw material supplies or of small but essential components, are vital to many industries. The level of activity in many sectors is also dependent on exports (e.g. the production, processing and transport of food and fibre). Even in areas where there is no obvious dependence on either imports or exports, e.g. roading, hydro-electricity generation or local authority activities, there is indirect dependence on products with imported elements, or demand generated by overseas earnings.

Conventional measures of dependence, such as estimates that about one-third of GDP comes from trade, substantially understate the full structural impact of the loss of external trade. Essentially the structure of New Zealand society, of where and how people live and what they do, has developed from an historical pattern which pre-supposes a high level of exchanges with the rest of the world.

NUCLEAR WAR IMPACTS

Over 80% of New Zealand's trade is with Northern Hemisphere countries. A major nuclear war, coupled with "nuclear winter" effects on combatant and non-combatant countries, would effectively end that trade and severely disrupt trade with Southern Hemisphere countries.

Immediately after a nuclear war, supplies of many raw materials, components and products would be limited to stocks on hand; and every export industry, along with all its services and infrastructure, would be under threat. In the long term there would be some potential to find alternative Southern Hemisphere sources or substitutes for imports and to develop different markets or alternative uses for the resources used for exports. Meanwhile, there would be a long period of shock and adjustment on a scale far beyond any economic depression New Zealand has experienced.

It is difficult to trace the path of the shock – beyond saying that those who are directly involved in importing or exporting would be among the first to feel it; that it would extend to those whose activities *seem* to rely on the domestic economy, e.g. timber workers whose raw material comes from and will be used in domestic activity but whose chainsaws and other tools depend on imported machinery and components; and that it would reach to those who feel they are not involved in "the economy" at all.

If, as discussed in Chapter 11, this shock to the physical economy were accompanied by collapse in the financial system and the money economy that enables complex transactions to be made, the shock would be transmitted more quickly and sharply. Sooner or later the loss of trade would have a substantial impact on everyone living in New Zealand.

While accurate estimation of the impacts is not possible, their order of magnitude can be indicated by simple measures which are described in Background Paper 17. Even if trade with Southern Hemisphere countries could be restored quickly, New Zealand's dependence on Northern Hemisphere sources of imports would have substantial effects across all sectors of the economy – primary, manufacturing and services. Simple estimates of the effects on employment from the loss of imports from and exports to Northern Hemisphere countries and from consequent reductions in domestic demand indicate that employment might fall by about 40-50%. In recent years unemployment has reached around 5%; in the depression of the 1930s it peaked at about 12%. It is difficult to imagine the catastrophic impact of unemployment levels four times greater than in the depression, even if New Zealand's social structure coped with all the other impacts of nuclear war.

Quantitative economic estimates of the implications of trade disruptions have severe limitations. The loss of a million dollars worth of imports of cedar and mahogany for the construction and furniture industries might have little impact other than to limit the consumers' choice to pine. But the loss of a few thousand dollars worth of ball-bearings could immobilise vital machinery.

The reduction in imports would mean in economic terms that New Zealand would not need export earnings to pay for them, but how would the economy adjust to needing say 15 million sheep rather than 65 million? The adjustment process and the uncertainties surrounding it would be pervasive, affecting not only the farmers but the retailers, wholesalers, and bankers, the mechanics, topdressers, fencers, and accountants who supply their needs; the shearers, truck drivers, meat workers, scourers and wharf labourers who handle their products; and the traders, marketers, advertisers, printers and shipping executives whose incomes depend significantly on the sheep industry. Similar ripple effects would be felt through all other export industries – beef, dairy, apple, kiwifruit, fishing, forestry, paper and many manufacturing industries. All jobs in private sector servicing industries would be affected by these uncertainties and there could be no security in the public sector as the role of government and its ability to finance its activities would be undermined.

There would be a rise in demand for manual labour to compensate for failures of labour-saving technologies and energy systems. But new systems for organising and paying for that labour would need to be developed.

While many of these effects would not occur immediately, it would very quickly be obvious that they were going to occur. Even without an immediate collapse of law and order or of the financial and money systems, uncertainty would quickly affect the lives and behaviour of everyone in the workforce and all those dependent on them.

EMP disruptions would add significantly to the "immediately unemployed" total and could well signal the end of the formal market economy. Without electricity, output and employment in many sectors would fall rapidly and industries would have to close. The effect of an EMP would hasten and exacerbate all the disruptions and uncertainties discussed above.

SOUTHERN HEMISPHERE TRADE

One of New Zealand's largest trading links is with Australia, accounting for about 17% of all imports and exports. It is New Zealand's most important trading partner in the Southern Hemisphere accounting for 79% of all Southern Hemisphere imports. Under Assumption 6a (Chapter 1) it was assumed that reduced levels of trade with Australia would be possible, but under Assumption 6b, with wider destruction of military bases, cities and a disabling EMP, trade between the two countries would collapse. Maintaining a trading link with Australia would, at first glance, appear to be of particular importance for New Zealand after nuclear war.

