World Future Council

THE CLIMATE-NUCLEAR NEXUS

Exploring the linkages between climate change and nuclear threats

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ABOUT THE WORLD FUTURE COUNCIL

The World Future Council consists of 50 eminent global change-makers from governments, parliaments, civil society, academia, the arts and business. We work to pass on a healthy planet and just societies to our children and grandchildren with a focus on identifying and spreading effective, future-just policy solutions. The World Future Council was launched in 2007 by Jakob von Uexkull, Founder of the 'Alternative Nobel Prize'. It operates as an independent foundation under German law and finances its activities from donations.

FOREWORD

While humanity faces a range of interconnected transnational threats and crises in the 21st Century—including extreme poverty, hunger, pandemic disease and demographic change—climate change and the continued existence of nuclear weapons stand out as the two principal threats to the survival of humanity. On the long arc of human existence, both threats are relatively new to the scene, having only appeared over the last century. Both threaten the survival of life on earth as we know it and both are of our making.

As part of its *Climate-Nuclear Nexus* project, the World Future Council (WFC) released in 2012 a report on 'Climate Change, Nuclear Risks and Nuclear Disarmament: From Security Threats to Sustainable Peace'. In the report, Prof. Dr. Jürgen Scheffran of the University of Hamburg in Germany exposes the interplay between climate change and risks associated with nuclear weapons, facilities and materials, in order to broaden understanding of how these perils interact with each other, and considers how forging sustainable solutions in one field could trigger action in the other.

Since the report's release, the WFC has organised workshops and prepared briefings for policy-makers, academics and civil society organisations on these important linkages. Developments over the last three years have prompted us to update the report and release it at a time when negotiations and initiatives for tackling the climate and nuclear threat are reaching a critical stage.

Climate change-induced extreme weather events such as floods, storms, droughts and heatwaves are occurring with rising regularity, resulting in the death and displacement of thousands of people. Furthermore, there has been increased recognition among defence and security establishments that climate change poses an urgent and growing threat to global peace and stability, as it has the potential to exacerbate many other challenges.

The 2015 UN Climate Change Conference convened against the backdrop of wide consensus that if negotiations don't lead to a legally binding and universal agreement on significant reductions of green-house gas emissions, the target to limit global average temperature rise to 2°C warming—commonly accepted as necessary to prevent critical climatic tipping points—will be surpassed.

Meanwhile, calls from a majority of states for a legally binding instrument or package of measures to achieve the universal prohibition and elimination of nuclear weapons—a goal as old as the nuclear age—have languished. Despite a recent series of interventions setting out the vision of a world free of nuclear weapons by high-level statesmen—including from the nuclear armed-states—concrete action toward its achievement has lagged, although this has the possibility to change with a new process for nuclear disarmament deliberations and negotiations having been established by the UN General Assembly in November 2015.

This lack of progress on nuclear disarmament has been starkly contrasted by a renewed focus on the catastrophic consequences of nuclear weapons and recent revelations on the kaleidoscope of risks inherent to nuclear policies and postures. The sobering conclusions are that: a) as long as nuclear weapons exist, their use, whether accidental or intentional, will be a matter of when, not if; b) any use of nuclear weapons in a populated area would have catastrophic consequences on human health, the environment, infrastructure and political stability; and c) the use of just a small percentage of the global nuclear arsenal would create climatic consequences that dwarf the current and projected impact of carbon emissions.

Despite an increased understanding of the climate and nuclear threat and a growing urgency for action on both fronts, little attention has been given to how they may interact with each other. That is where this report aims to make a contribution.

This updated report considers how both threats can have grave implications for global and human security and how they may interact with each other, thereby exacerbating other crises. It further examines the possible effects of nuclear explosions on the climate, as well as the consequences of climate change and extreme weather events on nuclear security. The report also exposes the pitfalls of including nuclear energy as an alternative to fossil fuels to curb climate change, and the nuclear weapon-proliferation risks of nuclear energy programmes. Finally, it reviews mechanisms and initiatives to neutralise both threats and considers how success in one area could benefit action in the other.

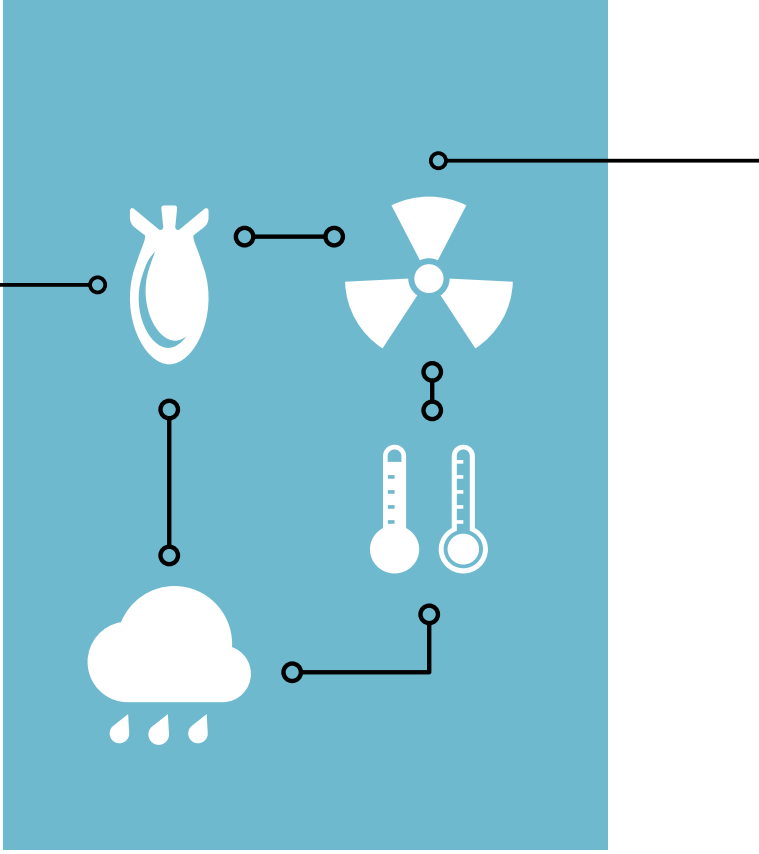
We must also recognise that for a rising number of people, the effects of these two threats are not a theoretical, future issue of concern. Behind the facts and figures are stories of real suffering from climate change and nuclear weapons programmes.

The plight of one group in particular is illustrative of the human impact of the nuclear enterprise and climate change. The inhabitants of the remote Pacific island chain of Bikini Atoll were forced from their homes in the 1940s so that the United States could test its atomic bombs there, bringing with it a legacy of transgenerational effects of radiation exposure, including high cancer rates, birth deformities and environmental poisoning. The lands they had called home were declared uninhabitable. Now, the tiny patches of earth they were relocated to in the Marshall Islands are at risk of suffering the same fate, as rising sea levels are breaching sea walls, washing over their islands, killing crops and forcing the Bikini Atoll refugees to consider relocating again—this time to foreign continents thousands of miles away. Their experience should serve as a cautionary tale. If we don't seize the opportunities soon to rid the world of these threats, we will drift toward a similar fate.

ROB VAN RIET
Coordinator, Peace and Disarmament Programme,
World Future Council

> "The two perils have a great deal in common. Both are the fruit of swollen human power—in the one case, the destructive power of war; in the other, the productive power of fossil-fuel energy. Both put stakes on the table of a magnitude never present before in human decision making. Both threaten life on a planetary scale. Both require a fully global response.
>
> Anyone concerned by the one should be concerned with the other. It would be a shame to save the Earth from slowly warming only to burn it up in an instant in a nuclear war"
>
> — JONATHAN SCHELL, "THE SEVENTH DECADE: THE NEW SHAPE OF NUCLEAR DANGER"

SUMMARY



CLIMATE CHANGE AND NUCLEAR WEAPONS REPRESENT TWO KEY THREATS OF OUR TIME. Climate change endangers ecosystems and social systems all over the world. The degradation of natural resources, the decline of water and food supplies, forced migration, and more frequent and intense disasters will greatly affect population clusters, big and small. Climate-related shocks will add stress to the world's existing conflicts and act as a "threat multiplier" in already fragile regions. This could contribute to a decline of international stability and trigger hostility between people and nations. Meanwhile, the 15,500 nuclear weapons that remain in the arsenals of only a few states possess the destructive force to destroy life on Earth as we know multiple times over. With nuclear deterrence strategies still in place, and hundreds of weapons on 'hair trigger alert', the risks of nuclear war caused by accident, miscalculation or intent remain plentiful and imminent.

Despite growing recognition that climate change and nuclear weapons pose critical security risks, **THE LINKAGES BETWEEN BOTH THREATS ARE LARGELY IGNORED.** However, nuclear and climate risks interfere with each other in a mutually enforcing way.

CONFLICTS INDUCED BY CLIMATE CHANGE COULD CONTRIBUTE TO GLOBAL INSECURITY, which, in turn, could enhance the chance of a nuclear weapon being used, could create more fertile breeding grounds for terrorism, including nuclear terrorism, and could feed the ambitions among some states to acquire nuclear arms. Furthermore, as evidenced by a series of incidents in recent years, extreme weather events, environmental degradation and major seismic events can directly impact the safety and security of nuclear installations. Moreover, a nuclear war could lead to a rapid and prolonged drop in average global temperatures and significantly disrupt the global climate for years to come, which would have disastrous implications for agriculture, threatening the food supply for most of the world. Finally, climate change, nuclear weapons and nuclear energy pose threats of intergenerational harm, as evidenced by the transgenerational effects of nuclear testing and nuclear power accidents and the lasting impacts on the climate, environment and public health by carbon emissions.

NUCLEAR ENERGY IS A CRITICAL ISSUE IN BOTH CLIMATE CHANGE AND NUCLEAR WEAPONS DEBATES. Although sometimes offered as a solution to climate change, nuclear energy is neither required for nor capable of solving the climate crisis. Nuclear energy lacks the capacity potential to significantly replace the huge amounts of fossil energy, is not economically viable, and is not flexible to meet demand fluctuations by consumers. Furthermore, it stands in the way of increased renewable energy and enhanced energy efficiency. In addition, the nuclear 'fuel chain' contains a variety of problems and risks, including the release of radioactive materials at every stage of the cycle and long-term safety problems of nuclear waste disposal. Another serious problem is the possibility at various stages of the nuclear fuel chain to divert nuclear technologies and know-how toward nuclear weapons development. The recognition of the right to the peaceful uses of nuclear energy in the Nuclear Non-Proliferation Treaty (NPT) further compounds this problem as it encourages states to develop nuclear industries, which can lead to high stakes confrontations and may trigger armed conflict.

The discrepancy between long-term goals and concrete steps **UNDERMINES THE CONDITIONS FOR INTERNATIONAL COOPERATION IN SECURITY AND CLIMATE POLICY.** Despite growing awareness of the urgency of tackling the climate and nuclear threat among policy-makers, academics and civil society, concrete action is lagging behind. Furthermore, there exist international legal obligations both with regard to curbing climate change and achieving universal nuclear disarmament. On both fronts, litigation has been used to ensure these obligations are implemented.

SCIENTISTS AND ENGINEERS invented the technologies to exploit fossil energy and nuclear power (both for civilian and military purposes) and so they **HAVE A SPECIAL RESPONSIBILITY IN ABOLISHING BOTH.** Because of their expertise, they can make major contributions to abolishing nuclear arsenals and developing the technologies necessary for a sustainable energy transition.

Preventing the dangers of climate change and nuclear war requires an **INTEGRATED SET OF STRATEGIES** that address the causes as well as the impacts on the natural and social environment. Institutions are needed to strengthen common, ecological and human security, build and reinforce conflict-resolution mechanisms, low-carbon energy alternatives and sustainable lifecycles that respect the capabilities of the living world and create the conditions for viable and sustainable peace.

Climate change and nuclear weapons represent two key threats of our time.

The linkages between both threats are largely ignored.

INTRODUCTION

Figure 1: Existential threats of our time: nuclear explosions and carbon emissions
(Source: Left – CTBTO Flickr; Right – Shutterstock)

In January 2015, the Bulletin of Atomic Scientists moved their symbolic 'Doomsday Clock' to three minutes to midnight, because of the gathering dangers of climate change and nuclear weapons, signalling the gravest threat to humanity since the throes of the Cold War. In his 2007 book *The Seventh Decade: The New Shape of Nuclear Danger*, Jonathan Schell writes on the linkages between nuclear weapons and global warming: "The two perils have a great deal in common. Both are the fruit of swollen human power—in the one case, the destructive power of war; in the other, the productive power of fossil-fuel energy. Both put stakes on the table of a magnitude never present before in human decision making. Both threaten life on a planetary scale. Both require a fully global response. Anyone concerned by the one should be concerned with the other. It would be a shame to save the Earth from slowly warming only to burn it up in an instant in a nuclear war."[1]

This powerful statement points to the important but largely neglected linkages between two key dangers of our time. The nuclear menace has survived the Cold War and will continue to threaten life as long as its destructive potential persists. Similarly, global warming is increasingly posing severe dangers for natural and social systems in many regions of the world, as it could exceed their adaptive capacities and undermine international stability. This article examines the linkages between nuclear and climate risks and considers an approach to move from living under these security threats to building sustainable peace.

