

Nuclear War Impacts on Noncombatant Societies: An Important Research Task

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# Nuclear War Impacts on Noncombatant Societies: An Important Research Task

Studies on the environmental consequences of nuclear war have generally stopped short of investigating the complex impacts on human societies. In particular, the research of impacts on societies in noncombatant countries is very limited. Such a study has been completed on New Zealand, a country that is often assumed to be a noncombatant and widely perceived as having better chances of "surviving" nuclear war than many other countries. The study revealed pervasive, complex, long-term, and highly disruptive impacts on all aspects of society, even as a noncombatant. Loss of trade, growing technological dependence (on Northern Hemisphere manufactures), the collapse of interlinking sectors (energy, health, transport, communications) and lack of preparedness were the four major causes of the disruptions. In the unlikely event of an electromagnetic pulse (EMP), from a high altitude nuclear explosion, the impacts would be far more devastating for the survival of society. By implication, many other noncombatant countries (both developed and developing) could be severely affected by the disruptions to their societies, even without ionizing radiation or nuclear winter. The study of nuclear war impacts on societies is therefore an important research task. It should be done through national case studies, although some countries may be grouped into a single study unit. These studies should improve our understanding of the long-term consequences of nuclear war. Such studies are also valuable since they can show how countries could be affected by sudden shocks, such as economic collapse or major climate change. The global imperative of making greater progress on nuclear disarmament should also become more obvious.

## INTRODUCTION

The paper will argue that the study of how nuclear war could affect societies in noncombatant countries is an essential research task if we are to understand the long-term consequences of nuclear war. This conclusion is based on a study of the impacts of nuclear war on New Zealand, a likely noncombatant country, far from the most probable regions of nuclear conflict.

The recent advances in understanding the consequences of nuclear war have been on the atmospheric, climatic, ecological, and agricultural consequences following the breakthrough by Crutzen and Birks in 1982 (1) on the potential impact of nuclear-generated smoke (2, 3). Those important studies did not investigate impacts on societies but acknowledged the need to do so. International research since then has, however, continued to refine and clarify uncertainties concerning the degree of climatic disruption, the physics and behavior of smoke particles, and ionizing radiation effects. With the recent review and endorsement of this research by a special United National Group of Consultant Experts (4) there should now be a redirection of research efforts into ecological, agricultural and societal impacts.

Study of the impact of nuclear war on societies is difficult and has been rarely attempted outside of the studies of the direct effects of exploding nuclear weapons. Previous studies focused on likely combatant countries. Katz (5) assessed economic and social impacts on the United States, but before the findings of the SCOPE studies were available. Other United States studies have tried to assess time taken for "economic recovery" after nuclear attacks (6). Sastry et al. (7), adapting a computer model developed by the Federal Emergency Management Agency, concluded that the United States economy would collapse if 1% of the Soviet strategic nuclear arsenal were to destroy energy targets. A more comprehensive approach was taken by the Greater London Area War Risk Study Commission in their report on how London would be affected by five different nuclear war scenarios (8).

The New Zealand study was stimulated by the 1985 release of the SCOPE-ENUWAR findings (2, 3). New Zealand scientists recognized the particular need for New Zealand to examine impacts beyond those of atmospheric and climatic disruption. Far from the Northern Hemisphere