However, two factors affect this conclusion and would diminish the "assistance" New Zealand might expect from ongoing trade links with Australia. First, the Australian economy, like that of New Zealand, is closely integrated with the rest of the world. That integration is particularly strong with the EEC countries, USA and Japan which supply almost 70% of Australia's imports.[1] Further, about 60% of those imports are machinery, petroleum products, transport equipment and chemicals; items that constitute a critical part of the capital equipment, essential materials and fuels for the Australian industrial system. Forty percent of Australia's automotive and industrial diesel oil and fuel oil is refined from imported crude oils. Lubricating oils would run out in about four months without rationing.[2] Without alternative sources the Australian industrial system would grind to a halt.[1]

Thus the economic shocks experienced by New Zealand would most likely be experienced by Australia as well, for similar reasons. What trade would be possible, given such profound disruptions, is uncertain but it would probably be much less than before nuclear war.

The second factor likely to diminish trade between Australia and New Zealand would be the products both countries would have available for export and required as imports. Both would face the same crucial shortages which neither would be able to supply. Other items now traded would be of reduced value in post-nuclear war conditions. A comprehensive study of the impact of nuclear war on Australian society and environment would help clarify these disruptions and the likely level of trading activity that might be possible.

At best, New Zealand has tenuous trading links with other countries in Africa and Latin America which would be less severely affected than

combatant countries. Historically, New Zealand's trade routes have been to the Northern Hemisphere. New Zealand would face formidable problems realigning its trade after nuclear war.

POLICY ISSUES

The impact on New Zealand of the loss of external trade following a nuclear war would be pervasive and fundamental. A fully effective strategy to reduce vulnerability to these impacts would similarly need to be fundamental. It is not simply a matter of identifying a small range of particularly vital imports and encouraging domestic production of them: it would involve a total restructuring and reorientation of our economic and social patterns away from external trade, with the dramatically lowered standard of living that would result. Such a complete restructuring would clearly not be feasible as a precaution against the possible occurrence of a nuclear war. It is however feasible to examine the barriers to domestic production of some key imports such as pharmaceuticals, to estimate the additional costs of domestic production, and to encourage debate on whether New Zealanders are prepared to pay those costs in order to reduce New Zealand's vulnerability.

REFUGEES

AS A RESULT OF A NUCLEAR WAR and the vast devastation of their homelands, many people would be forced to migrate. While it cannot be estimated how many would reach New Zealand, even a very small number would pose problems that post-nuclear war New Zealand would have difficulty solving.

This chapter discusses some of the factors that would prevent numbers of refugees from arriving, and draws attention to the problems that could occur if only a few did arrive. Included in the discussion are the hundreds of thousands of people living in other countries who have a right to enter New Zealand and who may wish to do so *before* a nuclear war, and the tourists and other visitors in or near New Zealand (under normal circumstances numbering in the thousands) who could be "trapped" here if nuclear war occurred with little or no warning.

POST-NUCLEAR WAR REFUGEES

Refugees likely to arrive in New Zealand could include civilians, some armed, and military personnel. Many of them could be carrying diseases and have various degrees of radiation sickness. Their intentions would vary from seeking refuge, to bargaining for resources, to direct military conflict. After a nuclear war, crews of military vessels and aircraft might decide that their best chance of personal survival would lie in making for non-targeted territories (including New Zealand). However there are several factors, apart from the health of the travellers, that would make it difficult for refugees to reach New Zealand.

Factors preventing their arrival

Distance would be the greatest obstacle (see Fig 10). Even the countries geographically closest to New Zealand are still a long way away (for example Australia is over 2,000 km distant). Refugee vessels would probably be overcrowded and poorly provisioned, and therefore under tremendous pressure to make the nearest, safest landfall. Refugees from Europe, Africa, Asia and eastern North America might find it easier to reach Southern Hemisphere countries other than New Zealand. Refugees from Australia and South Pacific Island countries would have the easiest sea voyages. If Australian bases and cities were bombed there could be considerable numbers of people from Australia seeking safety in New Zealand.

New Zealand has strong historical, cultural and economic links with Europe and North America. Both these regions would be devastated in a major nuclear war. Attempts by survivors to reach New Zealand would be severely hampered not only by distance, but also by the destruction of ports, airfields and fuel stocks. The larger the war, the greater the destruction and the more difficult it would be to travel by sea or air. Another major difficulty for survivors in combatant countries devastated by war would be the organisational tasks of equipping vessels for long-distance travel - finding crew, fuel, food and other provisions. Long-distance air travel would be particularly hampered by the need for refueling stops and the reliance on ground support staff.