1. THE SECURITY CHALLENGES OF NUCLEAR WEAPONS AND CLIMATE CHANGE

1.1. NUCLEAR WEAPONS AND CLIMATE CHANGE ARE EXISTENTIAL THREATS TO HUMANITY

While the nuclear arsenals have been reduced, more than 15,500 nuclear weapons still remain (see figure 2), enough to destroy life on earth as we know it multiple times over.[2] Recent studies indicate that the use of 50-100 nuclear weapons on military targets and populated areas might be sufficient to trigger catastrophic climate change.[3] This is about half the nuclear weapons in the Indian and Pakistani arsenals and less than 10% of the nuclear weapons that the United States and Russia maintain on high operational readiness to use (high-alert) under launch-on-warning policies. Although the stocks of nuclear weapons in the United States and Russia have diminished, nuclear weapons exist—and are often being extended and modernized—in an additional seven countries (United Kingdom, France, China, Israel, India, Pakistan, North Korea). In a few countries, such as Belgium, Germany, Italy, the Netherlands and Turkey, foreign nuclear weapons are still being deployed (see figure 3). In addition, over the years several states have been suspected of building nuclear weapons, which has become an issue of conflict as highlighted by the cases of Iraq and Iran. Besides nuclear weapons, a number of countries are acquiring ballistic missiles, while others enter the arena of missile defence and space warfare. These

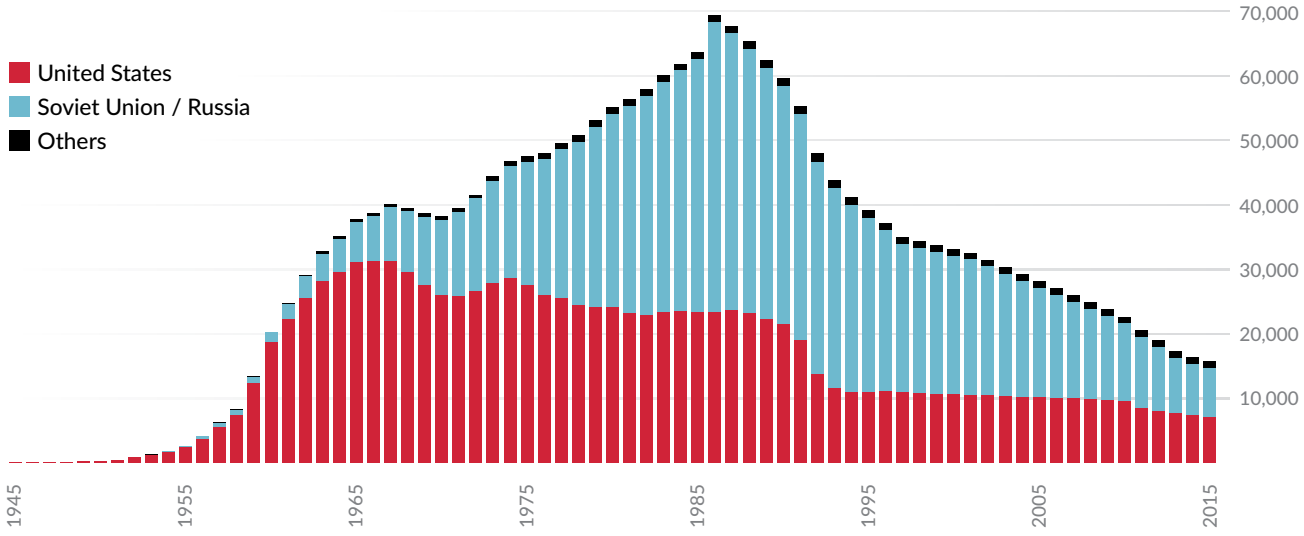


Figure 2: Global nuclear arsenals
(Source: Bulletin of Atomic Scientists)

developments show that the nuclear spiral is still alive and fed by powerful forces of economic growth, political power and a culture of war.

The continued existence of nuclear weapons bears incalculable risks and undermines efforts to prevent further states and non-state actors from acquiring the bomb. With nuclear deterrence strategies still in place, the risks of nuclear war caused by accident, miscalculation or intent remain significant. More than a thousand tons of nuclear weapon-usable materials remain as well, and with the projected increase of nuclear energy the precursors for nuclear weapons development are thus proliferating. The possibility that nuclear weapons or sensitive nuclear materials could fall into the hands of terrorists cannot be ruled out. Indeed, intelligence assessments deem such a scenario worryingly plausible, due mostly to weak borders and ill-secured nuclear facilities and depots.[4]

By continuing the possession of nuclear weapons and attributing a crucial role to them in their security policies, the nuclear weapon states set a bad example that continues to drive the pursuit of know-how and technology for nuclear weapons by other states. Military responses, including missile defence, counter-proliferation and nuclear weapons, fuel the arms race and undermine the political stability necessary for the controlled maintenance of nuclear weapons, which, in any case, cannot be guaranteed in the long run. As a flurry of reports in recent years has revealed, nuclear policies and postures are highly accident-prone and have brought the world very close to an accidental nuclear detonation on several occasions.[5] Without a systematic and controlled elimination of the nuclear threat, an intentional or accidental use of nuclear weapons is a matter of time. To move away from the nuclear abyss, the world needs to abolish all nuclear weapons as well as the main incentives for their development.[6]

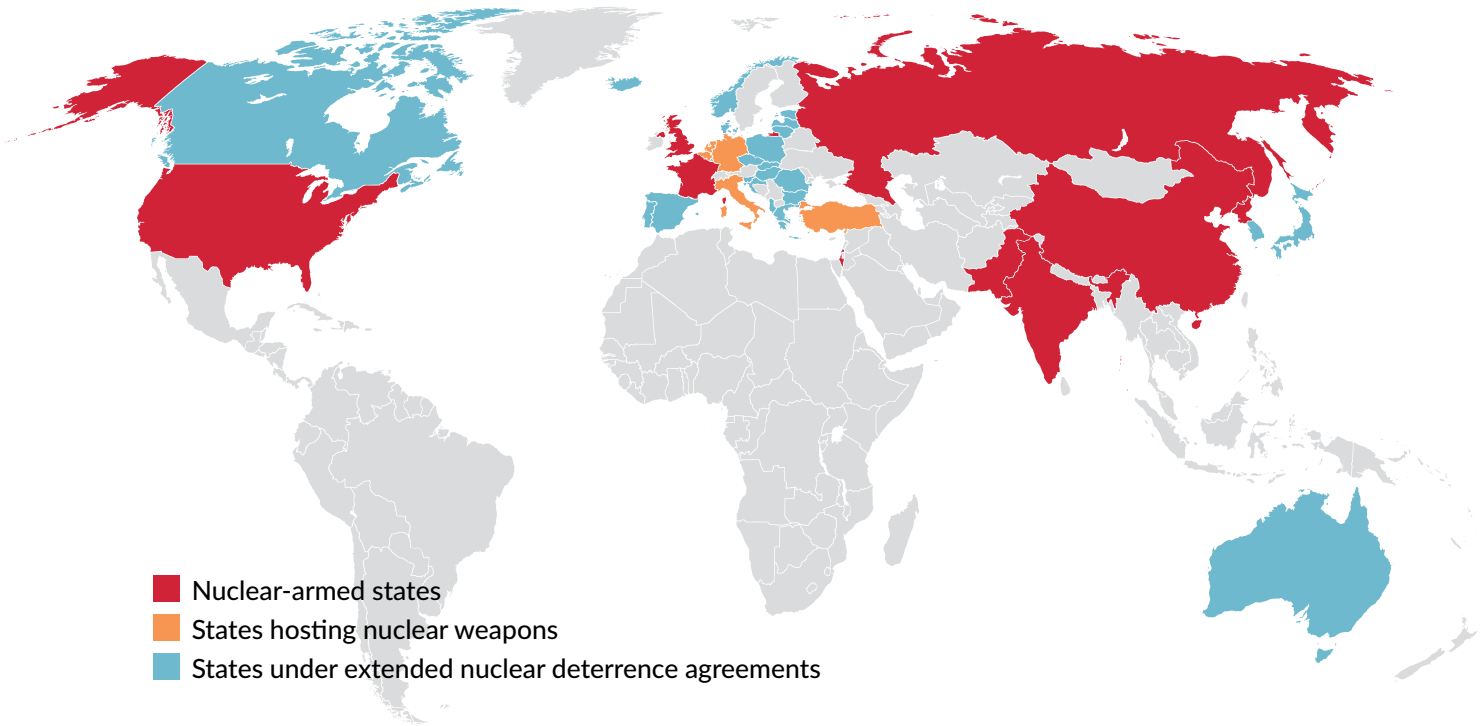


Figure 3: Nuclear-armed states, nuclear-hosting states and states under extended deterrence arrangements

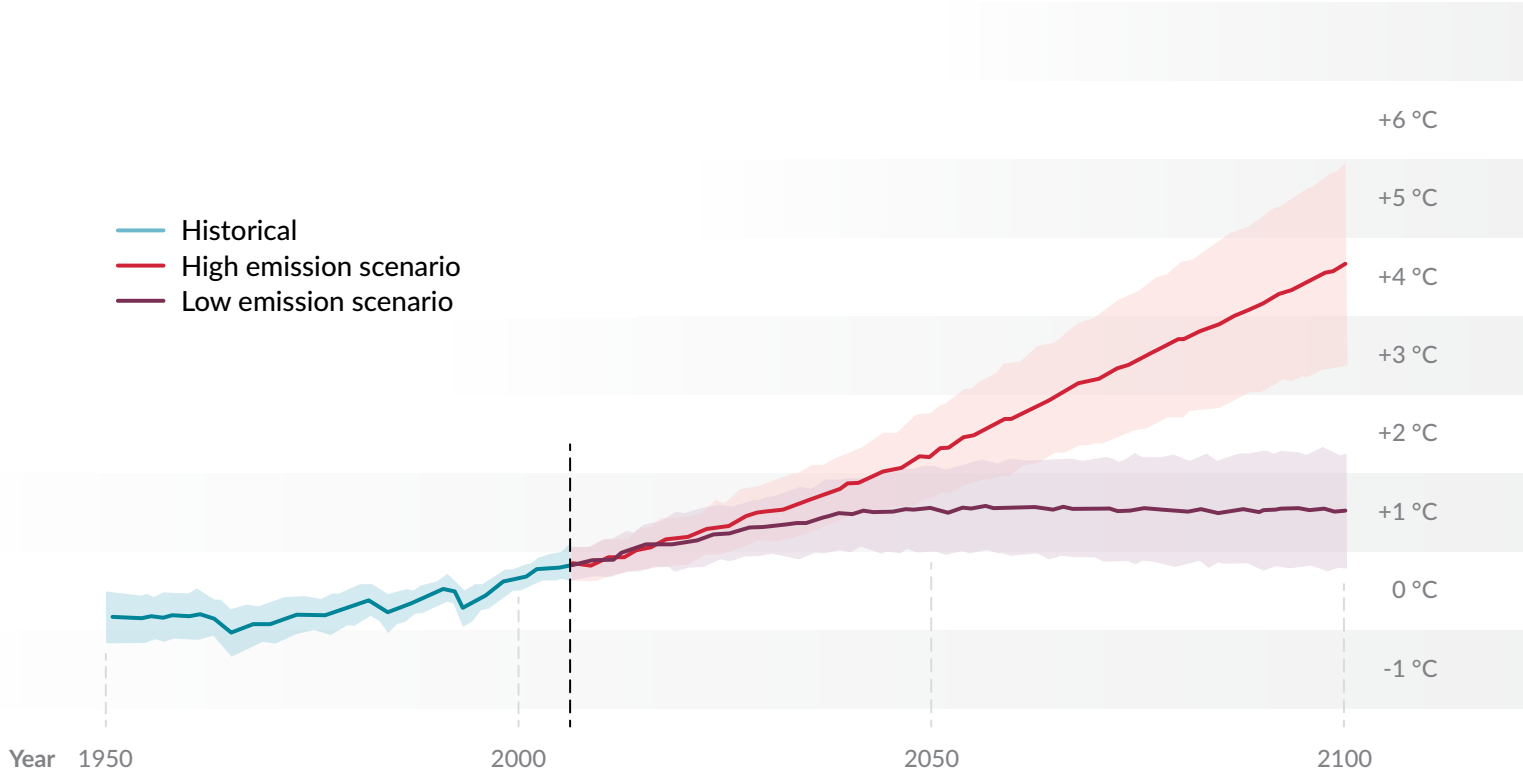


Figure 4: Projections for global average surface temperature change
(Source: Fifth Assessment Report of the Intergovernmental Panel on Climate Change)

Not less dramatic are the risks of global warming, caused by the emissions of carbon dioxide and other greenhouse gases. The Fifth Assessment Report of the Intergovernmental Panel on Climate Change has drawn a dire picture (see figure 4).[7]

Climate change endangers ecosystems and social systems all over the world. The degradation of natural resources, the decline of water and food supplies, forced migration, and more frequent and intense disasters will greatly affect population clusters, big and small. Climate-related shocks will add stress to the world's existing conflicts and act as a "threat multiplier" in already fragile regions. This could contribute to a decline of international stability and trigger hostility between people and nations.

Figure 5: The nuclear and climate threat in popular culture: movie posters for the The Day After (1983) and The Day After Tomorrow (2003)
(Source: Left – ABC; Right – 20th Century Fox)

1.2. DESPITE MANY SIMILARITIES, THERE ARE SIGNIFICANT DIFFERENCES BETWEEN NUCLEAR AND CLIMATE RISKS

TIMEFRAME | A nuclear war would result from short-term decisions of a small group of political and military leaders. It may be fought in a time span from hours to days and decisions are made within hours, even minutes. The consequences are felt within the same time span, e.g. a nuclear explosion can eradicate a whole city within seconds, but there are also long-term consequences spanning multiple generations, primarily due to radioactive fallout. For comparison, climate change occurs over long timescales and gradually undermines the living conditions of humanity and other life over an extended period. Decisions on climate change have an impact decades and centuries later and can hardly be attributed to anyone in particular. Nevertheless, extreme weather events such as hurricanes and tornados or floods and landslides may occur on rather short notice and affect millions of people who are unable to get out of harm's way in time. With the possibility of abrupt climate change, a sequence of cascading events and tipping points could make humanity feel the drastic changes within decades.[8]

SPATIAL SCALE AND INTENSITY | Nuclear proliferation and arms races are a global problem like climate change, even though the sources and impacts of either problem are driven by security issues and power structures on a local and regional scale. Global warming is caused by local emissions that accumulate in the atmosphere to induce global change, which in turn affects ecological and social systems locally. While an all-out nuclear war can lead to global human extinction, this is more unlikely for global warming because the consequences can be moderated by adaptive capacities that reduce the vulnerability of affected systems. Despite large uncertainties about the magnitude, frequency and distribution of risks, climate change is now widely recognised, including the human causes and impacts. The likelihood of nuclear war increases with nuclear proliferation and hawkish doctrines, but can hardly be quantified.

