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AOTEAROA/NZ CATASTROPHE RESILIENCE PROJECT 2023

HAZARD PROFILE

Nuclear War / Nuclear Winter

This Hazard Profile should be read as part of a comprehensive National Risk Assessment

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Introduction

A National Risk Assessment aims to evaluate risks of national (not merely regional) significance. National Risk Assessment is a helpful tool for risk dialogue, risk comparisons, risk prioritisation, and preparedness planning.[1]

There are various ways of conducting a National Risk Assessment. The following draws upon the Swiss approach, which was developed by experts from the public administration, academia, and the private sector, drew on international standards and guidelines, and was validated in a joint workshop.[2]

Using the Swiss approach, we present a Hazard Profile for nuclear war and nuclear winter from the perspective of New Zealand. This profile was updated/revised/corrected through a workshop (9 Feb 2023) with members of the public sector, private sector, and academia using an iterated process of expert elicitation.[3] The profile should be read in conjunction with profiles of other national risks to allow comparison and resource allocation according to appropriate decision rules.

National Risk Assessments can suffer from some shortcomings and we aim to address these below. Shortcomings may include an inappropriate time horizon, scenarios chosen, discount rates, and decision rules.[4]

Definition

For purposes of this Hazard Profile, nuclear war is defined as an event in which a state attacks another state with nuclear weapons.[5] This definition 'excludes nuclear terrorism and other attacks by nonstate actors, unauthorized detonations (which are made against the intentions of state authorities), and accidental nuclear detonations (which no one authorizes), unless these events cause interstate nuclear war.'[6]

[1] National Risk Analysis Methodology 2020 (Switzerland)
[2] National Risk Analysis Methodology 2020 (Switzerland)
[3] National Risk Analysis Methodology 2020 (Switzerland), p.15
[4] Boyd & Wilson 2022
[5] Baum et al. 2018
[6] Baum et al. 2018

Examples of Events

Events that have taken place help to better understand a hazard. They illustrate the origin, the process, and the effects of the hazard under investigation.

- **Japan 1945**: The United States (US) detonated two atomic bombs over the Japanese cities of Hiroshima and Nagasaki on 6 and 9 August 1945, respectively. Over the next two to four months, the effects of the atomic bombings killed between 90,000 and 146,000 people in Hiroshima and 39,000 and 80,000 people in Nagasaki. For months afterward, many people continued to die from the effects of burns, radiation sickness, and injuries, compounded by illness and malnutrition. Though Hiroshima had a sizable military garrison, most of the dead were civilians. Following the bombings, Japan surrendered to the Allies.

- **Cuba 1962**: On 27 October 1962, during the Cuban Missile Crisis, a group of 11 US Navy destroyers and the aircraft carrier USS *Randolph* located a Russian nuclear-armed submarine near Cuba. Despite being in international waters, the United States Navy started dropping signalling depth charges intended to force the submarine to surface. The submarine's crew had had no contact from Moscow for several days. The captain of the submarine, Valentin Savitsky, decided that a war might already have started and wanted to launch a nuclear torpedo. By chance, flotilla Commodore Vasily Arkhipov was on board the submarine and refused to authorise the order. Without Arkhipov's presence the attack may have occurred and likely could have caused a major global thermonuclear response.

- **Russia 1983**: On 26 September 1983, three weeks after the Soviet military had shot down Korean Air Lines Flight 007, Lt Col Stanislav Petrov was the duty officer at the command centre for the Oko nuclear early-warning system when the system reported that a missile had been launched from the US, followed by up to five more. Petrov judged the reports to be a false alarm. His subsequent decision to disobey orders, against Soviet military protocol, is credited with having prevented an erroneous retaliatory nuclear attack on the US and its NATO allies that could have resulted in a large-scale nuclear war. An investigation confirmed that the Soviet satellite warning system had malfunctioned. A few weeks later the NATO 'Able Archer' exercise involving nuclear release was interpreted by the Stasi and the Soviets as a cover for a nuclear attack and forces were put on the highest alert ready for a nuclear strike.

- **India/Pakistan 2022**: On 9 March 2022, India accidentally fired a BrahMos short-range supersonic cruise missile, capable of carrying a nuclear warhead, into Pakistan. The missile was not armed and there were no human casualties. Both sides projected calm in the incident's aftermath and the Indian Government issued a brief statement noting that the missile launch was a technical malfunction. Pakistan publicly called out India's mistake, asked for an explanation, and called for a joint investigation. The incident raises questions about the safety of cruise missile systems, especially given the real risk of accidental escalation between nuclear-armed adversaries.

