Extended abstract of the Technology for Life publication:

Antero Honkasalo, Environmental risks, circular economy and climate wars (2017).

We live in the world where population is growing, energy and material use per capita is increasing, easily exploitable natural resources are depleted and atmospheric commons are full of greenhouse gases. Ecosystems are fragmented and their ability to provide services to humans is weakened. Biodiversity is deteriorating. Due to climate change desertification is spreading and sea level rising. Usable land for agriculture and living space of different species is reducing. **The world is shrinking in concrete terms** (Korhonen et al. 2018). And even available time horizon to solve global environmental problems is shrinking dramatically, too. This process is leading to a head- collision and increasing risks of violent conflicts.

Armament consumes large amounts of capital, which could be used for the eradication of poverty and fight against climate change. Even in peacetime by equipping and training for war, the job of military directs resources away from other pressing problems. Institute of Economics & Peace (2017) estimates that economic impact of violence on global economy in 2016 was $14.3 trillion in purchasing power parity (PPP) terms. This figure represents 12,6 per cent of the world's economic activity (gross world product) or $1,953 for every person in the world. The average military expenditure for developed countries decreased by 25 per cent from 1987 to 2015, while developing countries have increased military spending by an average of 240 per cent, from US $2.13 billion in 1987 to US $7.25 billion in 2015. To put this in perspective, the economic impact of violence is approximately 11 times the size of global foreign direct investment.

It is evident that armament is a major factor for environmental problems. Rearmament and open wars affect the environment in many ways. First, they consume natural resources and require land. Manoeuvres and wars destroy both built and natural environment. Armies produce hazardous waste in the form of decommissioned arms, munitions and contaminated sites, too.

Nuclear, chemical and biological weapons are associated with the risk that they may fall into the wrong hands, or that an accident occurs in their treatment, that they are used by mistake. The risk of genocide caused by nuclear weapons has not disappeared, but it has changed its shape; the risk of an open nuclear war between the superpowers has diminished, but because of the fact, that number of states are in possession of nuclear weapons and politically unpredictable states such as Iran and North Korea are trying to acquire one, this adds the uncertainty of the management of security risks. The substantial levels of investment in nuclear weapons and nuclear weapons systems and their modernization in USA and Russia have also enhanced rather than decreased the likelihood of intentional or inadvertent detonation event. Human judgment has been key in identifying and resolving past instances of false alarms. Greater reliance on automated systems can lead to misplaced confidence while introducing new points of vulnerability (UNIDIR 2017).

The so-called dirty bombs with conventional explosive substance able to spread radioactivity to the environment by transporting and launching it into the centre of a big city, can cause hard to eliminate environmental hazards in addition to health hazards.

Environmental impacts of wars can occur a long time after, when the actual military operation is finished. For this reason, the environmental impact of arms race should be considered from the point of view of a life cycle approach. For example, mines can be found in terrain even years after their introduction.

Resource wars

The ownership of natural resources play at least some role in wars and military conflicts, if only in respect of the land area conquered. The uneven geographic distribution of resources (petroleum, metal ores, fertile soil, water) can be solved with trade, political pressure or open war. If trading is not possible, countries may even consider war as a solution. Accordingly, finite resources have caused wars conflicts throughout the history.

Supply of fossil fuels was an important factor behind both Iraq wars, and it still plays an important role in the strategic thinking of United States and other major powers such as China and Russia. A

vicious circle is created, where the armament eats precisely those resources that have been sourced it seeks to protect. The arms race is heavily technologically oriented and at the same time dependence on natural resources and especially of fossil fuels and rare metals will further increase.

Control of natural resources can lead to civil wars, which have tendencies to spread to neighbouring countries. Resource wars cause refugee flows and political problems, which can lead to violence in countries that receive these people. Resource wars even destroy entire states, which are left in chaos for years to come. They can also form areas for international terrorist organizations and mercenaries. Africa is a dramatic example, and especially Sudan and The Congo Republic.

In resource wars, the fighting parties are often guerrilla movements. For guerrillas, it is usually important to win the trust of residents of the area, but with the plundering of resources the situation is more complicated. The aim of operations can be that by terrorizing and intimidating the residents of the area its whole population is forced to move to another area to enable a full use of their natural resources.

In developing countries local people dig up natural resources in such areas by using very rudimentary technical tools. Occupational hazards are common, environmental damage high, earnings low and even forced labour is used. However, the ores produced by these poor people risking their lives will eventually end up in the end of a production chain in possession of multinational companies. These companies tend to be conscious of where the raw materials used come from. And even more so, they are involved in the conflicts in one way or other at least in the role of final buyer. Daly writes (2015):” Some think that strengthening global corporations by erasing national boundaries will reduce the likelihood of war. More likely we will just shift to feudal corporate wars in a post-national global commons, with corporate fiefdoms effectively buying national governments and their armies, supplemented by already existing private mercenaries.”