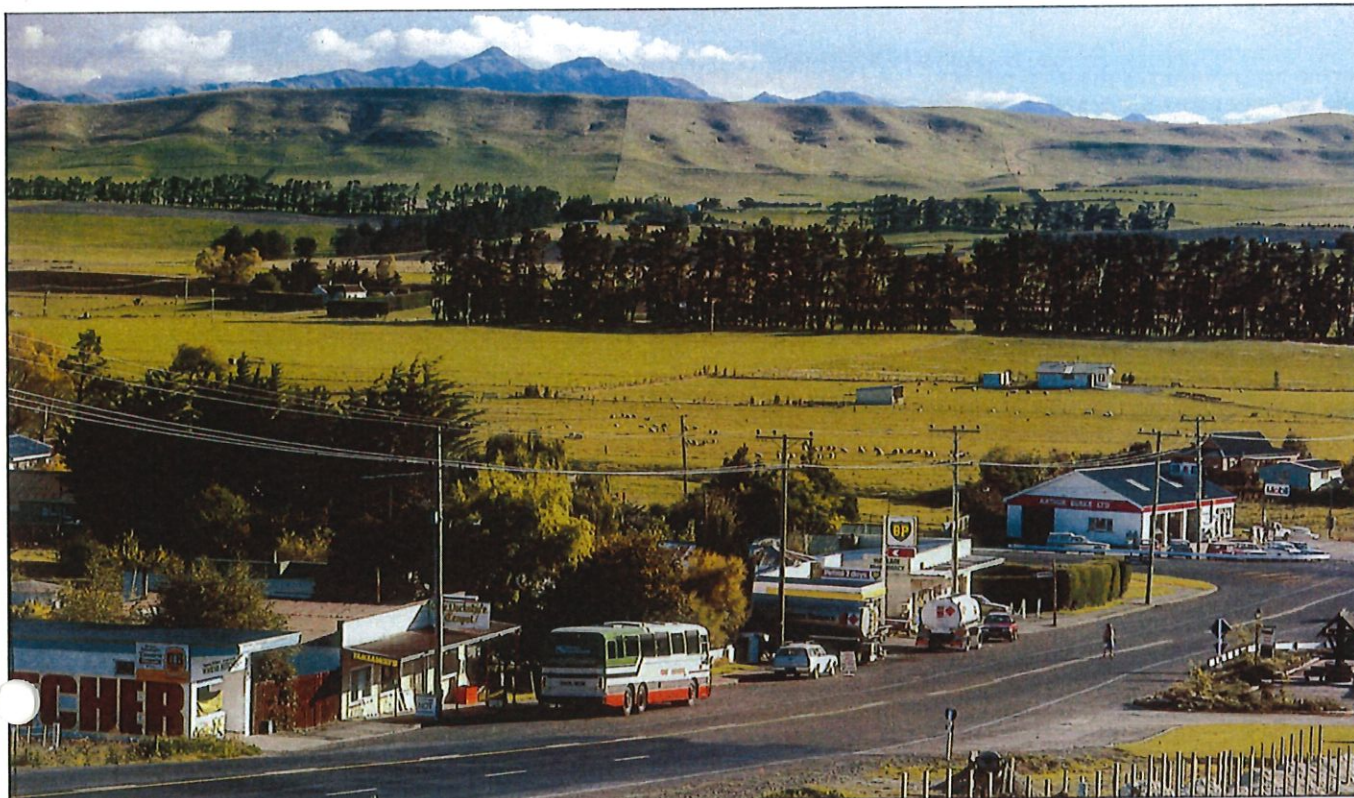
(34° to 47° S), surrounded by the moderating effects of the southern oceans, outside the zone of lethal fallout, and with food production well in excess of local supply, New Zealand's 3.3 million people were widely perceived as "surviving" nuclear war better than many other countries.

This government-funded study has dispelled any complacent notions people may have held. It reveals how nuclear war impacts would be pervasive, complex and highly disruptive to all aspects of society (9). Even without being a nuclear target the extent of the upheavals, even under the most optimistic of outcomes, would make a "return to normal" most unlikely. The study shows why impacts on New Zealand society would be more severe than climatic disruptions, or primary effects such as ionizing radiation. It has also provided a useful methodological approach for assessing the impacts of major disturbances at a national level.

## MAJOR FINDINGS

The study showed that a major nuclear war in the Northern Hemisphere would affect New Zealand most severely through enormous and complex disruptions to its society. Climatic and biological disruptions could be significant, but are likely to be less important. The direct effects of nuclear explosions would be minimal assuming New Zealand was not a target. Radioactive fallout might add 1% to normal rates of cancers over the following 70 years. This is a consequence of the low levels of global fallout predicted for New Zealand latitudes. The SCOPE study (3) predicted an average dose per person of 0.8 rems over 50 years, with a further 1.0 rem accumulated from diet over 50 years. "Worst case" assumptions of targeting nuclear power plants might double or triple this dose of about 2 rem for New Zealanders. Even with fallout from Australia, the total dose received would probably be less than the normal accumulation of natural background radiation of 10 rems per person over that 50-year period.

These findings show different outcomes from those predicted for noncombatant countries in the Northern Hemisphere and underline the value of detailed case studies in a diverse range of countries. The results also showed the variance between New Zealanders' expectations of nuclear war impacts on New Zealand per se, which are dominated by fears of radioactive fallout



Productive farmland in rural Canterbury, a South Island province N.Z. The complex agricultural sector is heavily oriented towards export for its markets. Total trade loss would probably cause greater dislocations than "nuclear winter" for food production and rural economies. Loss of transport fuels for farm machinery, trucks and cars would cause great difficulties to the mechanized farm operations. Photo: W. Green.