- **Ukraine 2022**: Nearly 10 months after the February 2022 Russian invasion of Ukraine, Russian President Vladimir Putin acknowledged that the conflict would be protracted and again warned of the 'increasing' threat of nuclear war. Putin said Moscow will fight by 'all available means at our disposal.' Coupled with Putin's earlier decision to put Russia's nuclear weapons on 'higher alert', the conflict in 2022 emphasises the potential role of nuclear weaponry in contemporary armed conflict.

- **Tambora 1815**: Recent modelling of firestorms likely to be caused using nuclear weapons concluded that massive amounts of soot could rise into the stratosphere blocking sunlight from reaching the Earth. Although for obvious reasons this effect has not been experimentally confirmed, analogy can be drawn from volcanic eruptions. Mount Tambora is a volcano in Indonesia. Its 1815 eruption (volcanic explosivity

index, VEI, 7) ejected 160–213 cubic km of material into the atmosphere. The ejecta from the eruption column dispersed around the world and lowered global temperatures causing an event sometimes known as the Year Without a Summer in 1816. This brief period of significant climate change triggered extreme weather and multiple harvest failures in many regions leading to widespread famine and cascading societal impacts including food riots, looting and infectious disease outbreaks.

- **Canada 2017**: Major wildfires lofted soot high up into the stratosphere. Researchers found that solar heating of the particles meant that debris reached heights of up to 23km and stayed in the stratosphere for at least eight months.

Influencing Factors

These factors can influence the origin, development, and effects of the hazard.

The climatic and oceanic effects of nuclear war depend on the number and size of bombs detonated, the targets including their 'fuel-loading' and the amount of soot lofted into the stratosphere, and the human response, which can also have a big impact on the number of fatalities.[7]

- **Source of danger**: The countries involved, size of arsenals available, design and yield of the weapons, nuclear doctrines, interaction with other military capabilities, and vulnerability of command and control.
- **Timing**: The time of year, lofting of soot, weather conditions.[8]
- **Location/extent**: The number and size of detonations, their accuracy, locations and altitude, topography at detonation site, population disposition/density, infrastructure at the target site (eg, ports, airports, global pinch points), whether firestorms form.
- **Course of events**: First strike only or retaliation, whether the conflict is ongoing, counterforce or countervalue strikes (targeting strategies), the response of countries and populations.

Intensities of Scenarios

Depending on the influencing factors, different events with different intensities can develop. The scenarios listed below attempt to be representative rather than forecasts. These scenarios serve to provide a framework for assessing the different courses that a disaster or emergency could take,[9] and can be used to prepare for the hazard.

Describing multiple scenarios overcomes the problem where a single scenario may not represent the worst possible or most likely scenario.[10]

[7] Cirincione 2008 (book chapter), Frankel et al. 2015, Baum & Barrett 2018, Rodriguez 2019, Boyd & Wilson 2022
[8] Frankel et al. 2015
[9] National Risk Analysis Methodology 2020 (Switzerland)
[10] Boyd & Wilson 2022

Scenarios where nuclear weapons are used range from a single detonation (eg, a terrorist low-yield 'fizzle') through to the entire world's arsenals being used in a global war. We have dropped these two limiting cases and next outline three scenarios between them.

Three Nuclear War Scenarios

Intensity	Hazard-specific parameters
Significant	50–100 nuclear weapons of 10–40 kT detonated, some on cities <5 Teragrams of stratospheric soot -1.8 C mean global cooling **Example:** Limited India-Pakistan regional nuclear war[11] **Brief description:** India and Pakistan continue to increase their nuclear arsenals. In our scenario, a territorial dispute over the Kashmir region progresses to conflict. Escalatory use of a nuclear weapon occurs. The conflict is difficult to de-escalate, and more nuclear weapons are used by both sides. Some urban areas are targeted, and firestorms occur releasing black carbon (soot) into the troposphere, which is then lofted into the stratosphere. Considerable geopolitical turmoil proceeds as wider trading blocs take sides. Trade in goods passing through or originating in the Asian South is catastrophically disrupted. Soot causes the global climate to cool by 1.8 C during the ensuing year. Crop failures beyond anything in living memory might occur in many Northern Hemisphere regions. Domestic food reserves and trade may buffer agriculture in year one, however, by the second year 1.3 billion people are at risk of starvation. Ongoing global hoarding and resource conflict ensues with resulting significant trade disruption for New Zealand.