In worst cases, resource wars may lead, in addition to the takeover of natural resources, to destruction of civilian population. People are not only terrorized and driven away from their homelands as refugees but also killed in masses. The fewer the people, the more resources will

remain for those who remain. Relying on religious and national ideologies even when it is simply a question of land ownership and the right to use natural resources, political leaders have tried to legitimate and ask approval for ethnic cleansings.

Environmental Warfare

Environmental pollution and damage can be used as means of warfare. Concrete forms of environmental warfare include burning of forests, destruction of fields, breaking dams (flooding), attacks on nuclear power plants, oil wells or setting buildings on fire. Tactics of environmental warfare can be said to be indirect when the aim is to cause harm to the ability to wage war instead of decreasing direct fighting power of the enemy.

The United States used large-scale environmental warfare means in the Vietnam War by introducing plant toxins it sought to destroy forests and crop productivity. Operations expanded all the time during the war. In addition, along with destroying the guerrillas, large-scale bombing damaged the environment badly.

Above all, environmental destruction can focus on buildings and crops. This has been called a scorched earth tactic. It is a very old tradition. Retreating army destroys the basic infrastructure of the community, which could be useful to the enemy advance. This includes an extensive destruction of buildings, food supply, bridges, means of communication and related sectors of the society.

The essential question in terms of environmental warfare is how the environmental damage is considered among the population for approval. If the goal is to get the support of local people, the damage of the environment may be attacker’s disadvantage, even if it helps military operations. For example, civilian population can turn against the attacking army when the life conditions are destroyed and it starts to support guerrilla forces and joins its ranks. Environmental warfare did not help the United States to defeat the guerrilla resistance in Vietnam.

During the Vietnam War the environment was destroyed systematically without considering the side- effects. This kind of practice is no longer possible without the international opinion strongly

condemning the action. In society, where the defence is outsourced to professional military or security companies, people and media do not seem to allow the destruction of the environment in the same way as in societies based on a national army. Environmental crimes caused by mercenaries easily raise more public outcry (Peltola 2011).

The concept of environmental warfare is also used when describing human-induced destruction among other species and natural systems. This is a war no one has declared, but it is taking place all the time in order conquer living space. Other species must step aside to make way for humans. Biodiversity declines and species face extinction.

In addition to hunting, men have deliberately destroyed other species, which were considered a rival for the same living space, to be dangerous, or which had destroyed crops and food stocks. The animals have been shot, caught in irons and killed by toxins. The cruellest means of killing have been prohibited and endangered species have been protected.

Climate wars

Attempts have been made to predict future climate wars, and to show where crises may break out and whom they may affect. As a starting point, we can use the information of environmental wars that had already happened in the past. Similarly, we can study how climate change will affect already existing conflicts. Furthermore, we can also consider which countries and areas are particularly vulnerable to extreme weather phenomena, and where food security most easily breaks or where warming will cause deforestation. In the longer term, armed conflicts can also arise where people are forced to leave their homes when the water level rises. We can also try to predict how environmental policy could cause so severe conflicts that risk of war may increase.

Adaption

Especially in developing countries climate change will cause floods, droughts, storms and other extreme weather events. As the temperature rises, the living conditions of plants and animals are rapidly changing and that is also the case for a variety of pests and pathogens.

These changes can no longer be entirely prevented. They come in large scale and undermine the basic conditions of life, and thus raise prices of food and energy, and thus increase the risk of rising rate of violent political uprisings, large numbers of desperate migrants and emerging epidemics. These security risks interact with one another. Increased water stress also affect food insecurity, and extreme weather events put additional stress on areas facing sea level rise. While these kinds of interactions have always existed, they are likely to be intensified as a consequence of a changing climate (Mobjörk, et al. 2016).

Population growth will only worsen the situation. Particularly strong growth of population takes place in Africa. The poor leave countryside villages. They hope to have a better life in the cities. Part of them will be able to get a job and to rise out of poverty. Part will remain permanently in slums. In addition to the poor in the slums, a new middle class is growing. Middle-class consumption will rise to the same level as in developed countries and partly beyond it.

All this affects food production in the developing countries. In the past, poor people mainly produced their own food. Small farms still produce circa 30-40 per cent of world's food supply. When climate change is progressing and food production is becoming more difficult in villages, this only accelerates urbanization. However, in cities these people are even more vulnerable to food insecurity than in countryside.