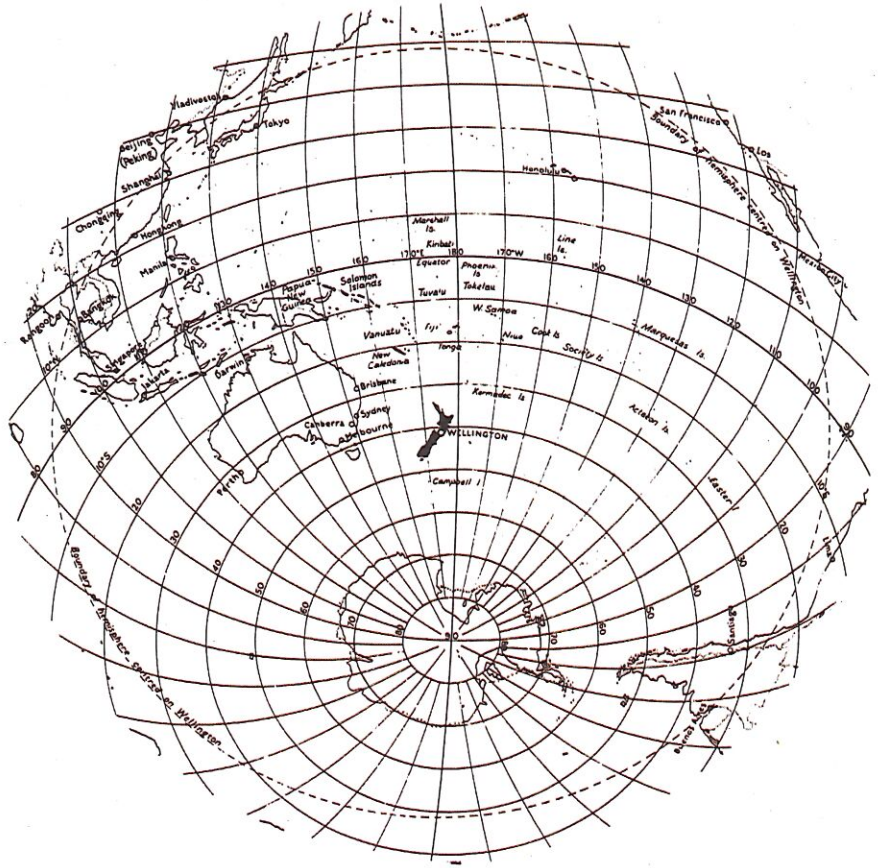
Another important factor affecting the numbers of refugees arriving in New Zealand is the policies and actions of authorities in countries of departure. Governments may prevent cargo ships from leaving with refugees, recognising the value of such ships for trade and freighting of essential materials. In combatant countries such control is less likely to exist, but in southeast Asian countries it could be a factor. In summary, although it may appear that there could be large numbers of potential refugees with the intention of going to New Zealand, there would be many constraining factors preventing their arrival, not the least of which is New Zealand's isolation.

Consequences for New Zealand

Notwithstanding the arrival of nuclear-armed vessels or surviving military forces, the most serious threat for New Zealand would be the arrival of refugees carrying infectious diseases. Even small numbers of refugees

Fig 10/
THE HEMISPHERE PROJECTION AS CENTRED ON WELLINGTON

The hemisphere centred on Wellington is dominated by vast expanses of ocean and great distances to major areas of population. Closest neighbours are Australia (2,000km) and the scattered island countries of the South Pacific Ocean. (Source: Map from Defence of New Zealand *Review of Defence Policy 1987.*



could establish pockets of infectious diseases. Some would bring diseases already present in New Zealand (hepatitis, tuberculosis, diphtheria), others might bring epidemic diseases now absent - plague, typhoid fever, cholera, typhus and leprosy.

Refugees arriving a year or so after nuclear war are more likely than earlier arrivals to be carrying infectious diseases since these diseases would have, under post-nuclear war conditions, established widely throughout the Northern Hemisphere, either by natural spread, or via migrants. The arrival of such diseases after, say, 6-12 months would find New Zealand in an extremely vulnerable position. Existing vaccines and other pharmaceuticals would be almost exhausted and adequate sources of supply or local manufacture to cope with major epidemics would probably not have been organised in that time. Well-organised quarantine facilities would be necessary in several parts of the country, depending on the numbers of refugees.

Large numbers of refugees would impose severe demands on basic services and would further overload a social system struggling to cope with local requirements. In peacetime, refugees can be housed, fed and supported by government and other agencies until they become financially self-sufficient. After nuclear war those services would be very heavily overloaded. Volunteer agencies would be fully occupied with social problems within local communitites.

Thus, the number of refugees that New Zealand could cope with easily after nuclear war is very small. Critical factors would be health-related issues, provision of quarantine, additional social stresses, and meeting basic requirements such as shelter.