WHO IS RESPONSIBLE? The sources of climate change are human activities, which cause nature to "respond" in accordance with natural laws. While human lifestyles contribute to carbon emission, industrial activities by countries are responsible for the lion's share. The five initial nuclear weapon states are leading in military expenditure and are among the world's largest carbon emitters. Different from the nuclear Non-Proliferation Treaty (NPT), which is a discriminatory regime that puts more restraints on the non-nuclear weapon states than on those with nuclear weapons, the United Nations Framework Convention on Climate Change (UNFCCC) recognises a universal obligation to prevent dangerous climate change, and assigns the greatest responsibility to the polluters.

WHO IS AFFECTED? During the Cold War nuclear weapons were largely directed against ideological antagonists who possessed the same type of weapons. The end of the Cold War and the spread of nuclear weapons caused the bilateral nuclear threat between the Western and Eastern blocs to fragment, altered the geopolitical landscape in several regions and increased the stakes in related conflicts. The development (including uranium mining) and testing of nuclear weapons have affected mostly indigenous peoples and poor communities directly impacted by the radiation emitted from these activities. As the effects of nuclear explosions cannot be contained in time or space, nuclear conflagrations may threaten the whole of humankind. By comparison, global warming is not a determined threat against competitors but affects many communities on the planet. The causes and consequences of climate change are distributed quite asymmetrically across different regions, raising questions of equity and injustice as well as difficulties of attributing responsibility for the consequences. While the powerful countries contribute the most to the risks, more affected are the weak and the vulnerable, in particular impoverished people in the global south. Ultimately, by undermining human security, large-scale climate change will likely

also affect the security of powerful nations, making their protection an increasingly costly endeavour.

WHO IS THE ENEMY? In traditional security thinking there are determined enemies that seek to acquire weapons of mass destruction, notably nuclear weapons, to challenge the powerful nations. While nuclear explosions can be attributed to an intentional act by a determined adversary (provided they are not accidental), motivations and perceptions are different for climate change, which is involuntary and not caused by a particular enemy. Global warming results from all human beings' greenhouse gas emissions, and at the same time affects humans across the globe by its impact. For those who are suffering the most from climate change, those who contribute more to the problem can be seen as more significant "threats". Using this kind of security thinking is, however, questionable and distracts attention from the causes and possible solutions to the climate problem, which is more an environmental than a security issue.[9]

1.3. NUCLEAR AND CLIMATE RISKS ARE KEY ISSUES IN CURRENT SECURITY DEBATES

During the East-West conflict, nuclear war was seen as humanity's gravest threat, and it may still be in terms of potential destructiveness. After the terror attacks of 11 September 2001, international attention shifted towards terrorism, and the George W. Bush Administration used the terror attacks as an argument to make nuclear disarmament, as well as climate policy, a low priority. This short-sighted view neglected the fact that the continued existence of nuclear weapons perpetuated the possibility of nuclear terror attacks. Furthermore, international destabilisation resulting from climate change could provoke conflicts in fragile regions of the world, which, in turn, could create more fertile breeding grounds of terrorism.

After a lost decade for disarmament, parts of the US establishment began to recognise that the continued existence of nuclear weapons could no longer be beneficial and that nuclear proliferation to other countries and non-state actors would undermine their own security interests. This view has been expressed by the group of US elder statesmen, George Shultz, Henry Kissinger, William Perry and Sam Nunn, in their 2007 Wall Street Journal op-ed. They predict that, without a major change in policy, the US will soon enter a "new nuclear era that will be more precarious, psychologically disorienting, and economically even more costly than was Cold War deterrence."[10] Similarly, the former British Foreign Minister Margaret Beckett at the end of her term warned of nuclear risks and made clear that, as with the abolition of slavery, the ultimate goal would not be regulation or reductions, but the elimination of nuclear weapons.[11] These calls for a nuclear weapon-free world have been repeated by officials and former statesmen from many other countries, including nuclear weapon states.[12]

Despite these calls, hundreds of missiles carrying an estimated 1,800 nuclear warheads in US and Russian arsenals remain on 'hair-trigger alert status', a doctrinal legacy from the Cold War that would send them flying at a moment's notice. In the wake of the conflict in Ukraine, nuclear weapons have enjoyed increased prominence in Russian and NATO defence doctrines. Russia's nuclear strategy appears to point to a lowering of the threshold for using nuclear weapons in any conflict, while NATO (especially its central and eastern European members) will be reluctant to lower or phase-out the role of nuclear weapons in the alliance.

Following hurricane Katrina in 2005 and the IPCC reports in 2007 and 2014, attention increasingly shifted to the security risks of global warming.[13] There was growing concern about large-scale cascading events in the climate system that could lead to international instability and become as devastating as a nuclear disaster. Among the potential tipping elements in the climate system are the loss of the South Asian monsoon and the Amazon rainforest, the breakdown of the North Atlantic thermohaline circulation, polar ice melting and global sea-level rise.[14] Tipping points and cascading events can also occur in social systems

where climate change may become a risk multiplier in the world's complex crises.[15] Major examples include hot spots of climate change and human insecurity; vulnerable infrastructures and networks; economic and financial crises; social and political instability; environmental migration; climate change and violent conflict (see figure 6).

UN Secretary-General Ban Ki-moon warned that climate change might pose as much of a danger to the world as war. In April 2007, the UN Security Council held its first debate on climate change indicating that global warming has elevated to the top of the international security agenda, rivalling the threat of war. Initiated by the United Kingdom, former Foreign Secretary Margaret Beckett compared emerging climate change to the "gathering storm" before World War II: "An unstable climate risks some of the drivers of conflict – such as migratory pressures and competition for resources – getting worse."[16]

In Spring 2008, the European Commission issued a report stating that climate change "is already having profound consequences for international security" which are not just of a "humanitarian nature" but include political and security risks that directly affect European interests.[17] It held that, "The core challenge is that climate change threatens to overburden states and regions which are already fragile and conflict prone."[18] This analysis has been supported by the defence and security establishments in many countries, including the US Department of Defense, which in a 2015 report stated that "global climate change will have wide-ranging implications for U.S. national security interests over the foreseeable future because it will aggravate existing problems – such as poverty, social tensions, environmental degradation, ineffectual leadership, and weak political institutions – that threaten domestic stability in a number of countries."[19]

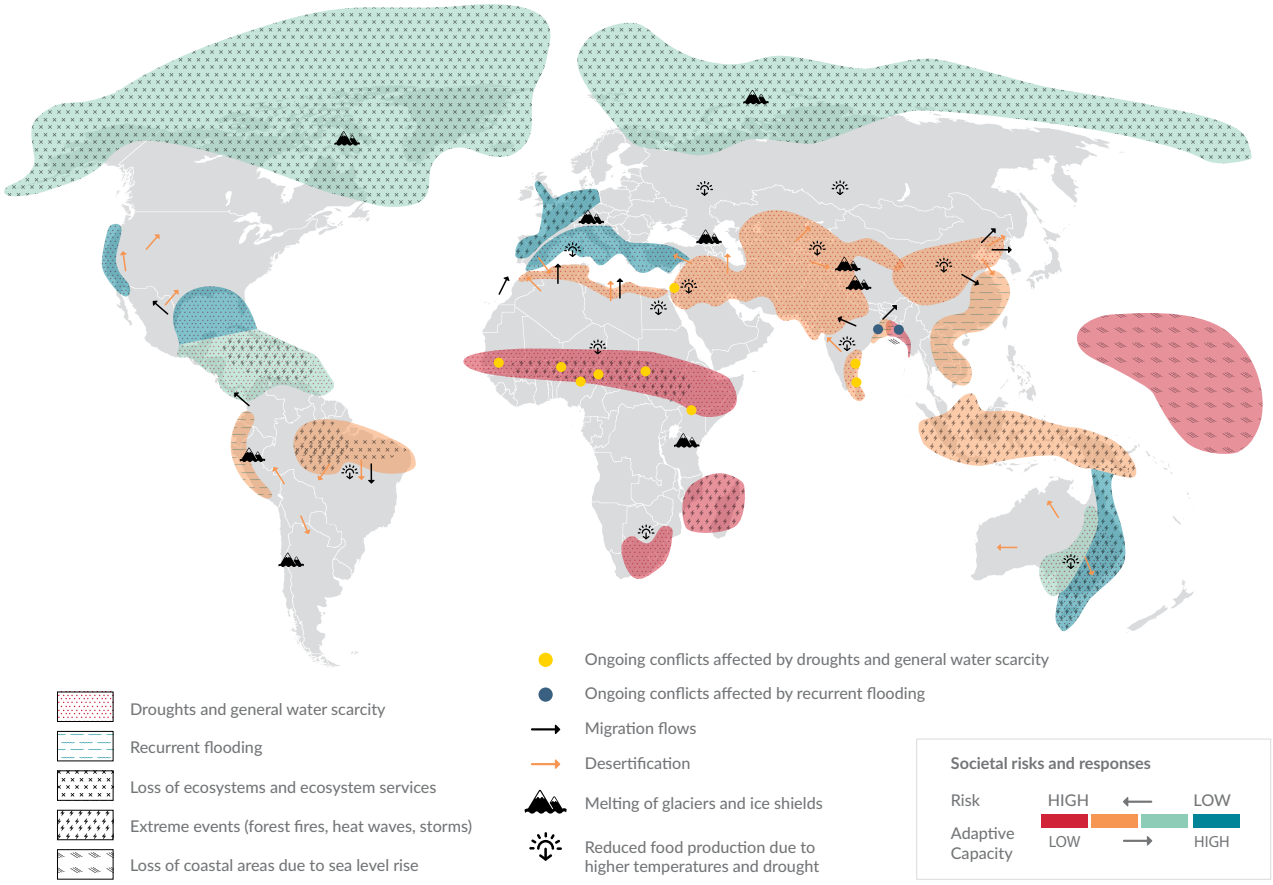


Figure 6: Climate change and instability hotspots
(Source: Climate and Conflict, Scheffran/Battaglini 2011)

Besides these political statements, the impacts of climate change on security have become subject to research, investigating the impacts of climate-related events on social and political stability on different parts of the world. Particularly unstable are fragile and weak states with social fragmentation, poor governance and management capacity. By altering the natural and social environment, climate change is a potential driver for violent conflict, including civil wars and military interventions that in turn are associated with various negative consequences such as famine and economic crises, forced displacement, resource exploitation and environmental degradation. There is a wide range of possible conflict constellations associated with the effects of climate change on rainfall and water scarcity, land use and food security, migration and refugee movements, extreme weather events and natural disasters, vegetation and biodiversity, which can become conflict factors individually or in conjunction.[20] They may trigger societal tipping points, leading to social unrest, riots, violence, crime and armed conflict.

A spectacular example is the social and political unrest in the Middle East and North Africa (MENA) since 2011, a region that has been preoccupied with fossil fuel dependence, wars on oil and nuclear proliferation for a long time. In the wake of the Arab spring, which affected the entire region and provoked a change of regimes in several countries, Syria and Libya experienced bloody civil wars. With a rise in temperature and decreased precipitation water supply and agriculture are hit, affecting the lives of people.[21] Possible connecting mechanisms between climate and conflict are international food markets and prices which are affected by hazard-induced harvest losses. Another factor were the devastating droughts that hit the main growing areas of Syria before the rebellion and drove many people from the countryside to the cities, in 2010 alone 50,000 Syrian families.[22] While in 2002 more than 30% of Syrians were working in agriculture, this share fell to less than 15% in 2010.[23] Syria already suffered from the presence of more than 1 million Iraqi refugees who had fled after the US invasion in 2003, a war that was justified by Iraq's nuclear programme, destabilised the region and opened the door to the Islamic State. This demonstrates that Syria is an example of a war with many root causes that multiply in highly complex ways.[24]

Finally, as several natural disasters in recent years have demonstrated, extreme weather events, environmental degradation and major seismic events can also directly cause dangers for nuclear safety and security. The wildfires that spread through Russia in the summer of 2010 posed a severe nuclear risk to the country when they were on their way to engulf key nuclear sites. In addition, there was widespread concern that radionuclides from land contaminated by the 1986 Chernobyl nuclear disaster could rise together with combustion particles, resulting in a new pollution zone. Luckily, the authorities managed to contain the fires in time.[25]

There has also been increased concern about the location of nuclear facilities in flood-risk areas. Sea level rise, storm surges and bursting dams all pose an increasing danger to nuclear power stations across the world. According to a 2011 report by the US Nuclear Regulatory Authority more than 30 nuclear installations across the country were in danger from

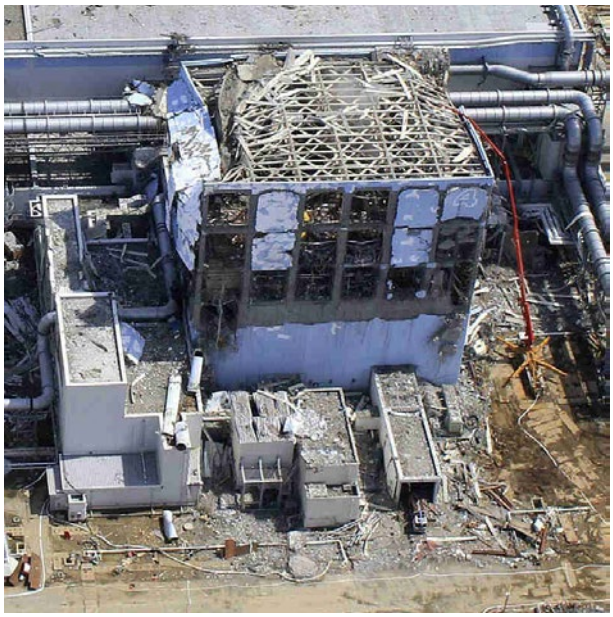


Figure 7: Damage to Fukushima Daiichi nuclear power plant's unit 4 reactor by explosions and fires caused by the earthquake and tsunami
(Source: Air Photo Service)

flooding.[26] Similar flooding concerns exist in other countries.[27] Apart from concerns about the impact of flooding on the integrity of reactors, which could result in a meltdown, flooding and other environmental degradation can also affect the general security of nuclear installations, civilian or military. This could be particularly dangerous in areas with non-state actors attempting to acquire a nuclear weapon or fissile material to fashion a 'dirty bomb'.