(study appendix) (9) and the important differences between recovery from natural disasters and from the effects of nuclear war. Unlike flood or earthquake victims, survivors of nuclear war would have no outside help, no previous collective experiences, no obvious authority to turn to, and no signs that life was going to return to normal. People would initially have to cope with a massive sense of grief and the pervasive psychological effects of loss and isolation. Other problems would soon follow.

#### Theme 1: Trade Dependence

Estimates that about 30% of GDP comes from trade substantially downplay the full economic and structural impact on New Zealand of the loss of external trade. Eighty percent of that trade is with Northern Hemisphere countries, a further 17% with Australia. Abrupt loss of that trade would eventually affect everyone in New Zealand and all sectors of the economy—primary, manufacturing, and services. How would people adjust to needing, say 15 million sheep rather than the present 60 million? How would the export-oriented forestry, dairy, meat, paper and many other manufacturing industries adjust?

For some industries, "adjustments" would not be possible, given New Zealand's dependence on imports for so many basic items—electric motors, pumps, machinery, vehicles, chemicals (industrial and agricultural), to all ball-bearings and lubricating oils.

Simple estimates of the effects of losing northern import and export markets suggested employment might fall by 40–50%.

This would be 3–4 times the highest unemployment levels of the 1930s. It is difficult to imagine how the social structure would cope with such an imposition—at a time when the ability of government to meet social welfare needs would have significantly diminished.

The disruptions of trade loss and the accompanying uncertainties would rapidly compound the pressures facing the financial sector. The closure of banks and other financial institutions could be likely for some days immediately after nuclear war. Such closures would increase people's anxieties and contribute to financial disruptions. Unpredictable changes to the relative value of assets would compound problems and threaten the existing complex systems of credit, investments and borrowing. Luxury apartments and stock bonds could suddenly be worth less than an old house with a vegetable garden and fertile soil. Coupled with the rapid loss of export-import related jobs, government would have a major role in trying to reduce the financial chaos.

The loss of imports would also cripple health care since New Zealand's dependence on imports of medical supplies and pharmaceuticals is virtually 100%. The list of imports includes all antibiotics, vaccines, anesthetics, analgesics (painkillers) contraceptives, X-ray film, laboratory chemicals, dental supplies, needles, and syringes. Medical supplies would run out at different times depending on stock levels and consumption rates. At normal rates most pharmaceuticals would last three to six months. Without a local supply, the loss of imported insulin could kill

6000 New Zealanders within the first year, about five times the extra fatalities from cancer caused by global fallout. Only an effective rationing system, promptly imposed, would extend stock levels to a maximum of two years. There would be some potential for local manufacture of medicines, assuming problems of supplies of ingredients, equipment and workforce could be overcome and co-ordinated during a time of severe social upheaval.

Health is even more dependent on essentials such as clean water, operative sewage systems, refuse collection, disinfectants and a healthy diet than it is on medicines. Waste disposal in large cities relies on a variety of engineering systems, electricity supply, transport, and a trained workforce. The failure of the system as a whole would lead to water contamination, pollution, and finally to outbreaks of infectious diseases. Pumps and machinery at sewage treatment plants would eventually break down if local substitutes for imported spare parts were not available. The likelihood that people would be stressed and possibly malnourished would increase their susceptibility to diseases. An influx of refugees could significantly increase the risk of epidemics, especially if people carrying diseases arrived many months after a war when vaccine supplies were exhausted.

Loss of imports would cause increasingly severe maintenance problems for the energy and transport sectors over a period of months and years. Like other western societies, New Zealand is dependent on processed energy—electricity, gas, and oil—for meeting most human needs in-

cluding food, water supply, sewage disposal, shelter, health care and travel. The most vulnerable parts of the energy system would be the country's single oil refinery, the synthetic petrol plant, and an offshore platform that provides 90% of the natural gas. All transport fuels (except for gas products) are processed at the one refinery. These facilities rely on a wide range of imports to keep them functioning—from drill bits and alloy steel to heat exchanges and catalysts. Engineers estimated the synthetic petrol plant could operate for about two years before half the plant would have to be closed to provide spares for the continued operation of the other half. Other parts of the energy sector would be faced with similar long-term problems, always assuming their present workforce continues to work as before. A loss of trained workers would obviously precipitate maintenance and operational breakdowns much sooner.