PRE-WAR REFUGEES

There are other categories of people who may, inadvertently, cause problems for post- nuclear war New Zealand. For instance, if a nuclear war occurred with very little warning, there could be up to 45,000 people in New Zealand (1986 census) who normally live in another country. These include tourists, business people, students, ships crews, and embassy staff. If there were an extended warning time before an outbreak of war these numbers might either decrease, if people returned home, or increase, if people attempting to "escape" the war set out for New Zealand. Even if these "trapped tourists" were the only refugees in New Zealand they

would create significant demands. Forty-five thousand people is four times the annual number of permanent immigrants presently accepted into New Zealand (excluding returning nationals). Those without jobs would require employment and assistance although it is unlikely government would be able to attend to these demands in the first few weeks. "Temporary" accommodation could be provided in hotels and motor camps.

If they were able to return, the number of expatriate New Zealanders would be sufficiently large to cause a problem. Present estimates suggest there are up to 400,000 New Zealand citizens overseas, by far the greatest number of them in Australia (207,000 according to the 1986 Australian census), and 23,000 Tokelau, Cook and Niue citizens, all with legal right of entry to New Zealand (see Background Paper 18). Many of these expatriates would be unable or unwilling to return to New Zealand, but if a significant number of them did arrive during a pre-war crisis period they would strain housing, employment and social services. Not all would have New Zealand relatives to rely on. Also to be considered are the 16 million Australians who, under the present no-visa policy are allowed free entry into New Zealand.

PEOPLE IN TRANSIT

Crews of cargo ships would constitute the majority of the people in transit at the time of a nuclear war who could reach New Zealand. On any one day about 1,650 cargo ships (of over 5,000 tonnes) are crossing the Pacific Ocean, all of which would normally have sufficient fuel to reach New Zealand. During pre-war tensions there would probably be considerably fewer ships at sea, so assuming only 1,000 of these ships were at sea at the time of a war and 20-30% headed for New Zealand (other destinations would also be sought) the number of crew arriving would be about 8,000.

A smaller percentage of the 2,400 cargo ships normally crossing the Indian or Atlantic Oceans might also reach New Zealand. This would add another few thousand people, giving a total of around 15,000 foreign crew arriving in New Zealand.

Aircraft in transit in time of war might be able to divert to New Zealand, if they survived EMP effects. On any one day about 12 international flights arrive in New Zealand with a total of 2,600-3,400 people. Other flights

operating in the Pacific area would usually have sufficient fuel to divert to New Zealand if they chose to do so.

If it is assumed that between 20,000 and 50,000 New Zealanders (mostly from Australia) returned to New Zealand before a war began, then a rough estimate of potential pre-war and immediate post-war arrivals is possible. If 40,000 foreign nationals are included, the total number (including ships' crews) would be 75,500 to 105,000 people. These estimates may seem conservative, but they still total significant numbers of people for New Zealand to absorb. They represent from 2.7 to almost 4 times the largest annual flow of migrants that New Zealand has experienced in the last 25 years (28,000 in 1974). Furthermore, migrants normally arrive over a whole year, not in a short period of time.

ETHICAL DILEMMAS

The ethical conflicts inherent in the refugee issues were evident in the different replies of respondents to the study. One wrote:

> *"A nuclear war is going to require us to be prepared to accept a larger, but uncertain number of refugees ... our responsibility [would be] for all our sisters and brothers",*

while another suggested:

> *"If the economy were unable to provide for the existing New Zealand residents it would be essential to repulse refugees ... I regard this as the most tragic aspect of the dilemma."*

The first view is the humanitarian response that, no matter what the cost or risks, New Zealand should allow unlimited entry to refugees. But would that be fair to other New Zealanders if the numbers were large, if they spread diseases and imposed significant demands on local resources? And even if only a few refugees were to be allowed entry, who would choose and on what basis? Either decision would be difficult to make and to implement if tens of thousands of refugees were to arrive. Because of New Zealand's long stretches of unpopulated coastline, the landing of refugees might be beyond the control of authorities, regardless of the policy at the time.

The responses of neighbouring Asian countries to the arrival of Vietnamese "boat people" in the mid-1970s provides a comparison. The first boatloads of refugees were allowed ashore and accommodated in camps.

Later, when the number of refugees severely strained local resources, ASEAN countries classified boat people as illegal immigrants in order to justify the rejection of new arrivals.[1]

POLICY ISSUES

Despite the uncertainties regarding the number of refugees, there is merit in developing policies based on the likely arrival of refugees in New Zealand after nuclear war. A better understanding of the key vulnerabilities would be a first stage in policy development, since practical issues would assist policy and planning considerations. For example, a particular set of problems is associated with refugees arriving with communicable diseases many months or years after nuclear war. These range from the problems of detecting arrivals outside populated harbours, to requirements for quarantine facilities, needs for medical treatment, food, and shelter. Any policy development should include ethical dimensions as well as practical considerations.

LINKS WITH SOUTH PACIFIC ISLANDS

LOSS OF IMPORTS has been identified as one of New Zealand's major problems if a nuclear war occurred. However, for many Pacific Islands the situation would be worse and there could be a vital role for New Zealand to play in assisting their survival. A primary question is whether a common interest in regional co-operation might exist in the event of nuclear war. Detailed analysis of how individual Pacific Islands might be affected by a nuclear war is an appropriate concern for the countries themselves to consider and New Zealand could provide assistance with such investigations. The following points raise some general concerns.