The major damage caused to the Fukushima Daiichi nuclear power plant in Japan in March 2011 after a 9.0-magnitude earthquake and subsequent tsunami hit the coast line has also drawn attention to the possible dangers of seismic activity for nuclear infrastructure (see figure 7). Worryingly, the Fukushima nuclear power plant is not the only facility located in a natural disaster-prone area. Research conducted by the International Atomic Energy Agency reveals that 20 percent of the world's 442 working nuclear power stations are in areas of "significant" seismic activity. These events confirm what many intuitively already feel: in this seismically active world, characterized by an increasingly unpredictable environment, nuclear facilities, weapons and materials represent a highly volatile variable in an already unstable equation.[28]

1.4. NUCLEAR WAR CAN LEAD TO A DRAMATIC AND IMMEDIATE COOLING OF THE ATMOSPHERE

Although US-Russian nuclear arsenals have been significantly reduced (by more than two-thirds since 1989) the total number of nuclear weapons in the world—93% of which belong to the US and Russia—is still sufficient to threaten the extinction of advanced life on earth. Recent scientific studies suggest that even a 'limited' regional nuclear exchange would eject so much debris into the atmosphere that it could rapidly cool down the planet to temperatures not felt since the ice ages ("nuclear winter") and significantly disrupt the global climate for years to come.[29] Researchers modelled the effects of a nuclear war between India and Pakistan, in which each would use 50 Hiroshima-sized nuclear weapons (about 15 kilotons each) on major populated centres, and estimated that burning cities could release as much as five million tons of soot (impure carbon particles) into the atmosphere, where the absorption of sunlight would further heat the smoke and lift it into the stratosphere. Here the smoke could persist for years and block much of the sun's light from reaching the earth's surface,

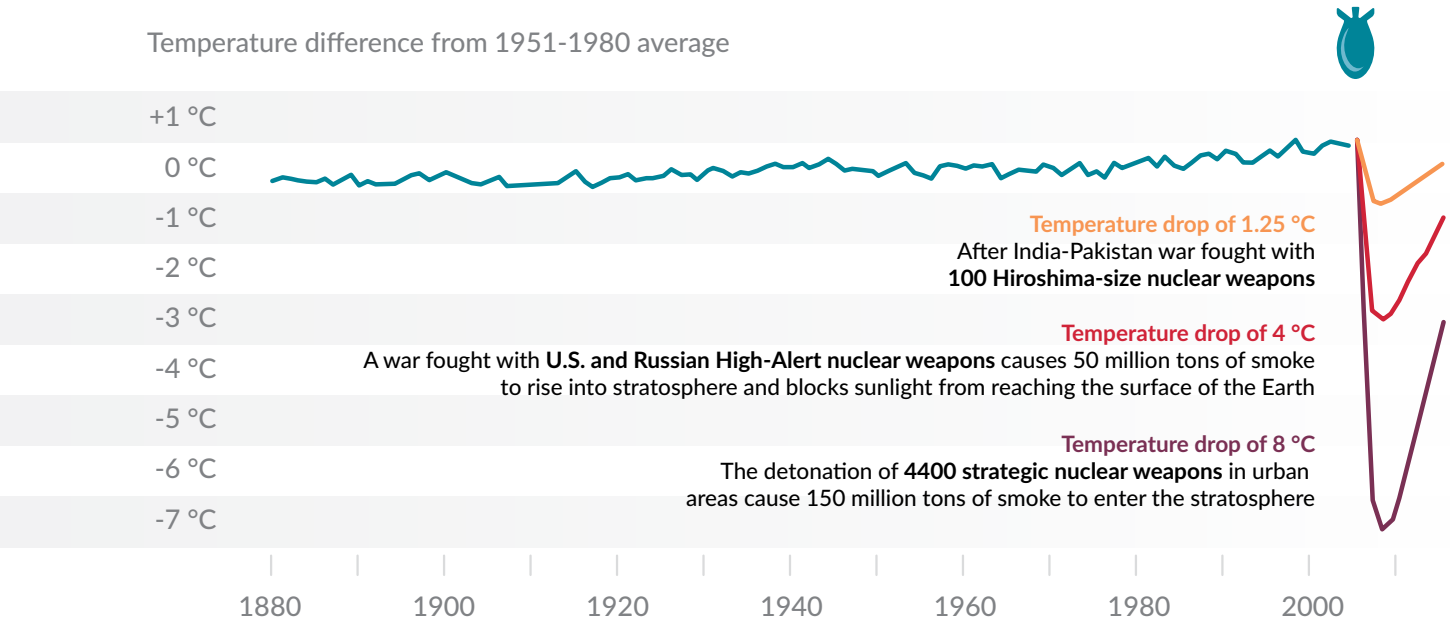


Figure 8: Global average surface temperature changes for small, moderate and large nuclear wars in the context of the change of climate since 1880 (Source: nucleardarkness.org)

causing surface temperatures to drop drastically (see figure 8). This would have disastrous implications for agriculture and threaten the food supply for most of the planet (see figure 9). It has been estimated that between one and two billion people could die of starvation as a result ("nuclear famine").[30]

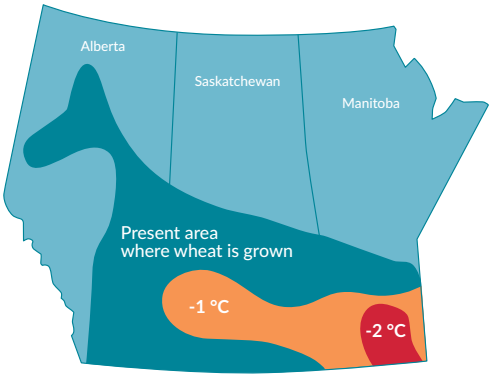


Figure 9: Projected Canadian wheat production loss after the global drops in average surface temperature caused by nuclear weapons use
(Source: nucleardarkness.org)

1.5 NUCLEAR WEAPONS, NUCLEAR ENERGY AND CLIMATE CHANGE: THREE INTER-GENERATIONAL THREATS

Nuclear weapons and climate change pose existential threats to humanity, as indicated above. Nuclear weapons and climate change, along with nuclear energy, also pose serious concerns of inter-generational harm.

The testing by detonation of over 2,000 nuclear weapons has generated radioactive contamination of lands rendering some uninhabitable for generations. The radiation released has also impacted on genetic codes in humans, which will affect reproduction for generations. Already, we are witnessing second and third generation birth deformities and congenital disease as a result of the atmospheric tests from the 1950s and 1960s.

The impact of carbon emissions and other climate change gases is also inter-generational. Carbon dioxide has unique long-term effects on climate change that are largely "irreversible" for hundreds of years. Even when emissions stop, the destructive impact would continue.

Nuclear energy also poses inter-generational risks from any leaks and accidents, and imposes intergenerational responsibility to manage the waste, which is dangerous for thousands of years. Nuclear accidents usually have impacts far beyond the direct surrounding environment and far beyond the generation in which it occurs. The nuclear accidents at Three-Mile Island, Windscale, Mayak, Chernobyl and Fukushima have shown that nuclear technology is uncontrollable and causes social and environmental damage, as well as inter-generational violations of human rights, including rights to life, health, land, houses and safe water. The detailed analysis on the Fukushima accident and it implications in 2011 in Japan sheds a sad light on the dangers of this technology. Compensation alone cost the operating utility of TEPCO more than $US 40 billion and only lucky circumstances prevented a much larger disaster impacting also on a number of other Japanese reactors.[31]

The nuclear industry has also been unable to find or develop a safe and secure disposal system for this waste, passing this problem onto future generations along with the waste itself. C.G. Weeramantry, former Vice-President of the International Court of Justice, says that this is "the gravest of possible crimes against future generations."[32]

He writes: "If people of the Stone Age had been able to cause damage to the environment and cause congenital deformities to our generation, we would have condemned them as savages, brutes and barbarians. Yet, even if they could have caused such damage, they could have had no idea of the irreparable harm they were causing to generations yet unborn. We, on the other hand, who are fully aware of the catastrophic damage we are causing to unborn generations, still proceed regardless pursuing activities which, it is patently clear, will release these dangers sooner or later. We continue to build nuclear reactors all over the world."[33]

2. NUCLEAR ENERGY: NO SOLUTION TO FOSSIL ENERGY DEPENDENCE AND GLOBAL WARMING

2.1. NUCLEAR POWER IS NEITHER REQUIRED FOR NOR CAPABLE OF SOLVING THE CLIMATE CRISIS

Nuclear power is often presented as a solution to the problem of climate change because it would replace fossil energy use as a source of CO2 emissions. Given the safety and security risks of nuclear power and its limited ability and economic viability in addressing global warming, this is not a viable alternative.[34] Nuclear energy cannot significantly replace the huge amounts of fossil energy and causes additional risks. Rather, it is is too costly and standing in the way of increased renewable energy, enhanced energy efficiency and smart grids.

While nuclear power's share in electricity generation has been declining both absolutely and relatively in recent years—in 2014 it constituted only 6% of global installed capacity (see figure 10)—a revival of nuclear investments is not unlikely. At the same time, renewable energy technologies broke another record last year, accounting for over 60% of net addition to the world's power capacity, providing more than 19% of the global energy consumption.[35] Since 2000, renewable energy capacity has grown 120% and the cost-competitiveness of renewable power generation technologies has reached historic levels.[36] Biomass for power, hydropower, geothermal and onshore wind can all now provide electricity competitively compared to fossil fuel-fired power generation and the levelised cost of electricity of solar photovoltaics (PV)

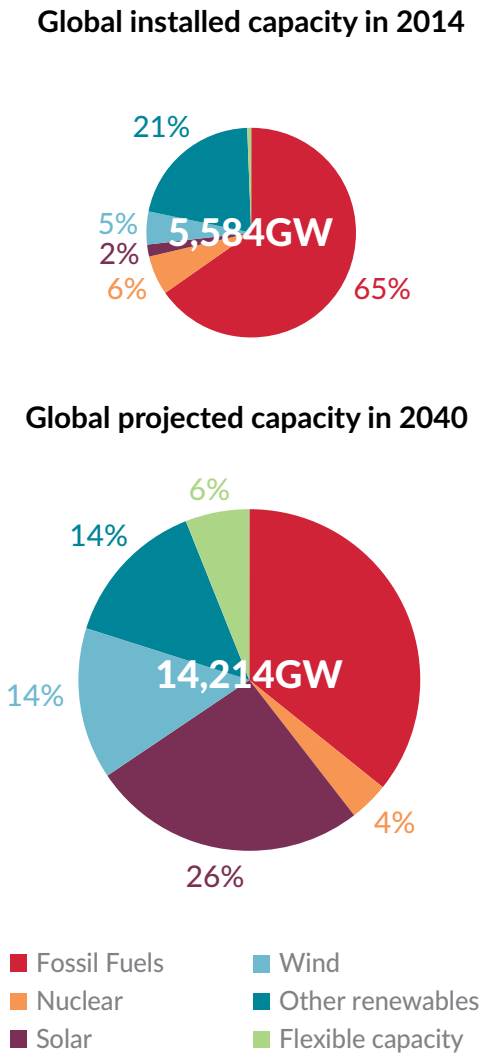


Figure 10: Global installed capacity in 2014 and projected capacity in 2040
(Source: New Energy Outlook 2015, Bloomberg New Energy Finance)

has halved between 2010 and 2014, so that solar PV is also increasingly competitive at the utility scale.[37]

Compared to nuclear, renewable energy technology are competitive and market-ready, they rely upon indefinitely available resources that are naturally occurring, constant and free to access as well as spur socio-economic development. The massive "nuclear renaissance" required for a significant impact would be unlikely to take place for economic and security reasons.

FLEXIBILITY AND ENERGY SECURITY CHALLENGES

Compared to other power sources, nuclear has the lowest flexibility to react to demand fluctuations by consumers. Nuclear power technology does not allow for a rapid electricity generation response, such as ramping up or ramping down capacity output within a few hours, let alone minutes or seconds what a modern power system based on variable renewables such as solar and wind might require. In fact, compared to all other power technologies, nuclear has the worst response speed and less than half or all nuclear capacity might be able to react within six hours.[38] So, nuclear is either 'on' or 'off'. As we deal with large capacities of individual nuclear plants, either mode has huge implications on grid stability. To maintain or expand large-scale inflexible nuclear power could reduce incentives for demand side efficiency of electric appliances. The inability of nuclear power plants to deliver flexible and demand driven dispatch loads means that they only work in an electricity grid that is heavily based on large base-load power stations (primarily coal, nuclear and gas). It also means that states that invest in or rely on higher shares of nuclear energy will likely hamper a transition to decentralised renewable energy systems since they would need to maintain an electricity system suited to inflexible base-load nuclear power.