[11] Frankel et al. 2015, Jagermeyr et al. 2020

Major	250–500 nuclear weapons of 10–100kT detonated, many on cities 10–30 Teragrams of stratospheric soot -4.0 C mean global cooling **Examples**: All-out India-Pakistan nuclear war in 2025,[12] OR limited US-Russia nuclear war with principally counterforce & command centre targeting[13] **Brief description of our scenario:** Coincident safety system failures lead to the accidental detonation of a nuclear weapon within Russian territory. In the context of an ongoing conventional war, Russian leadership cannot rule out nuclear attack and retaliate with a strike against a NATO military target. Immediate escalation occurs and the US and Russia launch 100s of weapons at military and command and control targets, these include strikes against capital cities. Simultaneous conventional attacks wreak mass destruction against Northern Hemisphere infrastructure. 30–75 million people are killed immediately.[14] Weeks of chaos follow as radiation disperses, deaths mount, normal business and trade functions halt, and communications are destroyed. Stratospheric soot immediately starts to cool the Northern Hemisphere and the mean global temperature falls 4 degrees C within weeks and lasts into the following years. Food production in North America, Europe, and Russia falls 60-90% in the second year.[15] As regional famines take hold, countries turn inwards, hoard commodities, and global trade is severely disrupted. New Zealand suffers from massive trade disruption and some modest impact on crop production (from cooler temperatures and reduced sunlight).
Extreme	>1000 nuclear weapons detonated, many on cities 50–150 Teragrams of stratospheric soot -8.0 C mean global cooling Extensive impact of electromagnetic pulse (EMP) **Example**: NATO-Russia nuclear war with countervalue targeting[16] **Brief description of our scenario:** Perceiving an existential threat in the wake of a military defeat and relentless mass protest at home, Russian leadership takes the decision to demonstrate its power by targeting critical European energy infrastructure with a nuclear weapon. Under hawkish leadership the NATO response is immediate and a high-altitude nuclear detonation creating an EMP is used in an attempt to disable Russia. Russia replies in kind and nuclear escalation continues and is sustained. Military targets around the world are struck, including US-aligned facilities in Australia as well as strategic cities. Devastation is widespread, making energy supply, transport, communications, trade in commodities and food, as well as maintenance of trust all but impossible. Crops are devastated and modern agricultural methods abandoned. Mass starvations occur anywhere where resilient food production cannot be expedited.[17] Great uncertainty surrounds the cascading impacts, and the degree of agricultural disruption, but the impact on every sector and social cohesion generally would likely be catastrophic.[18] New Zealand could suffer from the complete end to international trade, possible EMP damage from attacks on Australia, and substantial reduction in crop production over a decade (from cooler temperatures and reduced sunlight).

[12] Toon et al 2019
[13] Rodriguez 2019
[14] Rodrigeuz 2019
[15] Xia et al. 2022
[16] Coupe et al 2019
[17] Xia et al. 2022
[18] Frankel et al. 2015

Major Scenario

The following detailed scenario description is based on the above intensity level 'Major'. Such accidental nuclear war is a real risk, based on past near misses, especially in times of geopolitical tension.[19]

Preliminary Phase

- Coincident safety system failures lead to the accidental detonation of a nuclear weapon within Russian territory. In the context of an ongoing conventional war Russian leadership cannot rule out nuclear attack and retaliate with a strike against a NATO military target.

Event Phase (days/weeks)

- Immediate escalation occurs and the US and Russia launch hundreds of nuclear counterforce strikes on military and command and control targets, including strikes against capital cities. This counterforce targeting will also destroy some civilian assets.
- Widespread devastation results from blast, thermal radiation, ionizing radiation, and electromagnetic pulse.
- 30–75 million people are killed immediately.[20] This would have immense effects on workforce and social functioning in targeted nations.
- High altitude detonations may disable satellites, communications, and electronics, with partial recovery taking days to months depending on systems.[21]
- Counterforce targeting extends to industrial infrastructure, and attacks on global cloud and internet infrastructure cause lasting unprecedented disruptions to businesses and personal communications and data access in New Zealand.
- Earlier and subsequent conventional attacks wreak mass destruction against Northern Hemisphere infrastructure.
- There is widespread damage to US, Russian and NATO ports, airports, bridges, satellites, fibre optic cables, data centres, fuel and energy infrastructure, including key pinch points.
- Weeks of chaos follow as radiation disperses, Northern Hemisphere deaths mount, normal business and trade functions halt, productivity would plummet as populations seek shelter from radiation, many assets are lost, and communications are constrained.
- Within days to weeks almost everything that New Zealand imports from the Northern Hemisphere stops arriving. This includes all refined fuel.
- Up to 30 Teragrams of soot rises into the stratosphere. Skies are darkened in the Northern Hemisphere and the Southern Hemisphere is also affected. Continental temperatures drop by 5 to 20 C.
- Global panic and conflicting information (where communication is even possible), risks undermining internal state cohesion and inter-state cooperation.