TRADE AND FOREIGN AID

The South Pacific island economies are heavily dependent on trade and especially imports of food, fuel, medicines, tools and machinery; many things that have become the necessities of life. Their economies also rely on foreign aid, Australia and New Zealand being the major donors. Some countries, especially Western Samoa and Tonga, also depend heavily on remittances from migrants. New Zealand and Australia supply a large proportion of the imported food and medical supplies.

The tendency to deal with problems when they arise, rather than plan ahead for uncertain events, is not new. For example, the New Zealand "War Book" (the detailed planning procedures for managing the economy during World War II) was not completed until August 1939, although Britain and other Commonwealth countries had produced their versions several years earlier. A position of having no contingency plans in the event of nuclear war, no stockpiling of strategic materials and equipment, no bolstering of self-reliance in key industries for strategic reasons, does represent a coherent policy. It is a policy that assumes disruptions, trade embargoes, economic collapses, conventional or nuclear war are either a) non-existent threats, or b) would be preceded by sufficient lead-time to allow "appropriate action" to be taken. Other Western countries appear to take a more pessimistic view.

Despite its own considerable reserves of minerals the USA has had a strategy of stockpiling minerals since the early 1950s. US policy is to maintain sufficient stocks of 94 minerals to supply US industry for up to three years.[2] In 1982 the stockpile was worth over $12,000 million. Other Western governments, including France, Britain, Japan, Sweden, Italy and Spain already have, or are developing, strategic stockpiles of important minerals as a precaution against disruption of supply.

By contrast, New Zealand governments have shown little inclination to sustain similar policies. For example, following the oil price rises of the 1970s a National Strategic Petroleum Reserve was established but the last stocks it held (48,000 tonnes of diesel) were sold in January 1987. The government cited "little reason for continued investment"[3] as the justification for the sale which attracted little public comment.

As the NRB poll referred to earlier made clear, the public favour planning to help cope with the aftermath of nuclear war. The sentiments expressed by W. Anderton in 1959 may not have found a practical expression in the subsequent development of the Ministry of Civil Defence, but they continue to have public support.

RESPONSES DURING THE CRISIS PERIOD

With the news that nuclear war was imminent or had begun, people would focus very strongly on their personal, family and community needs, but they would probably look to government for assurance that those needs would be met.

People would expect official information about what had happened and what would be likely to happen. Should they expect bombs on New Zealand? How could they tell what radiation was being received? What was happening in Australia and in Pacific Island countries? Should they expect an invasion by military forces, or the arrival of refugees? How could they communicate with or travel to family members? When would the telephone system cope? Was there enough petrol for them to travel? What food was safe? What household supplies were likely to be scarce? What was likely to happen to their cash in the bank, their property, their wealth? Would their employer continue to pay wages?

The ability of central government to answer all these questions could be in doubt. Disasters and crises affect not only individuals, but also the behaviour and functioning of organisations. This is often overlooked in disaster planning (Chapter 5) and can be overlooked when considering the likely impacts on government. The focus here is on central government decision-makers (Parliament, and especially Cabinet in the event of a national crisis), advisors to decision-makers (senior public servants) and staff in government departments. People in all three categories have specific roles to play in the successful resolution of crises. Co-ordination between them would be essential if effective decisions were to be made and implemented during the first weeks after a nuclear war.

The ability of decision-makers and their advisors to exercise good judgement can be lowered by high levels of crisis-induced stress. There are several historical examples of the damaging impacts of such stress on national leaders. Theodore Sorensen observed President Kennedy's advisors during the Cuban missile crisis, and noted "during the long days and nights of the Cuban crisis, how brutally physical and mental fatigue can numb the good sense as well as the senses of normally articulate men".[4]

After a nuclear war New Zealand decision-makers would be facing much greater stresses. As well as their national responsibilities they would have to cope with the same fears and recognition of personal losses as everyone else. The suddenness of crises, the need for quick decisions, the lack of information, and the cumulative strain would cause enormous stress. The outcome could be hastily-made decisions without adequate analysis or consultation, and an over-reliance on personal beliefs or inappropriate historical precedents to resolve issues of unprecedented complexity.

CONCLUSIONS

SUMMARY

A major nuclear war would kill hundreds of millions of people through blast, radiation, disease and starvation. These effects would be felt principally in the Northern Hemisphere where there are the biggest population centres, the major likely combatant countries and most of the likely targets for nuclear weapons.

The effects on New Zealand would be devastating, but different from those experienced in the north. New Zealand is not likely to be a direct target nor suffer direct effects. Radioactive fallout would not be a major threat to health in New Zealand: it might add 1% to the normal incidence of cancers over the following 70 years. New Zealand would not suffer the extreme nuclear winter effects expected in the Northern Hemisphere: crop losses would occur, but probably not to the extent that people would starve.