Compared to low-risk renewable energy coupled with high energy efficiency and an innovative electric grid and load management in the power sector, nuclear energy is in fact a strong obstacle to energy security and to a smart and affordable consumer-driven electricity demand system with strong roots in decentralised and distributed energy architecture. In addition, nuclear has no role to play for providing basic power services for the about 1.3 billion poor people mainly in South Asia and Sub-Saharan Africa who do not have access to reliable and clean electricity. In particular access to electricity in non-grid connected areas is most cost-effectively delivered by decentralised renewable energy sources.[39]

CAPACITY SHORTFALLS

Because of the long planning cycles and its inadequacy for use in combustion and as transportation fuel, nuclear energy cannot replace in a reasonable timeframe the large amounts of fossil fuel currently consumed. Since the uranium resources are limited, a sustainable energy supply based on nuclear energy cannot be realised with a once-through cycle that avoids plutonium reprocessing. Even a drastic increase in nuclear energy could not compensate for the current growth in energy consumption, would come too late for preventing climate change and would lead to an enormous increase in plutonium stocks, with all its aforementioned problems.

Due to the expected shutdowns of aging power plants, it will already be challenging to replace these power plants, not to mention multiplying their capacity. In its low-use reference scenario for the nuclear power outlook, the International Atomic Energy Agency predicted that the installed capacity of nuclear power will remain nearly constant by the year 2030. In its high-use scenario, almost a doubling of nuclear power capacity is projected. In either case, the share of nuclear power in total energy generation and the CO2 reduction will remain only a few percent. This net effect would easily be negated by the energy growth in the South. What is actually required is a phase-out of CO2 emissions by 2050.[40] Even without a massive expansion of nuclear energy, the conventional uranium resources will be consumed within the next five decades (not considering uranium in the oceans). Switching to plutonium processing and fast breeder reactors could stretch the existing resources, but would be far more risky, more expensive and less

proliferation-resistant, thus adding to the existing risks of nuclear power.

ECONOMIC CHALLENGES

Given the high economic cost of nuclear power, cheap nuclear electricity has remained a fiction. While most renewable power utility costs (weighted averages) fluctuate between $US 1,000 – 4,000 per kW installed,[41] recent nuclear assessments show the utter increase of up to $US 8,000 per kW such as in UK (Hinkley Point).[42] Although nuclear power has been heavily subsidized by governments and external costs are still not internalised into its market price, nuclear energy is not commercially competitive compared to advanced renewable energies that receive similar financial support. In a comprehensive environmental and economic assessment, including external costs from waste disposal, uranium mining, fuel processing and radioactive emissions during normal operations, most renewable energy sources look better than nuclear energy. This partially explains the apparent slowdown of or withdrawal from nuclear power in industrialised countries and their diminished interest in a further build-up. The investment risk has further increased due to nuclear accidents, protests against nuclear energy and the higher requirements of governmental licensing procedures (especially in the US and Germany).

NO 'CARBON-FREE' ENERGY SOURCE

Nuclear power is not carbon-free if the whole life-cycle of electricity production is taken into consideration. The World Nuclear Association has compared a wide range of studies, finding a mean of 29 tonnes CO2/GWh for nuclear power (with some studies finding 130 CO2/GWh), which is comparable to hydropower, lower than photovoltaic and higher than for wind or improved efficiency of electricity generation and use.[43]

VULNERABLE TO CLIMATE CHANGE

Climate change will further exacerbate the risks of nuclear energy. We have seen already the need to power down some nuclear plants due to increased river water temperatures in summer that cannot deliver sufficient cooling. Nuclear energy might require, depending on cooling technologies, between 10,000 and 400,000 litres of freshwater per MWh while wind and solar PV need less than 100 litres.[44] While this is only one example, demand on natural resources such as water for production of nuclear energy are large and are not sustainable in a world that already faces increasing scarcity of these natural resources and where climate change poses additional threats.

A TARGET FOR ATTACKS

Over the past decades, at least two nuclear power plants (Armenian NPP and Zaporizhia NPP) were close to combat zones and at risk of being impacted. Nuclear power plants can always be damaged by modern weapons (such as a multiple launcher rocket systems widely used in local armed conflicts) or through non-conventional acts of terror (e.g. the use of civilian aircraft). There is no plan or design that could prevent it. Moreover, widespread placement of NPPs with their spent fuel pools, storages of spent nuclear fuel and radioactive waste on the banks of ponds endangers source of drinking water for millions of people, even if armed attack will not destroy the reactor itself.

2.2. PROBLEMS RELATED TO THE NUCLEAR 'FUEL CYCLE'

While fossil energy sources release carbon into the atmosphere, which is driving global warming, the nuclear 'fuel cycle' (which is more a chain or a spiral than a closed cycle) contains a variety of problems and risks.[45]

RELEASE OF RADIOACTIVE MATERIALS

Radioactive materials are released and accumulated at each stage of the nuclear chain, including uranium mining and fuel rod production, reactor operation and reprocessing, and transport and disposal (see figure

11). Even under normal operations, it is difficult to avoid radioactive materials from being released into the environment, not to speak of the dangers of repeated errors and accidents throughout the process. These radioactive emissions present a conflict potential with international dimensions. An increasing number of countries acquiring nuclear power as part of a "nuclear renaissance" would multiply the nuclear safety, health and proliferation risks.

HEALTH IMPACTS

Further, several stages of the fuel chain can bring significant negative health impacts such as increased cancer rates, polluted water and soils to the peoples on whose territories the uranium is mined and who had to and still have to work in the mines. The resultant mining waste, often including various grades of concentrations of remaining radionuclides, is often stored open-air posing risks for the radioactive contamination of ground and surface water as well as agricultural produce. When accidents occur, it is particularly local and socially vulnerable groups of people that suffer most. Since radioactive contamination causes various types of cancer, children are particularly at risk.

DUAL-USE RISK

Nuclear power is also inextricably linked to nuclear weapons development.[46] The linkage between civilian and military nuclear technologies contains potentially high security risks. So far, about one-third of the countries using nuclear power have built nuclear weapons, and only one (South Africa) has given them up, besides the successor states of the Soviet Union (Ukraine, Belarus and Kazakhstan). According to a Massachusetts Institute of Technology (MIT) study on "The Future of Nuclear Power", a four-fold increase of the world's nuclear capacity by 2050 could double the number of countries using this form of energy.[47] At various stages of the nuclear fuel chain, transitions to nuclear weapons technology are possible, contributing to the danger of their worldwide proliferation. A serious problem is the ambivalence of science and the civil-military dual use of nuclear technologies and facilities involved in the production and processing of weapons-grade materials. These include uranium enrichment, fuel production and reprocessing of spent nuclear fuel. Around 20 countries already have access to such technologies. This trend would increase with a further global expansion of nuclear energy.

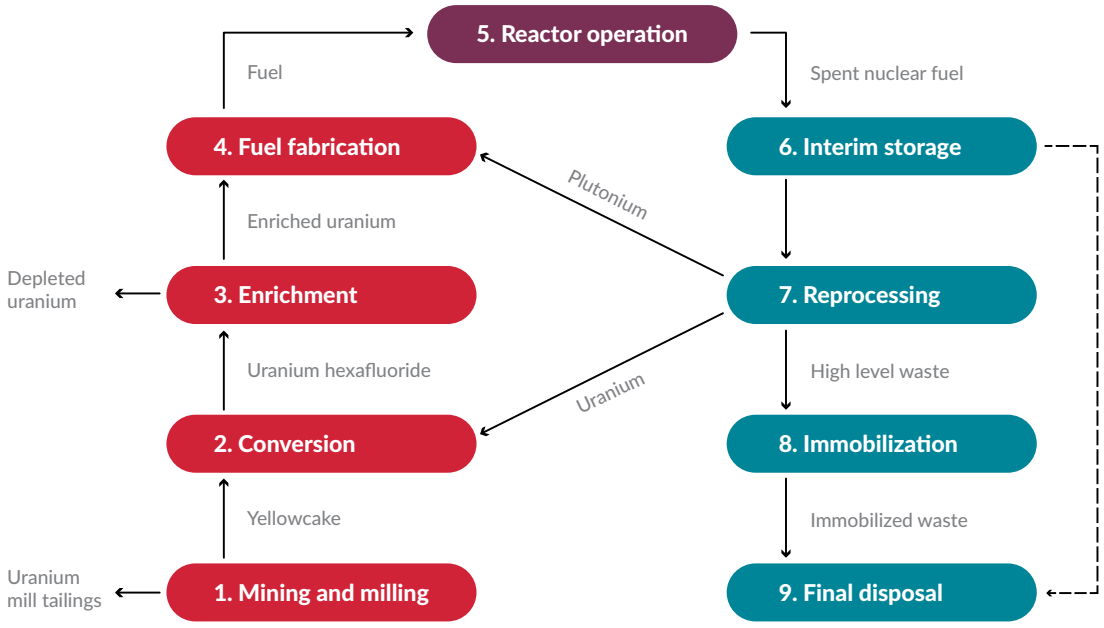


Figure 11: Nuclear fuel chain based on uranium
(Source: Adapted from Encyclopedia of Energy 2004)

Despite the elimination of almost 500 tons of Russian and US highly enriched uranium (HEU), the global inventory still totals around 1,345 tons, with almost 99 percent held by the nuclear-armed states.[48] The global stockpile of separated plutonium is about 500 tons, divided almost equally between civilian and military stocks (see figure 12). One hundred tons of plutonium would be theoretically sufficient for up to 20,000 nuclear warheads. A large fraction is still embedded into radioactive nuclear waste, which would have to be reprocessed in order to extract fissile materials. With increasing civilian use, the amount of plutonium also tends to increase. As long as plutonium use is pursued on a global scale, an irreversible path to a nuclear weapon-free world is difficult to achieve. The obvious problems and dangers of nuclear weapons proliferation and continued nuclear weapons development would be aggravated with more countries establishing national nuclear programmes, as this would allow access to nuclear-weapons materials, either intentionally or unintentionally.[49]

A considerable international effort of inspections is pursued by the International Atomic Energy Agency (IAEA) to avoid that non-nuclear weapon states which are members of the nuclear Non-Proliferation Treaty (NPT) divert material for nuclear weapons. An effective control that excludes the civil-military dual use in the nuclear sector does not exist. Even if there are currently no intentions to build a nuclear weapon, the nuclear option can be technologically prepared or maintained along the nuclear fuel chain. This provides critics and sceptics with reasons to speculate on actual or future intentions to start a nuclear weapons programme, which could easily lead to a high stakes confrontation. Undeclared programmes of nuclear weapons or ambivalent nuclear power programmes are often 'crisis multipliers' in regional conflicts. As has been illustrated by the decades-long political standoff over the Iranian nuclear programme, which led to a historic accord in July 2015 ending economic sanctions against Iran in exchange for restrictions on its nuclear programme, the difficulty in distinguishing between civilian and military nuclear ambitions remains a source for discrimination, threat, mistrust and fear in international relations.

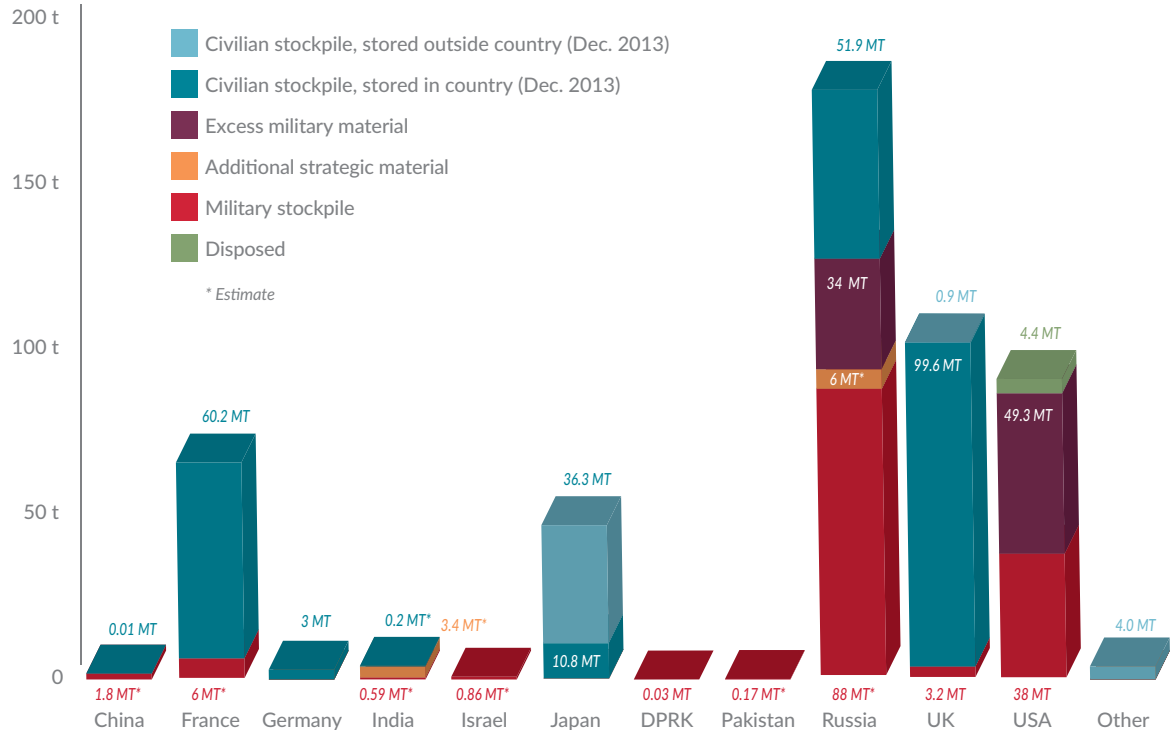


Figure 12: National stocks of separated plutonium

(Source: Global Fissile Material Report 2015, International Panel on Fissile Materials)

2.3. NUCLEAR WASTE DISPOSAL AND CLIMATE ENGINEERING ARE TECHNICAL ATTEMPTS TO BURY THE RISKS OR MANIPULATE THE CONSEQUENCES OF NUCLEAR TECHNOLOGY AND CLIMATE CHANGE

The long-term risks of nuclear energy become obvious at the end of the nuclear fuel chain. Nuclear waste disposal (whether from nuclear power production, nuclear weapons programmes or nuclear disarmament) will remain a problem over thousands of years, and many future generations will have to bear this load without having the short-term "benefit" of the current generation. Since about the early 1970s, some 350,000 tons of spent nuclear fuel had been generated worldwide with an annual growth of about another 10,000 tons today. This High Level radioactive Waste (HLW) is highly toxic and needs to be stored safely for several thousand years. Yet, even after almost 50 years of operations globally, the IEA admits: "No country has yet established permanent facilities for the disposal of high-level radioactive waste from commercial reactors, which continues to build up in temporary storage".[50] To decay half of the amount of plutonium 239, which is the primary fissile isotope used for the production of nuclear weapons, it takes around 24,000 years or 1,000 human generations, much longer than the known history of homo sapiens. After decades of nuclear energy production, the pile of nuclear waste is still growing, even though worldwide not a single site for final disposal of spent fuels is operating and temporary storage is continuously being extended. It is uncertain whether and when a responsible solution to the long-term disposal of radioactive waste can be found.[51]

All the solution concepts on the table are burdened with problems: dropping the nuclear waste into the deep ocean, storing it in the ice of Antarctica, launching it into outer space, injecting liquid waste under groundwater bearing layers and different variants of underground storage have all been taken into consideration.[52] In the 1970s the concept of "safe" disposal in deep geological formations was explored. This would provide long-term isolation and containment without any future maintenance. While many governments and international organizations prefer this approach, others want to keep the waste in a retrievable and controlled form, combined with long-term surveillance. In any case, it is highly uncertain whether the evidence for a final repository can ever be proven to sufficiently guarantee long-term safety and security.