[19] Baum et al. 2018
[20] Rodrigeuz 2019
[21] US Congress EMP Commission 2008

- New Zealanders in New Zealand escape immediate physical harm, and radiation impacts and darkened skies are relatively low, however the livelihoods of a large proportion of New Zealand's population are immediately at risk (eg, anything export- or import-dependent).
- There is the possibility of breakdown in social cohesion unless clear plans are articulated and agreed. The competence and credibility of authority will be under constant question.

Extended Phase (months)

- Severe rationing is required to avoid consuming all imported fuel and medical supplies in New Zealand.
- The New Zealand economy suffers an immense contraction as predominantly regional/local economic activity supplants national/international trade.
- Unless appropriately managed, trade, transport and economic shocks may lead to escalating civil disorder. The continued functioning of some states as democracies or constitutional republics would be under threat.[22]
- Blocked sunlight causes mean global temperature to fall 4 degrees C in the following years (with greater impacts for Northern Hemisphere continental land and lesser for Southern Hemisphere islands).
- Food production in the US, Russia and elsewhere falls 60-90% in the second year.[23] As regional famines take hold, countries turn inwards, hoard commodities, and global trade is severely disrupted amid a low trust, low capability context, in which the majority of countries are not food self-sufficient in normal times.
- Industrial civilization in the areas attacked might collapse and those elsewhere come under severe strain,[24] although it is unclear how to estimate the probability of this outcome, such collapses could trigger a sequence of global collapses due to interconnected complexity and systemic vulnerabilities.
- Global starvation/radiation-induced emigration begins, and panicked populations attempt looting, mass migration or piracy. There is risk of hostile attempts to reach New Zealand by state or non-state actors.
- Commercial air and sea transport is inoperative, informal attempts to reach New Zealand occur, some may succeed. Infectious diseases may arrive, especially if biological weapons have been used or accidentally release from damaged facilities.
- Climate impacts develop in the Southern Hemisphere including cooling mean temperature, decreased ozone and increased UV, and reduced precipitation.
- Climate impact alone causes agricultural yields in New Zealand to fall approximately 20% by the second year.[25]

[22] Scouras 2019
[23] Xia et al. 2022
[24] US Congress 'The Effects of Nuclear War' 1979
[25] Xia et al. 2022

- Modelling is currently unable to predict consequences in different infrastructures that are dynamically interdependent,[26] however it may be that: 'the effects of a nuclear war that cannot be calculated are at least as important as those for which calculations are attempted.'[27]
- The mental health of New Zealand's population suffers significantly and there is increasing crime and poverty.

Recovery/adaptation Phase (years)

- Persisting effects of ocean cooling on marine fish yield does not peak for several years.[28] There may be unpredictable cascading ecological impacts, especially if humans resort to increased dependency on fisheries for nutrition.
- Without a massive and effective increase in resilient food production (eg, cold-tolerant crops, greenhouses, ocean foods, etc) mass starvation occurs worldwide.
- Impact on commodity trade, expertise, infrastructure, and social cohesion constrains industrial society and leads to sustained widespread difficulties and breakdowns of complex system functioning across all sectors (eg, global banking, finance, transportation, energy production and supply, communications, etc).
- There is a risk that the residual economy declines further as stocks are depleted and machines wear out faster than production and trade can replace them.
- Intermittent normal course disasters such as storms, flooding, earthquakes, and wild fires may go unmitigated contribute to step-wise collapse.
- Psychological impact could be immense and political and social responses may be even more consequential than physical impacts.
- Non-traditional regional trading routes may begin to operate.
- There is potential for a well-planned pivot to optimised cold weather agricultural production to enhance New Zealand's opportunities.

Overall, nuclear war could cause multiple severe stresses that interact within global social-ecological systems. These stresses could cause shifts in system behaviour and simultaneous shifts in several social-ecological systems would likely interact to cause a large inter-systemic crisis. This crisis could propagate and severely impact all countries including New Zealand.