After North Americans, New Zealanders have the highest ratio of motor vehicles to population, one car for every 2.2 people. The continued use of these vehicles would be threatened by fuel shortages and lack of parts. Imported crudes, refined in New Zealand, provide about 40% of petrol and 55% of diesel supplies. Diesel is used for food production and processing, manufacture, mining, and gas production, as well as for transport fuel (shipping and road). Setting and implementing priorities for fuel use, especially for diesel, would therefore be extremely difficult without prior consideration.

All lubricating oils are presently imported. Stockpiles would last only three months without rationing. Production of some lubricating oils by the refinery would be possible while it continued to operate. A small amount of recycling of lubricating oils occurs now, but the capacity would need to be expanded to keep vehicles and machinery running. All vehicles and their spare parts are also imported. Local manufacture of spark plugs relies on imported ceramics from the USA, tyre production on imported synthetic and natural rubber. Improvisation, reuse and cannibalization would be essential to prevent a collapse of transportation.

Import losses would, over time, cause difficulties in other important sectors. The communications sector is sustained by high-tech equipment that is either imported or else depends on imported parts. Although New Zealand produces newsprint, the long-term failure of the present machinery would be likely without replacement of heavy rollers, bearings and other import-dependent parts. Radio and television service would be more erratic within a few years unless systems using older technologies were re-established.

The conclusion from this examination of New Zealand's dependence on imports is that few aspects of current social activity would be unaffected by the cessation of trade. So pervasive would be the problems, so rapid their onset, and so unprepared is the country at present to cope with such an upheaval, that the ability of New Zealanders to retain a reasonably cooperative, democratic society would be uncertain.

## Theme 2: Increasing Vulnerability

Technologies that supply basic needs are becoming increasingly vulnerable to the loss of imports and a diminished capacity for local substitution. The technologically advanced energy systems rely heavily on imported parts and even labor for their maintenance and repair. This applies particularly to the synthetic petrol plant, offshore gas platform and the oil refinery. The hydro-generating stations, the electricity grid and coal production represent older technologies and could be repaired and maintained more easily. This "vulnerability through modernization" theme also affects the communications sector and health system. Electronic telephones and switching systems, unlike their older manual counterparts, cannot be repaired within New Zealand. Mechanical printing presses have been discarded and replaced by imported electronic presses. Health workers rely on convenient one-use plastic syringes and stocks of re-usable glass syringes are discarded. The ability to repair vehicles with local material is also diminishing as electronics become more common in engine design.

In addition to the diminished capacity to repair and maintain modern imported technologies there is a continuing loss of skills, knowledge and equipment of older technologies which could, in an emergency, be serviced and manufactured within the country. This trend is not unique to New Zealand. The major technological innovations of a few northern countries increasingly dominate world markets and inevitably reduce the resilience of local industries in many countries.

## Theme 3: Interdependence Between Sectors

Many of these key systems are strongly interconnected in a manner that would promote instability in a crisis. Vulnerability in one system would threaten others. Conversely, if the vulnerability of one is reduced, so is the chance of survival of other systems improved. The sub-sectors of energy supply (which also depend on transport and communication) are good examples of the fragility of this interdependence.

The oil refinery and synthetic petrol plant would be, in the absence of imports, rendered useless if the single offshore gas platform were to cease operating. That breakdown point could occur after months or years. Loss of offshore gas supplies would reduce the gas available for other end uses such as manufacturing, heating and cooking. It would jeopardize transport by shutting off the local production of petrol and diesel. Compressed natural gas (CNG) and liquefied petroleum gas (LPG) are presently used in only 6% and 3% of vehicles. Given the vulnerabilities of the oil refinery and the synthetic petrol plant, the transport sector would be more secure if a much higher proportion of vehicles were converted to run on CNG or LPG fuels since neither fuel relies on complex refining. Gas reserves would suffice for many decades if used directly for transport fuels.

Loss of electricity would have serious consequences for production of liquid fuels and natural gas. Electricity is needed for operating gas pipelines and gas well-head equipment. Sudden failure of electricity and loss of pressure could cause air leaks in gas pipelines, which could lead to explosions. Electricity is also needed to run the numerous control systems at the oil refinery and the synthetic petrol plant.