Geoengineering is offered as a solution for reducing dangerous climate change by deliberately modifying the Earth System. Suggested measures of "climate engineering" (CE) include carbon capture and sequestration in biomass, soil, underground or in the ocean; aerosol emissions to absorb sunlight in higher layers of the atmosphere (similar to volcano eruptions); and other means of changing the Earth's radiation balance by reflecting sunlight, e.g. through large mirrors in outer space (see figure 13: Geoengineering proposals).[53] To varying degrees, these measures have unknown efficiency, costs and risks. Moving from involuntarily changing the atmosphere through emissions to the intentional manipulation of the climate system and the regulation of global temperature (like in a "global air conditioning system") opens a Pandora's Box of competing actions between countries.

The assessment of climate engineering should not focus only on the technical and economic dimensions, but consider the political and social implications as well.[54] Related policies should not become a playground for capital interests and power games or increase the barriers between North and South and between rich and poor. If these developments are not avoided, CE measures could turn into security risks or trigger conflicts for current and future generations.[55] What appears to be a remote possibility may turn into a real danger if the atmospheric manipulation by one state severely affects the interests of other states.

CE techniques should not create more risks than they avoid. As long as there are large uncertainties about the consequences of CE measures, they should not be pursued. It is important to differentiate between CE techniques with relative low risk (such as

afforestation and carbon storage in biomass) and those with a high potential risk (such as large scale manipulation of the atmosphere and the earth's radiation balance). Preference should be given to preventive mitigation measures, followed by practical adaptation against unavoidable climate consequences. CE should only be considered as a strategy of last resort if other measures have been used to the maximum possible degree. In comparing the options, the costs, benefits and risks of the alternatives need to be considered, as well as uncertainties, perceptions and complexities. Research can help to reduce the uncertainty, make risks more assessable and provide a better understanding of the alternatives. Currently there is no reason for hasty or premature decisions since climate change can still be contained in other ways and CE is not a full-fledged solution. Rather than expanding carbon emissions and burying or correcting the consequences through geoengineering, it is more appropriate to avoid the problems in the first place by mitigation measures.[56] To this end, it is essential to establish a nuclear-free, carbon-free and sustainable energy system.[57] Because of the adverse linkages between nuclear and climate risks, it is time to develop a new thinking that synergizes solutions in both nuclear security and climate policy with an integrated framework of sustainable peace.

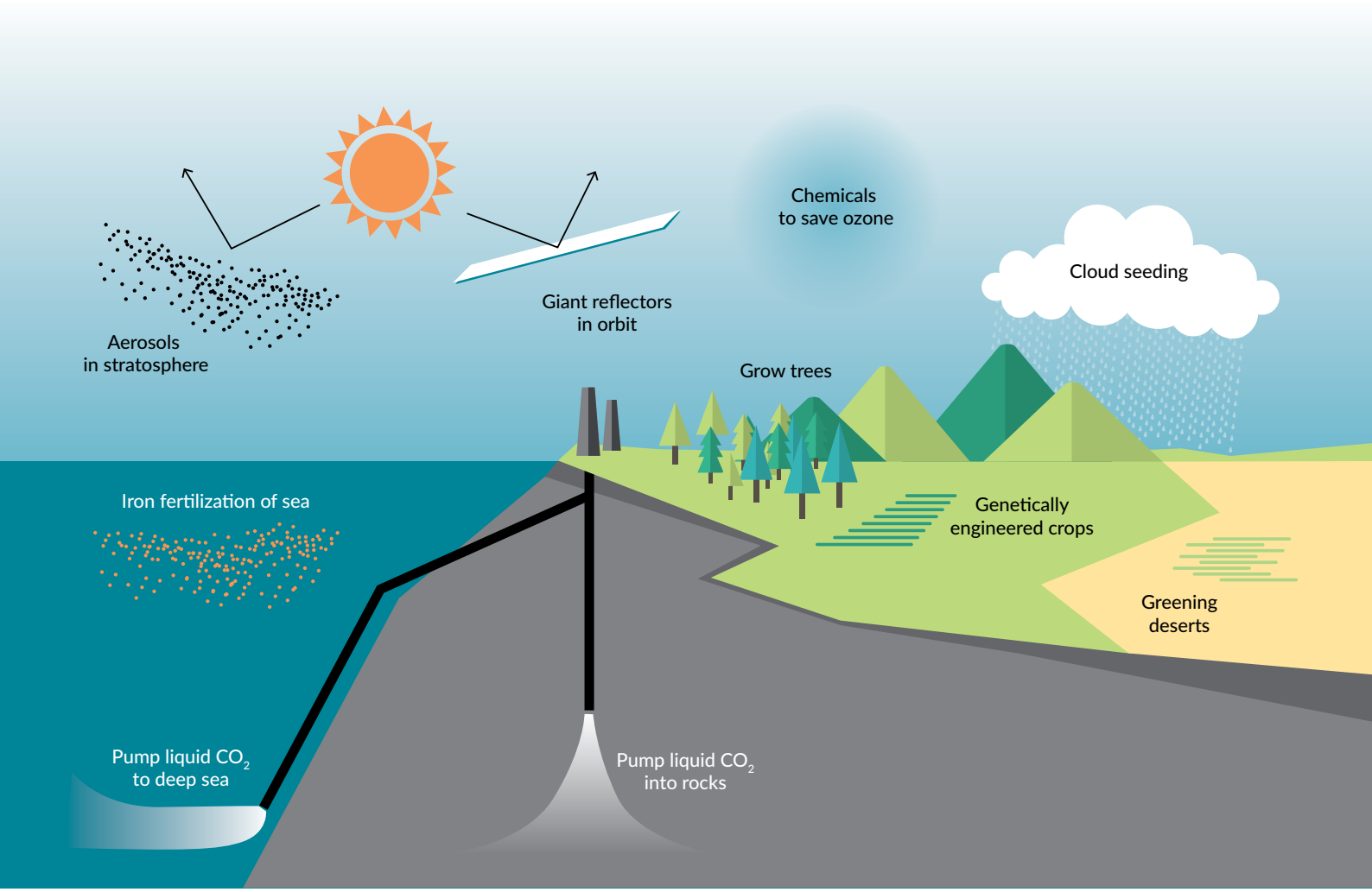


Figure 13: Geoengineering proposals
(Source: Adaptated from Keith, Nature, 2001)

3. FROM CONFLICT TO COOPERATION: TOWARDS SUSTAINABLE PEACE

3.1. THE DISCREPANCY BETWEEN LONG-TERM GOALS AND CONCRETE STEPS UNDERMINES THE CONDITIONS FOR INTERNATIONAL COOPERATION ON SECURITY AND CLIMATE POLICY

Whether nuclear risks and climate change will lead to more conflict or cooperation will depend on how human beings and their societies respond to these challenges. In the 1992 United Nations Framework Convention on Climate Change (UNFCCC), countries agreed to prevent dangerous anthropogenic interference with the climate system. In the 2009 Copenhagen Accord, most nations supported the goal of limiting global temperature change to 2 degrees Celsius by the end of the century, but failed to define concrete steps toward that goal. During his election campaign in 2008, candidate Barack Obama committed to an 80 percent reduction of CO2 emissions by the middle of the century,[58] but effective measures to achieve that goal have been repeatedly delayed. His presidency has been marked by staunch Republican resistance in the US Congress against climate regulation. Meanwhile, carbon emissions have continued to rise, with the global average concentration of carbon dioxide in the atmosphere hitting new records after crossing 400 parts per million in March 2015—a "new danger zone" according to the Executive Secretary of the UNFCCC.[59] The climate change agreement that the United States and China struck in November 2014, offers some hope for unilateral reductions of greenhouse gas emissions. Under the agreement, China agreed to slow and then peak its emissions by 2030 or sooner if possible, after which it would reduce emissions,

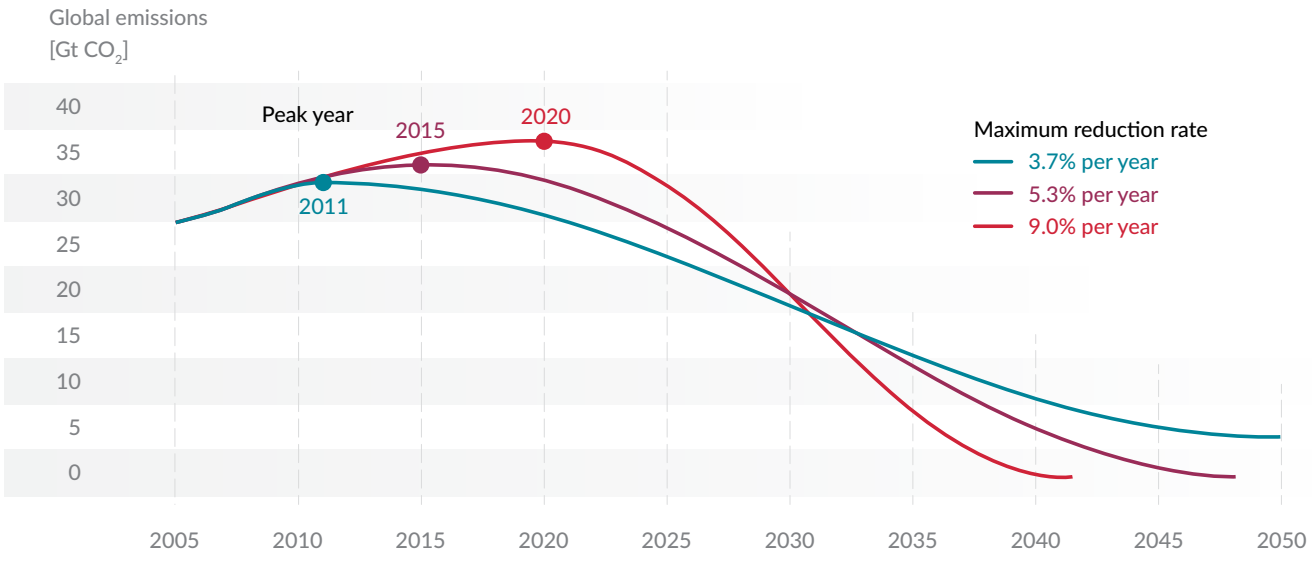


Figure 14: Possible emission paths for the 2°C goal
(Source: Solving the climate dilemma, German Advisory Council on Global Change 2009)

while the United States agreed to reduce emissions by up to 17% by 2020 and 28% by 2025.[60] The 2015 Conference of the Parties to the UNFCCC in Paris offers a vital opportunity to reach a global deal on reducing emissions but it would need determined efforts by the major polluters as well as financial support for poorer nations to enable them to invest in clean technology to cut their greenhouse gas emissions, and to adapt their infrastructure to the likely damage from climate change. Meanwhile, experts agree that the window of opportunity to act to avoid catastrophic climate change is rapidly closing.

Obama also spoke in favour of a nuclear weapon-free world in Berlin in 2008[61] and in Prague in 2009,[62] but so far concrete measures have lagged behind rhetoric. At his initiative, significant attention has been given to preventing nuclear terrorism through a series of Nuclear Security Summits on the topic of bringing nuclear materials, technologies and facilities under safer and more secure control. Furthermore, the international agreement to ensure that the Iranian nuclear programme remains for peaceful purposes has been widely heralded as a significant contribution to preventing nuclear proliferation. Although important, these efforts only focus on proliferation risks, rather than address the risks of the estimated 15,500 nuclear weapons still in the arsenals of the nine nuclear-armed states, many of which are on high-alert status, ready to be launched at a moment's notice. It is imperative that the same high-level political support given to combating nuclear terrorism and preventing proliferation is given to eliminating nuclear weapons.