Climate change may exist already in the background of many regional crises. In the Syrian War for instance, one of the underlying factors of the conflict might be the prevailing drought in the region, which drove poor people in distress. They could not produce enough food anymore. President's inability to tackle rural problems only aggravated the situation. Desertification in Darfur drove the Arab cattle owners to the areas of African farmers. In addition, population growth was rapid (Wenzel 2011).

However, statistical studies don't clearly support the argument that climate variability can be reason to armed conflicts. According Bauhaug (2010) African wars can be explained by widespread ethno- political tensions, poor national economy; and the collapse of the Cold War system.

Although these studies and arguments should be treated with caution, it is evident that the world's poor are in the most vulnerable situation. For them climate change strikes first, above all, in the form of food security collapse. And because they already often live in the extreme low limit of livelihood, their threshold to become refugees is the lowest. The 870 million people in the world who are chronically malnourished today have a baseline consumption of 1,750 calories or less per day. Even a 10% decline in their food consumption would put this entire group at risk (Helfand 2013).

The stability of governmental institutions influences countries' ability to adapt to climate change. In countries where governance is weak, climate change may lead to collapse of state and violent outbursts. In East-Africa, political institutions are found to be critical for understanding why some local resource conflicts turn violent while most do not (Mobjörk et al. 2016).

Mitigation

In addition to the actual climate change, climate policy itself can cause conflicts. The implementation of climate policy at international level may in future lead to such severe conflicts that they could be solved by military means. For example, if the industrialized countries conclude that the climate change has grown so strong that binding international goals and rules are necessary, and, however, developing countries do not agree to such terms and conditions, then it is possible that these countries would be forced to comply with the objectives by the threat of armed forces.

Climate scientists and environmental groups have argued that coal production should be quit and coal should be left in the ground. If this would be a necessary measure in international climate policy, this could lead to serious conflicts about how and for how long fossil fuels should be used. For many of the oil and coal producing countries this would be an economic disaster because of their social problems, incompetent political leaders and deep-rooted corruption. Russia, China and US have nuclear arms, which makes very difficult to force them to leave coal in the ground against their own political will.

In the future, fossil fuels may be left in the ground only due to market forces. Climate policy is designed to decrease carbon dioxide emissions to zero by 2050. Since carbon dioxide capture and storage technology development has been slow, most of the emission reductions must be achieved with renewable energy sources and improving energy efficiency.

The use of renewable energy must grow fast. At the same time, oil production capacity will still be so large that the oil supply far exceeds demand. This will result in a sharp drop in oil prices. It might lead to great economic problems and political unrest in countries that are economically dependent on oil exports, if they are not able to diversify the production structure in time. The development of solar energy and its lowering prices can still hasten the collapse of oil prices.

The abandonment of coal and oil will anyway have a major impact on international relations and the economy. The balance of power will inevitably change. Tensions caused by these changes, and the risk of conflicts should be anticipated in time not only in oil producing countries, but also at an international level.

Climate modification

Serious conflicts could also initiate from the artificial modification of the atmosphere, that is by geo- engineering. This can be done for example, by spraying enough sulphur dioxide into the atmosphere, that it can cool down the atmosphere near the surface of earth. The climate model calculations show that at sufficiently high levels of particulate matter the cooling effect would at least in principle eliminate mankind's greenhouse gas warming effect. However, these studies have shown that geo- engineering technologies may also have serious harmful side effects such as disruption of the monsoon circulation, which would threaten food production of billions of people (Hamilton 2013).

Fossil industry sees that geo- engineering gives them an opportunity to continue to use fossil fuels, even if the concentration of carbon dioxide in the atmosphere is growing. These industries argue that in this way they have time to develop cheaper and more efficient techniques to reduce emissions and save energy. When these techniques have evolved far enough, geo-engineering can be reduced. However, scientists have already warned of the risks that may result when once

started modification of climate is terminated. The results can include sudden and unpredictable changes in weather patterns (Hamilton 2013).

In the light of current slow progress in the international climate policy the future use of geo-engineering methods cannot be completely ruled out. Then, who gets to decide when and how to carry out climate modification? The effects of climate change vary in different countries and in different sectors of economies and industries. Thus, the temptation to apply geo-engineering methods could vary, too.

Can United Nations be able to ever take the necessary decision or would instead some superpower take unilateral action ignoring other nations? The use of sulphur dioxide is not even expensive; many countries can afford the use of this method of modification. Some political leaders may even think that it would not be sensible to freeze the climate, but to allow the growth of carbon dioxide, because it stimulates the production of biomass.