Excluding medical imports, the dependence of the health system on fresh water, operative sewerage systems, refuse collection, disinfectants and a healthy diet has already been mentioned. These separate elements rely, in turn, on electricity supply, the transport system, farm production, financial systems, engineering skills and social cooperation. Health, in its turn, is central to society's well-being and ability to function. Loss of fuels leading to loss of transport and collapse of much economic activity could have more serious impacts on people's access to food than the effects of lowered temperatures. Major cities have only 2-3 days supply of vegetables. Food supplies to processing industries (themselves reliant on fuels) and to cities could become erratic. The ability of people to purchase food for cash would be reduced and new distribution mechanisms would probably be needed for urban residents.

No sectors or systems stand alone. The study (9) identified numerous options for improving the country's ability to cope with the more disruptive dislocations after a nuclear war.

## Theme 4: Lack of Planning

Unlike other countries that stockpile strategic minerals and other reserves New Zealand has developed no contingency plans nor made any financial commitments to postwar recovery. Extremely difficult decisions would need to be made after such an event to set priorities, conserve materials and develop viable alternative systems. Contingency planning now could examine such issues without the pressure imposed by times of crisis. At present, New Zealanders are ill-informed and ill-prepared for coping with the impacts of a nuclear war. A public opinion survey conducted for the study showed that 46% of those questioned thought that radioactivity fallout would be the most serious consequence for New Zealand as a whole. Only 4% chose "loss of trade with other countries" as the most serious consequence.

If a nuclear war were to occur when those attitudes held sway then fear, panic and a sense of hopelessness about fallout could dominate people's responses and reduce the likelihood of more positive behavior. The preoccupation of people with the issue of radioactive fallout came as no surprise to the study team. Since Hiroshima and Nagasaki, images of exploding nuclear bombs and lethal clouds of radioactivity have dominated the images of nuclear war consequences. Media coverage and the Chernobyl accident continue to reinforce the concern over fallout. For non-combatant countries, however, especially those in the Southern Hemisphere, a more

complex picture is now emerging. It is important for the populations in such countries to appreciate the relevance of this new understanding. As well as the threats of nuclear winter, many noncombatant countries must consider their vulnerability to economic and social collapse.

One area where contingency planning was seen as valuable concerned the relationships between various levels of government and the people. The response of the government of the day to the crises imposed by a nuclear war became an impact that was examined in its own right. Disasters affect not only individuals, but also the ability of organizations to function effectively. The study identified the central role that government would need to play in crisis management during the initial weeks. The supply of information to the public, responses to financial uncertainties, implementation of rationing schemes, the setting of priorities and other demands would place enormous stress on government. Without any preparedness it would be difficult to make sensible decisions, let alone implement them.

Assuming government and the country survived the initial few weeks without social collapse, what then? Would the ongoing hardships, massive unemployment and erratic readjustments lead to civil unrest, social breakdown, and repressive government responses? That was one outcome that many contributors to the study predicted. Others saw more cooperative structures developing between government and communities. In fact, many outcomes would be possible. While the role of government in early crisis management was clear, the longer-term role of government was less obvious. The unresolved issue is not whether central government could retain power, but whether it should and for what reasons. The post-nuclear conditions would be qualitatively different to those that existed before. Consequently, new relationships between people and government would probably be needed. Trying to retain the old order may cause the very breakdown that people (and government) would want to avoid.

#### OTHER ISSUES

Of the other issues evaluated during the study three should be mentioned briefly.

#### IMPACT OF CLIMATIC DISRUPTIONS

The assumed temperature drops, should they occur, would significantly reduce food production in New Zealand. Calculations by New Zealand Meteorological Service staff showed that each 1°C drop could add 40–50 days to the frost period in North Island locations and 15–30 days in cooler South Island locations. Extensive frosts in spring or summer could therefore kill important frost-sensitive crops—green beans, courgettes, kumara (sweet potato), potatoes, maize, tomatoes, and wheat. Fruit crops (apples, grapes, citrus and stone fruits) could be eliminated in some areas. Grain yields could be substantially reduced, particularly in the South Island. Since grains are grown primarily in the cooler southern regions (57% of wheat,

91% of oats, 83% of barley) supplies could be insufficient for national needs if the growing seasons were reduced.