However, even without direct physical impacts, a major nuclear war would fundamentally disrupt New Zealand society. The effects would be widespread, some sudden, some longer lasting. There would be immediate fear, if not panic, at the possibility of direct targeting of nuclear weapons on New Zealand and of radioactive fallout. There would be for everyone a massive sense of grief and the pervasive psychological effects of loss of contact and isolation. The most serious longer-term effects would be caused by the loss of imported supplies on which every sector of activity in New Zealand depends and the loss of markets for export production which shapes much of the social and economic structure of the country.

It is not possible to predict whether society would hold together or tear apart: that would depend heavily on how well prepared New Zealanders were and how they responded to the enormous trauma and disruption. It is unrealistic to expect that the response could ever be calm and well-organised. Along with the realisation that nuclear war had occurred and the immediate shock and fear, there would be the growing realisation that people could no longer rely on structures and systems now taken for granted.

Central government would be under intense pressure during the initial weeks of crisis. People's demand for information and direction would be high, while government would be forced into rapid decisions on many urgent issues. Without prior contingency planning these difficulties could prove insurmountable. (In the months and years after a nuclear war the nature of government structures and decision-making might change considerably. Devolution of power to regional or community levels could be the most viable and appropriate option.) Some of the impacts that would shape post-nuclear society are summarised below. Health care in New Zealand is virtually 100% dependent on imported medicines, vaccines, and medical and dental supplies. Stocks on hand would suddenly become the only reliable source. Medicines could be rationed and supplies eked out for a year, or perhaps two. But if local alternatives were not developed rapidly a tremendous increase could be expected in diseases and illnesses now controlled by drugs. Refugees could bring new sources of infection. Water supply and waste disposal systems would be at risk from the loss of imported chemicals and spare parts. The energy and transport services on which those systems rely would similarly be at risk from the loss of imported fuels and spares. A computer system failure could close New Zealand's single oil refinery and reduce diesel supplies to zero. This in turn would cripple coastal shipping and ferries, diesel locomotives, much road transport, some manufacturing and food processing industries. The loss of these diverse systems would then create additional problems in many other areas.

Loss of export markets and of imported supplies, components and spares would make existing patterns of farming and forestry irrelevant, or unsustainable. This would cause major disruptions to asset values and prices, to employment and to wage and salary incomes. Shops, banks and other financial institutions would be affected by those disruptions as well as failures in their own internal systems.

In many cases the effects would not be immediate. stocks of imported items would be available and many early breakdowns could be fixed. But it would soon be apparent that the failure of major facilities and systems, such as the synthetic petrol plant, the refinery, power stations and the Cook Strait cable, would be inevitable over coming months or years.

These failures would be sudden and comprehensive if New Zealand were affected by an electromagnetic pulse (EMP). New Zealand's strategic insignificance means there is little likelihood of it being a deliberate target for an EMP. But the growing militarisation of space and the importance of the Australian communications facilities do increase the possibility of New Zealand becoming an indirect target. The likelihood of an EMP affecting New Zealand is lower than the probability of nuclear war but the consequences would be devastating. Communication, energy, banking and transport systems would be crippled instantly with no time to develop alternative systems. An EMP could well mark the end of present social and economic structures and force people into subsistence living.

In reviewing the overall findings of this study, four main interrelated points should be noted. These are the extent of New Zealand's dependence on international trade, the increasing vulnerability of the technologies used in key systems, the strong interdependency between sectors, and the lack of contingency planning.

Imports provide vital materials and spares for most activities in New Zealand; exports are the predominant outlet for major primary industries on which depend, directly or indirectly the jobs and incomes of hundreds of thousands of New Zealanders. Disruption of trade following a nuclear war would dislocate the lives and wellbeing of all New Zealanders.

Technologies used now in sectors supplying basic needs such as communications, energy, transport and health are very vulnerable to the loss of imports and to an inability to repair, replace parts or manufacture substitutes solely from local resources. In addition there is a continuing loss of the skills, knowledge and equipment of older technologies which could be serviced and manufactured locally.

Strong interdependence between sectors means that vulnerability in one sector produces vulnerability in others. Conversely, reducing vulnerability in one enhances its reduction in others. The health system depends on trade, energy and transport. The sub-sectors of energy are deeply dependent on one another and on transport and communications. No sector or system stands alone.

After ar war extremely difficult decisions would need to be made to set priorities, conserve stocks and develop alternative systems. Contingency planning could help in this process but at present there is no planning within or outside government for responding to the impact of nuclear war.

As noted earlier, while the direct impacts on New Zealand would be relatively minor, the overall effect would depend crucially on how well prepared New Zealanders were. At present New Zealanders are ill-informed and ill-prepared.