The New Strategic Arms Reduction Treaty (New START) is a moderate and important step towards further reduction of the US and Russian nuclear arsenals. Its ratification in the US Senate in December 2010 demonstrates that the strong resistance at the domestic front can be overcome, albeit at the cost of meeting the Republican Party's demands for a costly modernization of the nuclear arsenals.[63]

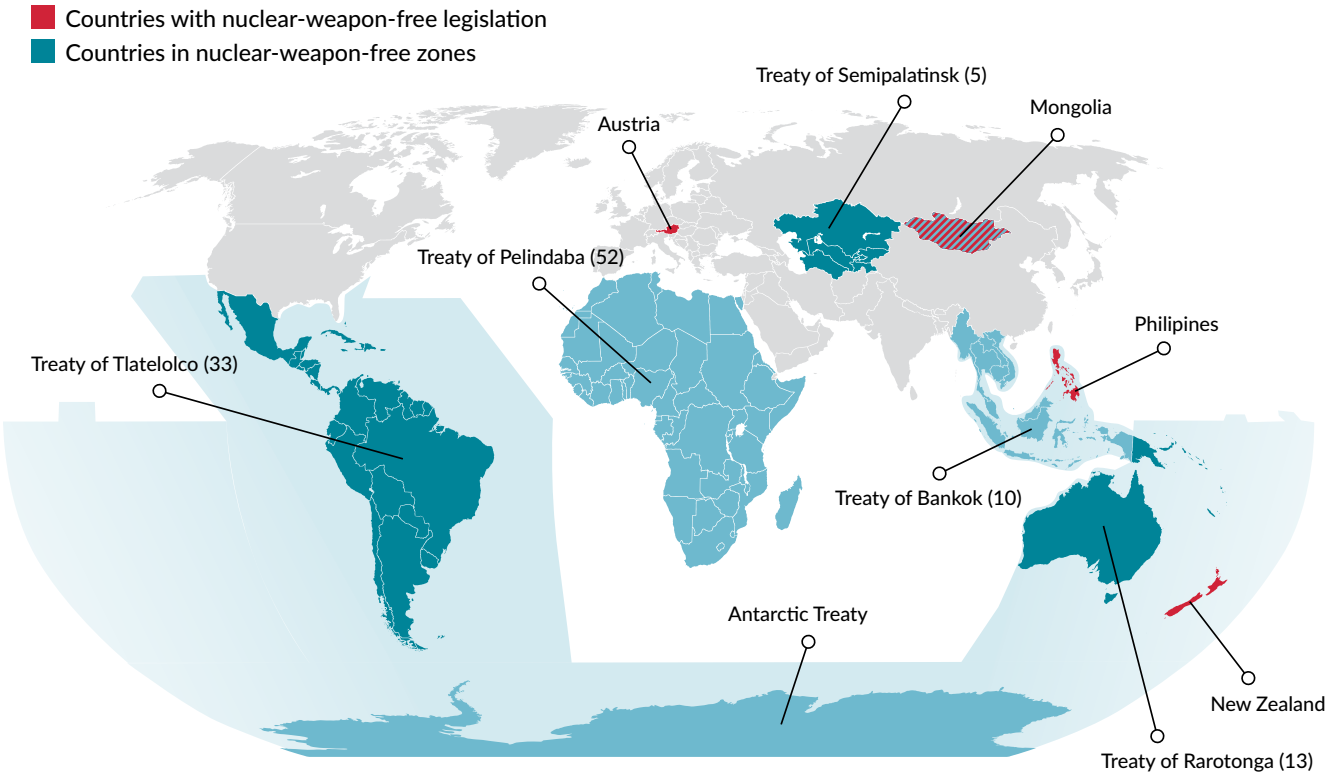


Figure 15: An overview of existing Nuclear Weapon-Free Zones and countries with national nuclear prohibition legislation

On the international level, the goal of nuclear abolition has found wide support, in particular in recent resolutions in the UN General Assembly;[64] a vote by the UN Security Council in 2009;[65] a 2013 High-Level Meeting of the UN General Assembly on Nuclear Disarmament;[66] a United Nations Open-Ended Working Group (OEWG),[67] set up by the UN General Assembly in November 2012 "to develop proposals to take forward multilateral nuclear disarmament negotiations for the achievement and maintenance of a world without nuclear weapons";[68] governmental conferences on the humanitarian impact of nuclear weapons held in 2013 and 2014 in Oslo, Nayarit, and Vienna; and the introduction of the 'Austrian Pledge', which seeks to "fill the legal gap for the prohibition and elimination of nuclear weapons" and to date has gained support from 121 states.[69]

Furthermore, over the course of the last half-century, a great number of states have adopted policies prohibiting nuclear weapons, primarily through establishing Nuclear Weapon-Free Zones. Five such zones exist today, with four of them spanning the entire Southern Hemisphere (see figure 15). In addition, several countries, including New Zealand, Austria, The Philippines and Mongolia have adopted national legislation banning nuclear weapons. Other countries, including Ukraine, Belarus, Kazakhstan and South Africa have dismantled their nuclear weapons capabilities.

Support among non-nuclear weapon states and civil society groups for a legal instrument that would prohibit and eliminate nuclear weapons has grown considerably in recent years. Options proposed include a Nuclear Weapons Convention (NWC) or package of agreements involving all states, a ban treaty involving those states that are ready now to prohibit nuclear weapons, a ban on use followed by negotiations on elimination, a framework agreement (i.e. an agreement on what is required to eliminate nuclear weapons and on negotiations to achieve this), or a hybrid mix of some of these approaches.[70] The final document of the 2010 NPT Review Conference[71] noted UN Secretary-General Ban Ki-moon's five-point proposal for nuclear disarmament of 24 October 2008, "which proposes, inter alia, consideration of negotiations on a nuclear weapons convention or agreement on a framework of separate mutually reinforcing instruments, backed by a strong system of verification."[72] Many states and anti-nuclear civil society groups see negotiation of a NWC as politically feasible and necessary to move beyond the current disarmament stalemate.[73] So far, major progress has not been achieved due to resistance from the nuclear weapon states, which, instead, have engaged in vertical proliferation programmes and shown little willingness to downgrade the role of nuclear weapons in their security doctrines.[74] The failure of the 2015 NPT Review Conference to agree on an outcome document is further evidence of the profound disagreements between nuclear weapon states and non-nuclear states about the progress of implementation of the treaty's disarmament obligation and the inadequacies of the existing nuclear disarmament machinery.[75]

3.2. INTERNATIONAL LAW OFFERS AN EFFECTIVE FRAMEWORK TO PREVENT THE RISKS OF NUCLEAR WAR AND CLIMATE CHANGE

While nuclear arsenals have declined since the end of the Cold War, carbon emissions are still going up and it is not clear when or if a peak will be reached. Since the early 1960s, a number of arms control agreements have been achieved: INF (Intermediate-Range Nuclear Forces) and START Treaties, the Moscow Treaty (SORT), Comprehensive Test Ban Treaty (CTBT), Nuclear Weapons-Free Zones, Conventional Forces in Europe (CFE) Treaty, Chemical Weapons Convention, Biological Weapons Convention, Anti-Personnel Mine Ban Convention and the Convention on Cluster Munitions. With the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer, international law was extended to the atmosphere. While the goal of the United Nations Framework Convention on Climate Change (UNFCCC) to stabilise carbon concentrations in the atmosphere at non-dangerous levels is far from being achieved, the 1997 Kyoto Protocol specified

short-term emission goals for industrialised countries and introduced several instruments. However, most countries failed to reduce greenhouse gas (GHG) emissions to the 1990 levels. Voluntary declarations are insufficient to stay within a maximum temperature change of two degrees Celsius above pre-industrial levels and achieve an 80 percent emission reduction by the middle of the century, which for many experts is essential to stabilise the climate. While this does not exclude a number of risks, it is meant as a barrier against the potentially more dramatic risks at higher temperatures. To act on a global level, the international community has to agree on a maximum carbon budget for the whole planet that does not exceed the temperature ceiling, and then allocate admissible emission pathways to individual countries within the budget limit according to principles of justice.[76] What justice means in this context is heavily contested.

Among the short-term steps for nuclear arms control are further US-Russian cooperation on strategic arms reductions and a multilateral Fissile Material Cut-Off treaty on nuclear weapons materials. Similarly, a number of adaptation and mitigation measures have been proposed for reductions of GHG emissions, which need to be implemented. However, an incremental approach alone will not solve the problems in either field in the foreseeable future. Besides developing political and legal regimes in both the nuclear and climate policy arena, an integrative framework can help to combine various steps in a coherent approach to move toward a "double zero" of nuclear weapons and carbon emissions.[77] A comprehensive approach in each field is not only wise, it is legally required. Nuclear disarmament and climate protection both involve implementation of general legal obligations setting a framework for action contained in international legal agreements, such as the NPT, UN General Assembly Resolutions on nuclear disarmament and the UNFCCC.

In the case of nuclear weapons, the International Court of Justice (ICJ), in an unanimous conclusion, clarified that Article VI of the NPT and other international law obligates states "to pursue in good faith and bring to a conclusion negotiations leading to nuclear disarmament in all its aspects under strict and effective international control."[78] At the present time there are no negotiations relating to nuclear disarmament.[79] Indeed, aside from modest US-Russian bilateral agreements on reductions, that has been the case for many years, dating back to the 1996 CTBT. More than forty-five years after the NPT entered into force, and nearly 20 years after the ICJ's Advisory Opinion, it is time for a multilateral process to negotiate and achieve the complete elimination of nuclear weapons, a process that would encompass measures like further US-Russian reductions and fissile materials agreement but not be limited to them.

For comparison, the UNFCCC sets as the "ultimate objective" the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic [human-caused] interference with the climate system."[80] It sets out general obligations, including that each developed state party "shall adopt national policies and take corresponding measures on the mitigation of climate change, by limiting its anthropogenic emissions of greenhouse gases and protecting and enhancing its greenhouse gas sinks and reservoirs."[81] It also envisages further cooperative action, including the adoption of additional agreements; the Kyoto Protocol is an example of such an agreement, and an agreement sought to be reached in Paris in late 2015 would be another. As a matter of law the current negotiations on a new climate agreement and other actions must aim to achieve the objective set by the UNFCCC of stabilisation of greenhouse gas concentrations at safe levels.

In both arenas, states must act in accordance with the fundamental legal principle *pacta sunt servanda*: a treaty is legally binding and must be performed in good faith. In existing climate negotiations, and future nuclear negotiations, good faith in conducting the negotiations requires among other things awareness of the interests of other parties; a persevering quest for an acceptable compromise, with a willingness to contemplate modification of one's own position; and no undue delay or prolongation of the process. Finally,

good faith requires that states refrain from actions that undermine achievement of agreed objectives, a requirement hard to reconcile with nuclear-armed states' plans to maintain their nuclear arsenals indefinitely and with many states' plans for ongoing reliance on fossil energy technologies causing massive climate risk.

To turn rhetoric into concrete actions, non-governmental organizations have made specific proposals for comprehensive solutions in both the nuclear and climate fields. The Model Nuclear Weapons Convention, drafted in 1997 and updated in 2007 by an international group of experts, outlines a path to global zero.[82] It does not include a ban on nuclear power, although it is recognised that the goal of nuclear abolition would be easier to achieve and verify with such a ban than in a world where nuclear power continues to be pursued.[83] A model treaty for drastic emission reductions was presented by NGOs in preparation of the 2009 climate summit in Copenhagen, but unfortunately did little in influencing the outcome. To make progress, it is the major powers that have to commit to drastic reductions in emissions and nuclear weapons. Without their serious involvement, a world free of both these scourges will remain elusive.

3.3. USING LITIGATION TO ENSURE NUCLEAR DISARMAMENT AND IMPLEMENTATION OF CLIMATE CHANGE OBLIGATIONS

In another effort to stimulate progress in the nuclear sphere, non-nuclear weapon states, supported by civil society, have resorted to litigation. A major landmark in international law as well in the nuclear weapons sphere, the 1996 International Court of Justice Advisory Opinion on the legality of threat or use of nuclear weapons resulted from a request of the UN General Assembly, supported by a world-wide coalition of non-governmental groups numbering more than 600, and hotly contested by nuclear weapon states. Since then civil society groups have proposed that

Figure 16: The International Court of Justice in session (Source: UN Photo/ICJ-CIJ)

the General Assembly make another request for an Advisory Opinion, this time on the legal implications of the nuclear disarmament obligation contained in the NPT and articulated by the Court in its Advisory Opinion. So far the General Assembly has not taken that step. However, in 2014 the Republic of the Marshall Islands filed applications in the ICJ against the nine nuclear-armed states (US, UK, France, Russia, China, India, Pakistan, Israel, North Korea), claiming that they are in breach of obligations relating to nuclear disarmament under the NPT and under customary international law applying to all states.[84] Cases are proceeding against the three of the nuclear-armed states that have accepted the compulsory jurisdiction of the ICJ, the UK, India, and Pakistan. These are contentious cases, in which judgments are binding on the parties. If judgments on the merits are issued, they will clarify key issues, including whether states are required now, not in the distant future, to pursue and engage in multilateral negotiations on the abolition of nuclear weapons, and whether modernization of arsenals is contrary to good faith compliance with the disarmament obligations. The Marshall Islands also filed a companion case against the United States alone in a US court; that case was dismissed on the ground that its resolution was not within the authority of the court, a decision now on appeal.

Litigation has also been sought to ensure that policies are adopted to curb dangerous climate change. In the Netherlands, the NGO Urgenda, together with nine hundred co-plaintiffs, initiated legal action

against the Government in 2013 for failing to take sufficient measures to reduce the country's green-house gas emissions within targets set by IPCC to help avoid critical 2°C rise in global temperatures.[85] The initiators of the case argue that the action is supported by the 'Oslo Principles on Global Climate Change Obligations',[86] which were agreed by an international group of eminent lawyers in April 2015, and note that states on the basis of tort law and human rights (among others) are already legally accountable for emissions of greenhouse gasses from their own territories. A district court ruled in favour of the plaintiffs, noting that the State has a legal obligation to protect its citizens, and is therefore required to take the necessary precautions. The court ordered the Netherlands to reduce its CO2 emissions by a minimum of 25% (compared to 1990) by 2020.[87] The Dutch Government has appealed the decision. This is the first time that a judge has legally required a State to take precautions against climate change and this precedent is already being used in legal action in other countries, including in Belgium, where a similar case has been filed.