New Zealand's major agricultural exports—meat, wool, and dairy products—rely on grass. Since pasture growth occurs at temperatures above 5.5°C and is not affected by frost, grass would continue growing, but lower temperatures would reduce production. A computer model of pasture growth showed that a drop in spring temperatures of 3°C would reduce pasture production by 34% to 66% in three representative locations, from the Waikato (North Island) to Canterbury (mid-South Island) and Southland (South Island). Pasture growth over the whole year would be reduced by 19–36%. Impacts of increased UV radiation and loss of precipitation were not considered.

These temperature drops and associated losses in production would, by themselves, be unlikely to put the New Zealand population at risk of starvation. Agricultural production is far in excess of local consumption and is a major export earner. Normal stock levels of cheese, milk powder and butter could supply New Zealand needs for 18–30 months. Nonetheless, food shortages may well occur for other reasons relating to difficulties faced in food processing, distribution and access. These impacts were covered under Theme 3.

#### REFUGEES

Despite the disruptions identified above, New Zealand would still be relatively "better off" than many other countries after a nuclear war. People from many countries may flee appalling conditions in the hope of finding somewhere more suitable. Some would reach New Zealand. Such refugees could include civilians, armed and unarmed, and military forces. Their intentions could range from passive to openly hostile. The greatest barrier against refugees reaching New Zealand is the distance they would have to travel. The distance from New Zealand to Australia is over 2000 km and the major centers of population are several thousand kilometers away.

Quite apart from aggressive military forces, the most serious threat for New Zealand could be the arrival of people with infectious diseases. Those arriving many months after nuclear war would be more likely than earlier arrivals to bring epidemic diseases now absent—plague, typhoid, fever, cholera, typhus and leprosy. Existing vaccines would probably be exhausted by that time. Well organized quarantine facilities would be needed. Without predicting likely numbers of arrivals the study concluded that New Zealand could cope with relatively small numbers of non-hostile refugees before they precipitated significant social stresses.

#### EFFECTS OF AN ELECTROMAGNETIC PULSE

One of the study assumptions was that New Zealand might be affected by an electromagnetic pulse (EMP) from a high-altitude nuclear explosion. The likelihood of such an event affecting New Zealand during a nuclear war was thought to be low, but given the possible impact of the consequences the event was included for analysis. Most of the published material on EMP effects deal with the impacts on military equipment and military communication systems. It is now standard procedure to "harden" vulnerable military hardware against EMP effects. The analysis showed that an EMP would have enormously disruptive effects on New Zealand society that would be qualitatively different from the no-EMP scenario. Impacts of EMP on civilian society have been given little attention in the public media.

The brief burst of energy from an EMP would be absorbed and concentrated by conducting metallic "antenna", including power and telephone lines, aeriels and other above-ground wiring. The larger the network or structure, the greater the amount of intercepted energy. Most easily damaged by the resulting instantaneous surge of power are sensitive electronic items that use microchips—computers, and electronic control units, for example. Integrated circuits are not made in New Zealand.

An EMP would cripple not only the industrial infrastructure but also the mechanisms of government. The national electricity grid would probably be overloaded with voltages that were two orders of magnitude greater than the design limits. Insulation damage and short-circuits would probably cause immediate failure of the whole grid. An abrupt failure of the electricity grid would paralyze all other energy systems. Engineers estimated that 20%–30% of the electricity supply could be restored in 10 days, perhaps 40%–50% after one year. Direct damage to the computer control systems of the synthetic petrol plant and the oil refinery would make them inoperative. The refinery would need to be converted to a manual system (taking six to twelve months) before limited production could be contemplated. Natural gas production would be crippled and transport fuels could run out in weeks. Wood and coal could become the main source of energy as they were one hundred years ago.

The results of an EMP would be disastrous for communication systems. The telephone system would be completely out of action and there could be severe loss of radio, television and newspapers. People would only know what they could find out for themselves. Rumors and panic would be highly likely. The government would have limited access to information and, more importantly, would be unable to communicate effectively with the public. The collapse of energy systems and loss of computers would probably mean the collapse of existing financial systems along with the prewar social, political and economic systems. If electricity were not widely restored then the continued functioning of large cities would be extremely difficult. Any mass urban-to-rural migration flow would generate additional tensions and social problems.

Thus, the consequences of a high-altitude nuclear explosion, leading to a sig-

nificant EMP over New Zealand, could be to force the population into conditions of subsistence living practiced by their ancestors a century ago. There are now 3.3 million people living in New Zealand however, and in a post-nuclear world few would have the skills and equipment that were appropriate in that earlier age.