Geo-engineering techniques can also be used, at least in principle, for military purposes. Enemy territory could be targeted for such a long period that continuous rains would destroy harvests and cause flooding. Similarly, by destroying the cloud cover it would be possible to produce such lengthy droughts that they would erase vegetation from large areas of land. Ash and artificial clouds could, in turn, provide means to produce long cold periods. However, changing climate as a method of warfare is problematic, because the limitation of the effects to the desired purpose is difficult.

Nuclear winter

A nuclear war can cause climate change, too. This phenomenon is called nuclear winter; temperature decreases all over the globe and food production is in danger. The temperature would drop abruptly at the earth's surface, and soot and dust would remain in the heights for years. The impact would be so fierce and sudden that it could endanger the whole of mankind, several species and natural systems. Researchers with the International Physicians for the Prevention of Nuclear War (Helfand 2013) have assessed that a nuclear exchange between India and Pakistan

involving 100 weapons would cause climate disruption putting up to two billion people around the world at risk of starvation. Within nations where famine is widespread, there would almost certainly be food riots, and competition for limited food resources might well exacerbate ethnic and regional animosities. Among nations, armed conflict would be a very real possibility as states dependent on imports attempted to maintain access to food supplies. It is impossible to estimate the additional global death toll from disease and further warfare that limited regional nuclear war might cause, but given the worldwide scope of climate effects, deaths from these causes might well amount to hundreds of millions (Helfand 2013).

These models carry many assumptions and preconditions; however, they show that nuclear winter can be a huge threat to humankind. They also show that the impacts of a limited nuclear war can reach the whole globe and its population.

Conclusions

Climate change increases the risk of war in many ways, is it a question of adaptation, climate change mitigation or modification. However, the causes are different. Adaption weakens the living conditions and food security that will lead to flows of refugees. Mitigation measures will create political conflicts, because some countries will win and others lose. The same will happen if climate modifications take place. In all cases, the problems first hit the world's poor.

It is obvious that the shrinking world increases the risks of resource wars. This underlines the importance of energy and material self-sufficiency. It helps countries to prepare for the risks caused by the uncertainties of the world economy and thus prevents conflicts. In the global markets, self-sufficiency is not considered as a positive value, and it can be seen easily as a form of protectionism. However, self-sufficiency of a country does not necessarily mean, that it is turning inward and giving up on international cooperation. Rather, it puts nations as equal partners in co-operation, as they are no longer so dependent on the global resource market, or at least better hedged against various types of crises.

Globally, it is important for industrial countries to significantly reduce their own energy and materials use, as consumption in developing countries must rise to eradicate poverty, and to secure basic conditions of life for their people and give them opportunities for development.

Developing countries need self-sufficiency above all in energy and food production, but because of the low entry level, also new material investments to infrastructure and industry are necessary.

In today's environmental policy the security issues related to natural resources and climate change receive only a little attention. In security policy, the environmental issues and climate change have been taken seriously. The focus has been on how crisis management can prepare for these new threats and not so much in the mitigation of climate change. Militaries make scenarios of how climate change will cause political unrest and armed conflicts and large migratory flows, but then these are seen primarily from the military strategies point of view.

These military based strategies have been criticized with the fact that their purpose is only to protect Western countries from the violent effects of climate change by transforming them to a fortress, which climate refugees cannot reach or to a rescue boat, which will be accessible only to those with money and influence. The conflicts and insecurities, state breakdowns, which are expected to occur, are at the same time managed mainly by military means so that harmful effects are limited inside developing countries. The first sign of this can already be seen in president Trump's America First policy. After the Syrian war, also some EU- countries have already started to build walls at their borders to prevent refugees from entering their territory.

In our society, risk management is a common meta-theory for many sectors of the society. The concept of risk is central for both environmental and security policies. However, both policies are mainly interested in only their own risk issues. Risk communication between sectors is difficult, because both sectors have their own concepts, codes and practices. It can also be that the concept of risk is too abstract to fulfil a converging and unifying task.

Environmental protection is based on natural science and technology. Control of emissions and establishment of natural protection areas have been the main way of reducing the risks. Into this frame wars and arm race are fitting poorly, even though the environmental protection creates an intense political controversy. These are something secondary, which hinders to see real scientific facts.

Nicholas Georgescu- Roegen (1975) started his thesis of bioeconomics by writing: " *First,* the production of all instruments of war, *not only of war itself,* should be prohibited completely. "
The Bruntland Committee's report "Our Common Future" (1987) dealt with disarmament as part of sustainable development. It saw the proliferation of weapons environmentally dangerous and as a destructive waste of resources. Now this view should be raised back to the sustainable development policy arena. To elevate the political debate of the links between the exploitation of natural resources, environmental damage caused and the proliferation of weapons is a challenge both to the environmental and peace movements and scientific community.

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