There is other evidence of the judiciary becoming more active on climate change. In Pakistan, a farmer sued the national government for failure to carry out the 2012 National Climate Policy and Framework. The Lahore High Court ruled on 14 September 2015 that, "On a legal and constitutional plane this is clarion call for the protection of fundamental rights of the citizens of Pakistan, in particular, the vulnerable and weak segments of the society who are unable to approach this Court."[88] The court found that "the delay and lethargy of the State in implementing the Framework offend the fundamental rights of the citizens."[89] The court therefore directed several government ministries to each nominate "a climate change focal person" to help ensure the implementation of the Framework, and to present a list of action points by 31 December 2015. The court also created a Climate Change Commission with representatives of key ministries, NGOs, and technical experts.[90]

There have also been some signs that climate litigation will be pursued at the international level. In 2011, the Pacific Island State of Palau announced in the UN General Assembly that it would seek an Advisory Opinion from the International Court of Justice on the topic of climate change damage, more specifically by asking the ICJ to provide guidance on how the 'no harm rule' and the UN Law of the Sea Convention apply to climate change damage.[91] Another element of a request for an advisory opinion could concern the legal implications of the framework obligations set forth in the UNFCCC and whether states are in compliance with those obligations. There has also been some discussion in academic and diplomatic circles about the possibility of filing contentious proceedings at the ICJ against major polluters for the effects of climate change.[92] To date, neither a contentious case nor an Advisory Opinion has been sought.

3.4. SCIENTISTS HAVE A SPECIAL RESPONSIBILITY FOR ELIMINATING THE RISKS OF FOSSIL ENERGY AND NUCLEAR WEAPONS

Since scientists and engineers invented the technologies to exploit fossil energy and nuclear power, they have a special responsibility in abolishing both. With the advent of nuclear weapons, physicists took the responsibility in calling for nuclear disarmament. As the Russell-Einstein Manifesto notes: "In view of the fact that in any future world war nuclear weapons will certainly be employed, and that such weapons threaten the continued existence of mankind, we urge the governments of the world to realize, and to acknowledge publicly, that their purpose cannot be furthered by a world war, and we urge them, consequently, to find peaceful means for the settlement of all matters of dispute between them."[93]

Joseph Rotblat refused to continue working on the Manhattan Project to build the atomic bomb when he learned that the bomb was no longer needed against Hitler. He called for the moral responsibility of scientists: "The time has come to formulate guidelines for the ethical conduct of scientists, perhaps in the form of a voluntary Hippocratic Oath. This would be

particularly valuable for young scientists when they embark on a scientific career … I appeal to my fellow scientists to remember their responsibility to humanity."[94] In conjunction with the Pugwash Conferences, he was awarded the Nobel Peace Prize in 1995 for his efforts towards nuclear disarmament. The Intergovernmental Panel on Climate Change, together with Al Gore, received the Nobel Peace Prize in 2007 for their efforts in studying and educating on man-made climate change.[95]

3.5. TO ESTABLISH A FOUNDATION FOR PEACE THAT PREVENTS CLIMATE CHANGE AND NUCLEAR WAR, IT IS CRUCIAL TO DEVELOP AND ESTABLISH THE CONCEPTS OF COOPERATIVE SECURITY AND SUSTAINABLE PEACE

Because of their expertise, scientists and engineers can make major contributions to abolishing the nuclear arsenals (e.g., by verifying the disarmament process), as well as develop the technologies necessary for a sustainable energy transition that would avoid further human-induced global warming. The challenge to avoid dangerous climate change could foster the readiness for cooperation, on local and global levels. And a push toward nuclear disarmament could help transform the international security landscape into a more peaceful and sustainable world order.

If the nuclear and climate problems are not tackled comprehensively but remain stuck in piecemeal approaches, one problem could impede solving the other. As long as countries acquire nuclear power and nuclear weapons, arms races and threat perceptions could spoil international relations, which in turn could undermine the conditions for cooperative climate policies (including the development of global emission standards and goals, ensuring the use of appropriate renewable energy technologies, maximising the effectiveness and sharing of research, and

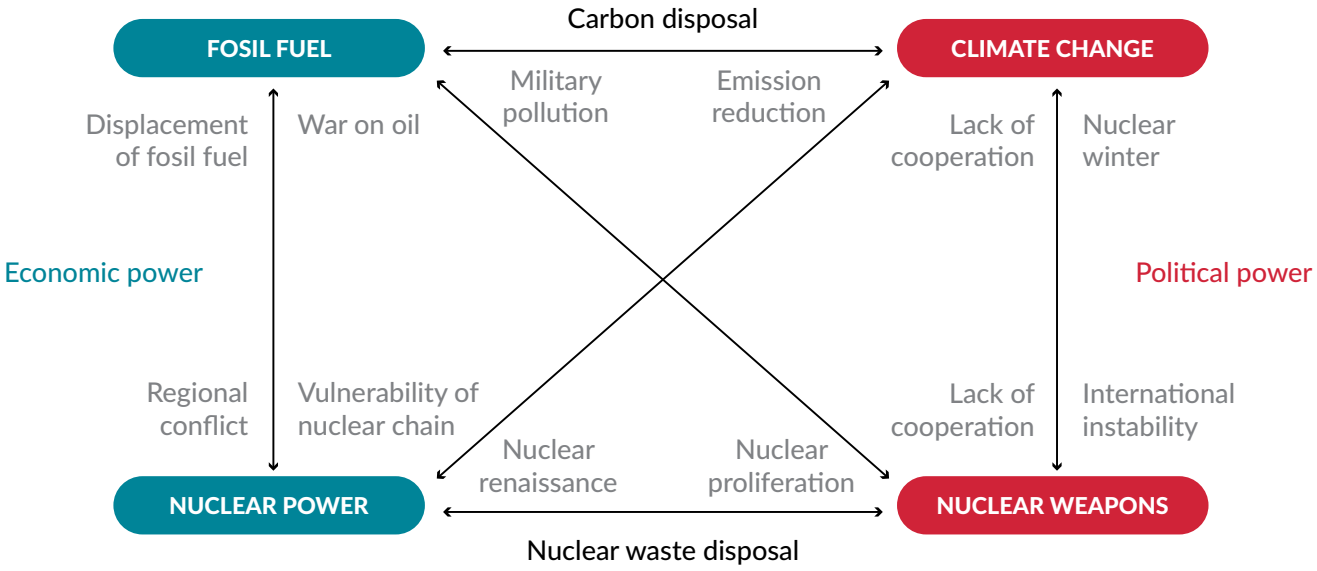


Figure 16: Links between nuclear and climate risks
(Source: Scheffran 2011)

energy 'sharing' to minimise wastage). On the other hand it could induce cooperation on addressing a host of other transnational crises, such as demographic changes, refugee movements, pandemic disease, resource scarcity, environmental degradation, extreme poverty and migration. On the other hand, progressing climate change could undermine human and international security, causing incentives to use violent means to protect resources and interests. To avoid such a doomsday scenario, it is essential to strengthen the positive linkages between both policy areas. Negotiations on roadmaps for nuclear disarmament and carbon emission reduction could overcome the stalemate in both areas.

Regional approaches could help to trigger global solutions, such as establishing Nuclear Weapon-Free Zones (NWFZs), starting in regions with complex security environments, including the Middle East, Northeast Asia and the Arctic. With regard to the proposal to establish a NWFZ in the Arctic, the denuclearisation (and possible demilitarisation) of the Arctic could improve conditions for further environmental protection and safeguards in the region. Such an initiative could be modelled on the 1959 Antarctic Treaty, which demilitarised and denuclearised the South Pole and introduced a range of agreements on protection of the environment and conservation of species in the region, making it "a natural reserve, devoted to peace and science."[96] Regional partnerships in environmental security could prevent disasters in climate hot spots and support the capacity building of societies against the risks of climate change. In a win-win scenario, progress on nuclear disarmament would improve the conditions for climate cooperation, which, in turn, would support an international political climate that would make nuclear weapons increasingly obsolete.

In line with this, renewable energy technologies provide alternatives to this struggle. By harnessing local renewable energy sources, jurisdictions increase their political and energy independency, while the degree of local and international cooperation needed for the transition to 100% renewable energy can act as a catalyst for such cooperation in tackling other transnational security threats. This helps solving geopolitical crises, avoid future armed conflicts triggered by climate instability and resource scarcity, and build co-operative security mechanisms.

The financial resources needed for this are available. Part of the money that would be freed up by stopping investments in nuclear weapons—around $100 billion a year[97]—as well as the roughly $5 trillion spent annually on global fossil fuel subsidies[98] (equivalent to $10 million a minute every day) and the high subsidies for nuclear power, could be redirected toward investment in renewable energy research and development as well as other social and economic programmes in all countries.

Ultimately, preventing the dangers of climate change and nuclear war in the long run requires an integrated set of strategies that address the causes as well as the impacts on the natural and social environment. New concepts of security could serve as building blocks for a more peaceful world, including *common security* (pursuing common responses to common threats), *ecological security* (preventing environmental problems from turning into security risks), *human security* (shielding and empowering people against acute threats) and *global security* (protection of the whole planet against common threats).[99] Satisfying human needs and harnessing human capabilities makes societies more resistant to climate change and allows them to implement low-carbon energy alternatives and conflict-resolution mechanisms. Both require the creation of institutions that ensure the benefits of cooperation via establishing and enforcing common rules and regulations. Reducing poverty and implementing human rights would significantly strengthen human security and build problem-solving capabilities. Less wealthy countries need development cooperation and international financial assistance, e.g., by effectively using micro-finance. North-South transitions towards a "Green New Deal"[100] would provide the framework for the financial and technology transfer required to build a low-carbon society that tackles the challenges of energy security, climate change and human development at the same time.

To face both nuclear risks and climate change, it is important to create sustainable lifecycles and livelihoods that respect the capabilities of the living world. It is crucial to evade the vicious cycle of unsustainable economic growth, unchecked accumulation of political power and escalation of violence that for too long have contributed to environmental destruction, underdevelopment and war. Instead of such a "climate of violence" strategies are required that support a "new climate for peace"[101] and build a "virtuous cycle" that transforms the current world disorder into a more peaceful, sustainable and viable world order.[102] To avoid conflicts related to the scarcity of natural resources, or at least reduce their destructive effects, a bundle of measures is required that is not limited to the traditional means of conflict management, such as military intervention, arms control, refugee support and disaster operations.

A world that is violent and unpeaceful is at the same time unsustainable und unjust, and vice versa. Strategies for preventing the causes of violent conflict integrate a set of measures, including the preservation and efficient use of natural resources, implementing principles of equity and justice, strengthening cooperation and changing lifestyles. Accordingly, concepts of peace that rely on avoiding dangerous conflict, on preventive arms control, the reduction of violence and the abolition of nuclear weapons, and on compliance with human rights and cooperation, will improve the conditions for the co-operative implementation of sustainable development. The inherent linkages need to be further developed in a mutually stimulating way to an integrated concept of sustainable peace.[103]

There will be no role for nuclear weapons in a peaceful and sustainable world. On the contrary: they prevent it because they are based on principles fundamentally violating the conditions for peace and sustainable development. The world should eliminate and prohibit these weapons that symbolise so badly the last century of violence. They belong to the past, not to the future.

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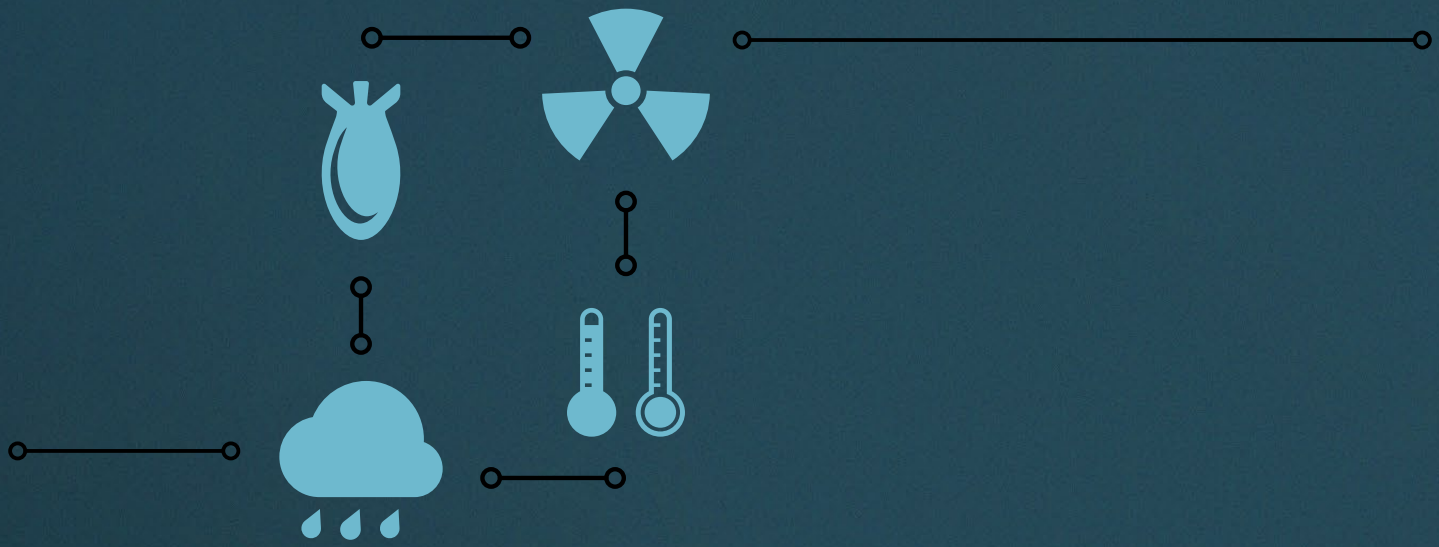

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