WHAT TO DO

The highest priority in the face of the threat of nuclear war must always be given to prevention. Although New Zealand would be among the countries least severely affected by nuclear war, the effects here would still be catastrophic. For our own sake as well as out of concern for the rest of humanity it is important to find and pursue the policies that will be most effective in preventing nuclear war.

But even the best strategies for prevention may fail. Nuclear war is not inevitable but it is possible. What is it worth doing in preparation in case prevention fails?

Faced with relatively unlikely but disastrous possibilities, people do take precautions individually and collectively – such as paying for fire insurance, conducting civil defence exercises and strengthening buildings against major earthquakes. What they are prepared to do depends on a combination of the probability of the disaster occurring and the cost of preparation compared with the cost of not being prepared if disaster did occur. Similar considerations apply in the case of the threat of nuclear war.

This study was asked to assess the likely impacts on New Zealand of nuclear war and make recommendations for more detailed second phase studies to resolve important issues of uncertainty. Three categories of follow-up programmes should be considered:

- improving public knowledge of the likely impacts on New Zealand of a nuclear war;
- drawing up contingency plans for action if war occurred; and
- taking action now to reduce vulnerability to the effects of nuclear war.

Improved public knowledge of the consequences of nuclear war for New Zealand is an essential first step. It is needed as the basis on which people decide how much effort to put into preventing nuclear war and to preparing for it.

Because most of the information available now relates to what is likely to happen in Northern Hemisphere countries it is particularly important to provide better information about the very different effects likely to be felt in New Zealand.

The authors hope that this report will make a useful contribution to better public knowledge. The report does not claim to be definitive: critical discussion of it will identify where fact and interpretation can be improved. There are many areas where more research would be useful; some concerning New Zealand alone are mentioned in the later discussion of contingency planning. Two are more international in character.

Better information is needed about the climatic effects in the Southern Hemisphere of nuclear war. Closer regional co-operation between scientists in Australia, New Zealand and the Pacific Islands could ensure that improved information from Northern Hemisphere research programmes is monitored and that the necessary studies are carried out to adapt and interpret their results for Southern Hemisphere countries.

This study has wide international relevance for studies of the consequences of nuclear war. As a remote food-exporting nation New Zealand is more likely than most countries to survive nuclear war relatively unscathed. However, this study found that physical survival would not guarantee social survival and that without northern trade, collapse of New Zealand economic and social systems is possible. If this is a credible outcome for New Zealand, how might other non-combatant countries fare? Studies carried out in other countries along similar lines would add further understanding of the impacts of nuclear war on the global community.

While research is necessary it must be stressed that making the results available and accessible to the general public is vitally important. It is not just government officials and scientists who are affected by the threat of nuclear war. General understanding of what is likely to happen if nuclear war occurs allows an informed public debate which is necessary both for effective prevention and for effective responses if prevention fails.

Contingency plans for key sectors and systems would play a major role in reducing uncertainty and disruption if nuclear war occurred. The process of preparing them would also improve our knowledge of the impacts of nuclear war and identify areas where more research would be worthwhile.

Previous chapters identify where contingency plans could be developed now. For example: a plan for central government should set out the major decisions to be made, the methods of communication government would use, and the extent to which it should rely on central direction or the devolution of power to regional or community agencies.

In the health sector, agreement is needed on plans for managing limited stocks of medicines and for maintaining preventive public health systems. The feasibility of producing human medicines in New Zealand should be studied to identify present barriers to production and whether production could begin quickly following the loss of current sources of supply.

For the financial and monetary system, a set of procedures should be agreed for maintaining or replacing electronic systems, guaranteeing deposits, maintaining adequate cash for people's needs and adjusting assets and liabilities in an orderly fashion. This should reduce the danger of sudden collapse in the financial system and retain a capacity to assist rather than impede adjustments in production, employment and consumer demand.

Similar contingency plans should be given priority in communications, energy and transport, and in sectors not examined in this study.

Two important points should be noted. The public exchange of information adds a vitally important dimension: plans drawn up and kept internally by government or by individual sectors would be less useful than plans developed through a public process and exchanged between sectors. Without wide public support, contingency plans would be of little value. Secondly, the preparation of contingency plans for a possible future event like a nuclear war can be useful now by identifying weaknesses in current practices. For example, is it only cost that prevents the production of medicines in New Zealand? To what extent does present use of local energy resources take account of uncertainty in future supply?

Vulnerability to the effects of nuclear war cannot be eliminated. It arises not just from dependence on a few strategic imports: it flows from all ties to the rest of the world. But key areas of vulnerability can be identified and the options and costs of improving self-reliance examined. This study has identified some obvious candidates for closer examination. Among medical supplies there may be some which could easily be produced locally and

others where the costs of domestic production would be very high. In communications and computer technologies there will be choices between hardening against EMP effects, installing back-up systems, or retaining the capacity to resort to simpler technologies. Stockpiling trace elements for agriculture and promoting a variety of recycling industries are examples of other options for reducing vulnerability to the loss of imports.