When producing a Hazard Profile, where information is lacking or there are significant uncertainties as to the extent of the impact or the frequency or likelihood of occurrence of scenarios, the Hazard Profile should be assessed by experts in a workshop setting. This scenario was assessed at the Massey Joint Centre for Disaster Research by diverse experts on Feb 9 2023.[29]

[26] US Congress EMP Commission 2008, Frankel et al. 2015
[27] US Congress 'The Effects of Nuclear War' 1979
[28] Harrison et al. 2022
[29] National Risk Analysis Methodology 2020 (Switzerland)

Impacts

The impacts on NZ will likely be due to several key drivers:

- Physical destruction of Northern Hemisphere targets (+/- EMP effects)
- Air: Effects on air transport/trade, communications (eg, satellite), and climate
- Sea: Effects on shipping/trade, undersea cables, and ocean environments
- Land: Effects on ecosystems and agriculture
- Social response in NZ and the world

Many Nationally Significant Risks identified in Department of the Prime Minister and Cabinet (DPMC) documentation[30] could plausibly all be triggered at once by nuclear war. These include: drought, communicable diseases, global satellite disruption, multiple critical infrastructure failures (eg, water, energy, transport, ICT), commodity and energy price shocks, major trade disruption, financial crisis, armed conflict, civil unrest, mass arrivals, and maritime territorial incursion.

The damage timeframe varies by hazard. A potential weakness of some National Risk Assessments is neglecting long-term or ongoing harm (potentially by using a high discount rate for future impacts).[31] When considering future or lasting impacts, a timeframe of years or decades could be appropriate.

To assess the effects of a scenario, the Swiss method examines 12 damage indicators from four damage areas. The expected extent of damage from the scenario described can be represented in the table below. The damage increases by a factor of three for each class of damage (chart column below).

[30] DPMC 2022
[31] Boyd & Wilson 2022

Possible impact of the 'Major' nuclear war scenario on New Zealand across 12 impact indicators

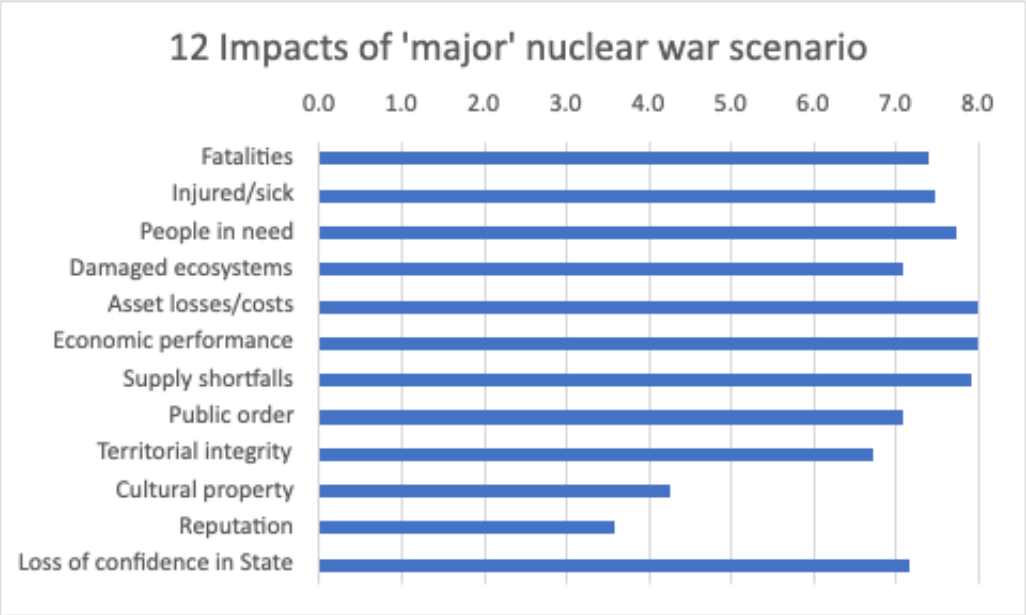

Chart Legend: The figure shows the mean impact assessment for New Zealand of the 'Major' scenario based on responses from experts (n=12) following an interactive workshop. Impact is represented on a 0–8 scale (with each point increase representing a 3x increase in impact). The table below attributes monetised value to each impact.