## CONCLUSIONS AND FUTURE DIRECTIONS

This study of the likely impacts on New Zealand of nuclear war has shown the catastrophic long-term disruptions that could occur in a noncombatant country far from the likely war zone. Fundamental disruptions to New Zealand society would occur in the absence of direct targets or climatic change. Analyses based only on physical and climatic effects are therefore inadequate to understand the likely range of nuclear impacts on New Zealand. This case study demonstrates the value of investigating impacts on society in other national case studies that examine the consequences of nuclear war. Indeed, studying societal effects should be seen as a necessary part of such studies in non-combatant countries, integrated with studies of climatic and agricultural effects.

The value of social impact studies for noncombatant countries is high. However, "... it is a feature of the age we live in that we are inclined to study what we can measure rather than what we need to know. The social impact studies might never get done" (10). The inclusion of societal effects as part of national case studies is now a logical and possible extension of nuclear impacts research, given the very solid groundwork of advances in our understanding of physical and biological effects. The massive increase in our understanding of nuclear consequences that is contained in the SCOPE report (2, 3) provides the initial conditions on which societal studies need to be based.

The purpose of societal studies is not to predict outcomes as a consequence of analysis. The flexibility of human responses makes such a goal impossible even ignoring the uncertainties that accompany other potential nuclear war effects. For some situations it may be possible to determine thresholds of stress beyond which the survival of society would be unlikely. However, even when that is not possible the study of effects on societies has other values. The New Zealand study gave a more relevant and realistic account of likely impacts than had been available previously. This served to raise awareness of the issue, brought the issue before policymakers, and prompted a public debate about the difficult dilemma (in New Zealand) of increasing the efforts on prevention of nuclear war or developing contingency measures that might reduce nuclear impacts. Of course, these two options are not mutually exclusive. Many New Zealanders urged the Government to commit money to develop contingency measures. No such program has yet been started.

The study also provided insights into the structure of New Zealand society and the separate roles and interdependencies of

the parts. This holistic view of the interactions between key sectors and their vulnerabilities is useful in other contexts. It shows policymakers how the country might cope, or not cope, with a range of other major disruptions such as extensive natural disasters, sudden climate change, economic collapse, or conventional war. These events would have features in common with those identified in the nuclear impacts study.

Policymakers are also made aware of the broader themes of vulnerability, complexity and resilience. Vulnerability is increased through certain technological developments and particular linkages into global trading systems. Market specialization of productive effort and expertise can increase vulnerability, should sudden shocks occur. Complexity, represented by the sophistication of New Zealand's financial markets and technological infrastructure, is revealed as a potential liability should things go seriously wrong. While a return to the "old days", and "obsolete" technologies is not advocated, it is pertinent to identify key vulnerabilities and examine the costs and options of improving self-reliance. Ironically, some of those options such as more local recycling of materials, increased energy efficiency and renewable transport fuels, are also important in the global context of moving to sustainable development practices and reducing the impacts of global warming.

Resilience, the ability to bounce back from upheavals and disruptions, is an established concept in ecology (11, 12). The concept has relevance to other fields of inquiry, including the consequences of major shocks on societies. Some types of social organizations and economic activity will be more resilient than others. These

are relevant to development policies and security in an uncertain, unpredictable world. The New Zealand case study provides another example of the importance of viewing national security in wider terms than simple military power. Much has been written recently on this topic (13, 14).

To sum up, the New Zealand case study has been useful for several reasons. The New Zealand people now have a more realistic analysis of the multitude of disruptions they would face should nuclear war occur. The disruptions would be more complex and longer-term than most people had previously realized. That knowledge provides further justification for New Zealand and other non-nuclear countries to redouble their pressure on the nuclear powers to move more rapidly towards nuclear disarmament. The risks to all our futures are now unacceptably high.

The study also provides a basis for contingency planning initiatives should government and the people wish to do so. By identifying general vulnerabilities, the issue of national security can be placed in a wider context which includes choices between different development options. The way we use our water, land, and consumable materials is called into question; the issue of sustainable development is raised as a consequence of identifying New Zealand's vulnerability to a distant nuclear war.

Our global interdependencies are recognized, once again, for what they are—the reality that should stimulate us to seek cooperative, equitable solutions to the Earth's mega-problems, or the shortening fuse that will push nations into further conflict and self-destructive competition. The choice is ours.

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