The overall purpose of continuing this study of the impacts of nuclear war into a second phase should be to advance from research on the consequences of nuclear war into an active public information programme and into contingency planning where the public is effectively involved in deciding what risks should be accepted and what price should be paid for reducing risks.

Responsibility for these diverse public information, research and contingency planning activities in different sectors should not be given to one agency. Much of the work needs to be done within existing public and private sector agencies. However, to initiate, organise and co-ordinate this second phase programme, a specialist unit should be set up and funded for a limited establishment period. At the end of that time full responsibility for ongoing work should return to the agencies most directly concerned. The specialist unit could prepare material for public information, co-ordinate continuing scientific investigation, initiate the development of contingency plans and investigate the feasibility of reducing import vulnerabilities.

Above all, it is important that the second phase of this project be paralleled by continuing public discussion about the part New Zealand can play in nuclear war prevention strategies. For while survival may be preferable to death, life without the nuclear threat will *always* be the most important goal.

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PUBLIC OPINION SURVEY

AS PART OF THE NUCLEAR IMPACT STUDY, a market research firm, AGB:McNair was commissioned to establish the depth of knowledge and beliefs held by the New Zealand public as to the most serious consequences for New Zealand following a nuclear war.

Two questions relating to New Zealand after a nuclear war were included in an AGB:McNair Omnibus survey, which was based on a random sample of 1,137 people selected to represent the New Zealand population.

For the first question (which was unprompted) respondents were given the following scenario:

> *Imagine there has been a major nuclear war and most of the nuclear targets have been in the Northern Hemisphere. New Zealand has not been hit by any nuclear bombs.*

and were then asked:

> *Under these circumstances what do you think would be the serious consequences for New Zealand as a whole? What others?*

The following table gives the responses, grouped into categories, of the consequences people gave (the percentage base was weighted down to 1,101). Percentages total more than 100 since people gave more than one consequence in their replies.

CONSEQUENCES	PERCENTAGE BASE = 1101
Food/crops	25
Radioactive fallout/radiation	22
Trade loss	21
Colder weather/'nuclear winter'	19
Refugees/overpopulation	12
Disease/sickness	11
Change in atmosphere	10
Isolation	9
Death from radiation	8
Environmental contamination	8
Death – General	7
Resources/supplies	6
Economic disaster	5
The end of everything	4
Haven't thought/try not to	4
Breakdown in law and order	4
Lack of medical supplies	4
Breakdown in society	2
General chaos	2
Threat of war etc	2
No outside news	2
Effect on people/suicide	2
Don't believe it will happen	1
Other	7
None/No effect	2
Don't know/Not specified	8

Although direct mention of radioactive fallout/radiation was mentioned by 22%, the percentage was in fact higher, since a proportion of the replies in the categories of "disease/sickness", "death from radiation" and "environmental contamination" contain references to radiation.

For the second question, people were then told:

> *Here is a card which lists some possible consequences in New Zealand of a major nuclear war in the Northern Hemisphere.*

and asked:

a) *Which one would you suggest as the most serious for New Zealand as a whole?*

b) *Which one would be the second most serious?*

c) *Which one would be the third most serious?*

The following table gives the responses, as percentages, of people's choices for the most serious consequence. There were no significant differences in sex and ethnic origin with respect to the most serious consequence they gave, and few in terms of age.

MOST SERIOUS CONSEQUENCE	*PERCENTAGE BASE = 1101 (100%)*
Radioactive fallout/radiation	46
Colder weather ('nuclear winter')	11
Not enough food	7
Shortage of medical supplies/drugs	6
Refugees coming in from overseas	6
Breakdown in law and order	6
Disruption to the economy	4
Loss of trade with other countries	4
More disease	2
More mental breakdown and suicide	2
Lack of information from overseas	2
Transport problems	0
Don't know/refused	4

When all the consquences mentioned as being serious were analysed in combination (whereby those given as the most serious consequence were multiplied by a factor of 3 to reflect their importance, those given as the second most serious consequence were multiplied by 2 and those given as third most serious were multiplied by a factor of 1), radioactive fallout/radiation was still perceived as being the most serious consequence for New Zealand.

The following table shows the relative importance of the consequences.

CONSEQUENCES	*PERCENTAGE (of potential maximum score achievable)*
Radioactive fallout/radiation	57
Colder weather ('nuclear winter')	23
Not enough food	23
Shortage of medical supplies/drugs	18
Breakdown in law and order	14
Refugees from overseas	12
Loss of trade with other countries	11
Disruption to the economy	11
More disease	10
More mental breakdown and suicide	5
Lack of information from overseas	4
Transport problems	1

It is curious to note some of the topics that were not specifically mentioned, which in fact the Nuclear Impact Study found *would* be a problem for post-nuclear war New Zealand, that is: transport, loss of fuels, communication problems, and loss of jobs through the loss of export markets or imports.