Twelve impacts of the 'Major' scenario on New Zealand (mean of expert assessments, n=12)

Impact	Quantitative estimate (mean)	Monetised estimate (mean)
Fatalities	22,000	NZ$130 billion
Injured/sick	195,000	NZ$10 billion
People in need	330 million person days	NZ$80 billion
Damaged ecosystems	31% of NZ land area equivalent	NZ$25 billion
Asset losses/costs	NZ$250 billion loss	NZ$250 billion
Economic performance	NZ$240 billion loss	NZ$240 billion
Supply shortfalls	175 million person days	NZ$90 billion
Public order	265 million person days	NZ$130 billion
Territorial integrity	Temporary very severe violation	NZ$55 billion
Cultural property	Loss of many regional/national	NZ$1.5 billion
Reputation	Minor impact on standing	NZ$10 billion
Loss of confidence in the State	Considerable damage/months	NZ$55 billion

Risk

The level of risk can be determined simplistically by multiplying the impact of the hazard by its likelihood.

In peaceful times, there is a real chance of inadvertent nuclear war through human error or miscalculation, accident, component fault, or compromise.[32] In times of crisis the risk will be higher. Published probability estimates for various kinds of nuclear war often range from 0.3% to 3% per annum,[33] but estimating such risks is inherently problematic.

The role of chance in amplifying the risk of nuclear war is important and should be considered (see 'Examples of Events' above).[34]

Agential or unprecedented risks, which lack a historical data set or depend on fluctuating willingness to act, such as nuclear war, can be classified according to the *plausibility* of the specific scenario being considered (ie, the 'Major' scenario above).

Plausibility is construed by combining the degree of intent and ability possessed by the likely perpetrators with the technical and operational feasibility of the scenario (expressed as the average of the two assessments in the next table below).

Plausibility of the 'Major' nuclear war scenario expressed as two factors

Expert assessment (n=11) of the plausibility of the 'major' scenario was assessed in a workshop. A scale of 1–5 was used to assess both the intent and ability of potential perpetrators of the scenario, as well as the technical and operational feasibility of the scenario.

	Expert assessment	**Category**
Perpetrator's intent & ability	3.0/5.0 [range: 2.0–4.0]	Clear indications of intent & ability
Technical and operational feasibility	3.7/5.0 [range: 1.5–5.0]	Feasibility ranges from easy to challenging overall
Overall plausibility	3.4/5.0 [range: 2.0–4.3]	Quite plausible

[32] Baum et al. 2018
[33] Hellman & Cerf 2021
[34] Pelopidas 2017

Risk Diagram

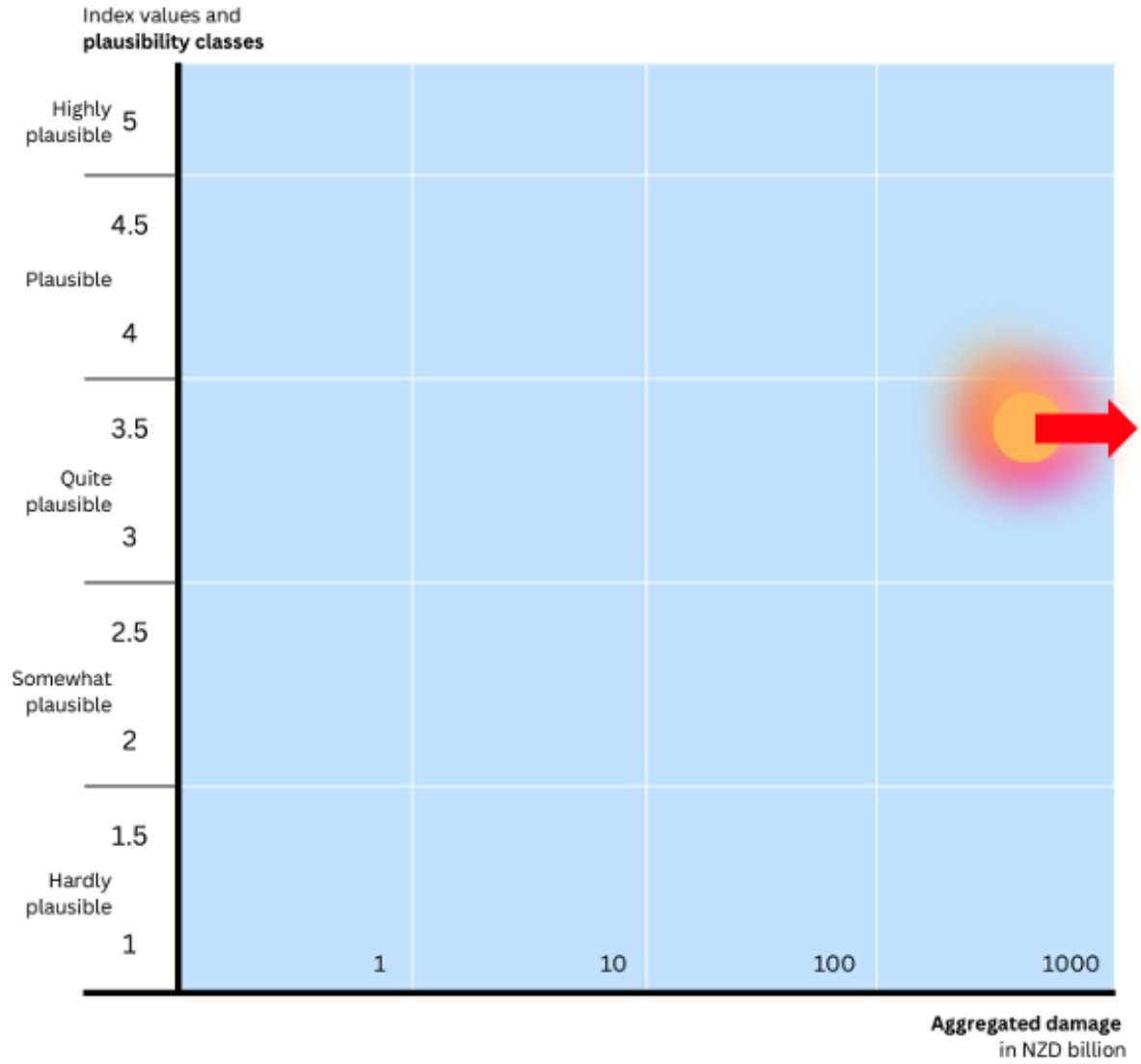

Figure Legend: The figure displays the plausibility assessment for the 'major' scenario mapped against the impact assessment. The circle indicates the mean of independent assessments of diverse experts (n=14) conducting a pre-workshop activity. The arrow indicates that the assessment moved towards a higher impact category (~$1 trillion monetised harm) following workshop interactions with diverse other experts (n=12).

Related Risks

Other global catastrophes could produce impacts with various similarities to the impacts of nuclear war. These hazards include solar flares, supervolcano eruptions, and asteroid/comet impacts. These previously occurring hazards may be more appropriately assessed using a 'return period' measure of likelihood to generate annual probabilities. These scenarios should be assessed separately, and the analysis used to estimate the total likelihood of the common impacts resulting from nuclear war and these other hazards.

Additional Decision-relevant Information

The scenarios and Hazard Profile above characterise the risk of nuclear war for New Zealand in terms of impacts (at a macro level) and plausibility. However, there are other decision relevant factors that should be considered in any resource allocation decisions.

- Impact and plausibility may depend on the time horizon under analysis, however, for rare events the horizon should be long, or no generation will address them. Consideration should be given to future impacts and care taken that discount rates don't mask future catastrophes.
- The risk will depend on which scenario is chosen for analysis (significant, major, extreme). Decision rules such as maximin may favour analysis and mitigation of the 'extreme' scenario. Such questions should be publicly discussed.
- The logic of escalation means that if nuclear war were to occur, the outcomes could tend towards those of the extreme scenario.
- Reliable information about the impact of nuclear weapons is largely about the physical effects of detonations, this can provide only a lower bound assessment of the impacts of nuclear war. The impacts of EMP or nuclear winter could be severe.[35]
- The cascading effects of nuclear war that cannot be calculated might be at least as important as those for which calculations are attempted.[36]
- Four interacting factors were identified in the New Zealand Nuclear Impacts Study (1987) that likely raise the risk to New Zealand:[37]
    - Trade-dependency
    - Increasing vulnerability of complex industrial and societal systems
    - Interdependence between sectors
    - Lack of planning
- Additional risk factors plausibly include poverty, alienation, social fragmentation, and low trust in authorities (as per Covid-19 responses in many high-income countries).
- The cascading effects of severe trade disruption have the potential to degrade economies and societies around the world to the point where industrial activity is unable to be sustained and modern civilization collapses. Indeed, the collapse of complex civilization is considered by many

[35] Frankel et al. 2015
[36] US Congress 'The Effects of Nuclear War' 1979
[37] Green et al. 1987

to be likely if critical functions collapse, such as electricity to water supply infrastructure, the ability to access data necessary for business/government operational requirements, or the ability to cooperate to continue agriculture. In these cases fatalities could be particularly high.

- Prospects for recovery following such collapse are unclear and societies could stagnate with chronically low levels of wellbeing. This possibility increases the salience of nuclear war as a risk.
- There is plausibly a risk of human extinction if industrial society collapses into stagnation amid the worst food shortage ever experienced and other factors such as outbreaks of epidemic or pandemic disease, or ongoing conflict.
- New Zealand is plausibly one of the countries in the world most resistant to the physical and climatic impacts of nuclear war. This privileged position is reason for New Zealand to ensure resilience to the likely impacts, thereby maintaining a hub of functioning industrial/social complexity for the sake of humanity.
- Ensuring a functioning hub of complexity may depend on a pre-catastrophe analysis of the risk of territorial incursion (from state actors, non-state actors, military units, or refugees) and a workable plan for managing this eventuality.
- The strength of knowledge underpinning the points above is low, the cost-effectiveness of interventions is unclear, and even which interventions might be possible is not yet agreed. These factors raise uncertainty around the consequences of nuclear war and elevate risk.
- The possible impact of nuclear war on future generations is decision-relevant and appropriate value should be placed on their wellbeing.
- Other global risks with similar potential impacts (eg, supervolcano eruption, solar flare, asteroid/comet impact, extreme pandemic) mean the total risk of a range of common consequences (and the potential for cross-cutting solutions) is higher than it might appear when hazards are analysed separately.

Knowledge Gaps

The scenarios above are illustrative only, however, they point to key knowledge gaps which should be addressed to enable a more comprehensive risk assessment to support (1) a national plan in case a major nuclear war occurred, and (2) a national strategy of resilience building to mitigate the effects of nuclear war (and other global catastrophes with common consequences for New Zealand).

- This Hazard Profile should be connected to a capabilities assessment, ie, an assessment of how specifically the conditions resulting from a ‘Major’ nuclear war would have downstream impacts on NZ and how domestic activity could be adapted to preserve systemic functions.
- More understanding is needed including consideration of:
    - Nuclear war/winter risk and the principles of Te Tiriti o Waitangi
    - An appropriate pre-catastrophe resilience narrative to maximise the potential for cooperation should the hazard strike
    - The degree that international trade to NZ would be degraded in a range of global catastrophes including various nuclear war scenarios.

- The impact on fuel imports, NZ fuel reserves, and consequences for industry, agriculture and the general economy.
- The other impacts on agriculture, including climate effects and the potential loss of export markets if trade ceases.
- Possible social responses to these conditions and how they may be unlike any that have been experienced before.
- NZ's reliance on international communications/digital infrastructure and a need to understand the importance of communications to social responses/behaviours.
- The potential arrival of refugees and how NZ could and ought to manage friendly or hostile mass arrivals.
- How reliant healthcare is on imported commodities (including precursor chemicals) and who is critically reliant on these for survival.
- How decision-making might be most pragmatically determined.
- The resilience (of communities) to larger scale shocks.
- The resulting impacts on social welfare, education, and unemployment.

Mitigation Strategy & Plan

The DPMC's list of Nationally Significant Risks[38] includes many of the likely impacts of nuclear war, however these are not contemplated in combination or in sequence, or as resulting from nuclear war.

The New Zealand Nuclear Impacts Study in the 1980s recommended a specialist unit (eg, 8 people) for analysing the severe risk to New Zealand of nuclear war.[39] But this was not operationalised (and no substantive NZ focused work has been done on this topic since this time).[40]

Given the uncertainties, potential catastrophic impacts, and low strength of knowledge underlying this Hazard Profile, timely research should proceed to better understand the consequences for New Zealand industry and society.

Research should include information gathering across public and private sectors based on the scenario conditions described above. Information should be sought on cascading impacts, potential adaptations, and long-term resilience measures.

This research can then serve as a basis for cost-effectiveness analysis and prioritisation of strategic interventions aimed at enhancing resilience to the hazard, as well as response planning.

Importantly, many of the consequences (individually or in combination) could flow from other more likely and smaller scale catastrophes. Cost-effectiveness analysis should account for the benefits across all hazards.

[38] DPMC 2022
[39] Green 2022 (McGuinness Institute Report)
[40] Note that the budget for this unit might be comparable to the cost of a recent pedestrian crossing in Wellington, (prioritization across risks/departments could target resources for maximal impact according to Hazard Profiles).