AGILE INITIATIVE

OXFORD MARTIN SCHOOL

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EVIDENCE SYNTHESIS REPORT

Weaponisation of Nature

Environment and National Security: Exploring the Risk Pathways

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About

This document is one of a series of reports from the Agile Initiative's Environment and National Security: Exploring the Risk Pathways project. The Evidence Synthesis Reports provide the detailed evidence underpinning the shorter Priority Policy Questions: Summary of Key Findings reports.

The project also produced a Forward-looking Research Agenda containing an overview of the whole project, a conceptual framework illustrating the links between environment and security, a summary of the current UK government policy position, a research agenda listing almost 200 evidence gaps, analysis of potential interventions, and guidance on how to communicate the key issues effectively based on insights from behavioural science.

The Evidence Synthesis Report Series

- The role of critical natural infrastructure in supporting national security
- Managing demand: energy security, food security and UK national security
- Climate risks and opportunities for shipping and UK maritime trade
- Weaponisation of nature
- Societal resilience and mental capital

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Summary

This report aims to address the following policy questions:

Q1

How can nature and weather be weaponised in current conflicts, including subthreshold and conventional warfare, and what insights can be drawn from the US/Israel-Iran, Ukraine/Russia, Gaza and Sudan conflicts?

Q2

What indicators exist that might warn that states and non-state groups are taking steps to weaponise either nature or weather?

Q3

What are the environmental impacts and critical national infrastructure interdependencies that affect our ability to protect the UK from attempts to weaponise nature and weather?

> The weaponisation of nature is the *intentional use, manipulation, targeting, and destruction of environmental systems and natural resources in armed conflict and hybrid warfare by both state and non-state actors*. It is also called environmental warfare and ecological warfare.

The laws of war **give the natural environment civilian status**[1]. Nature cannot be the *deliberate* object of attack. But it is, and always has been, by state forces and armed groups.

This review of over 100 selected documents finds that **the weaponisation of nature is increasing in frequency, intensity and global impact** in the twenty first century. This creates **a new level of planetary vulnerability with significant implications for UK security** and gives the UK vital earth interests alongside traditional national interests.

The weaponisation of nature in the era of climate change and global trade means that **one country's environmental war is another country's food shortage, energy crisis, migration emergency, and biodiversity extinction risk**. Environmental warfare anywhere today can produce a cascading effect of severe and enduring **all-life disaster** for humans and nature far away from the epicentre of the conflict as international trade and global biodiversity are damaged. These **cascading risks** from the weaponisation of nature around the world centre the Earth in UK security policy and make attacks on or through nature geostrategic and geoeconomic for the UK, whether they are conducted by the UK's adversaries or allies.

Nature can be weaponised **topographically, biologically and atmospherically** in various ways. Nature is sometimes **a direct target** of destruction as in scorched earth strategies or water poisoning. At other times it works more as **a vector** which exposes people to extreme conditions as in weather warfare, deliberate flooding, insect infestation, or the manipulation of maritime chokepoints. Weaponising fire sees nature both a vector and a target of destruction. Nature can also be used as an **obstacle** to deter or expose an adversary and protect territories.

The study reviews **different historical types of nature weaponisation**, including scorched earth, water weaponisation, deforestation, weather warfare, and nature-based war economies. It also looks ahead at **emerging forms of the weaponisation of nature** in geoengineering, bioengineering, and hybrid warfare strategies of sabotage that exploit new climate-related opportunism in heatwaves, floods, and droughts. One state's environmental policy can also be weaponised against another in "polfare" and "lawfare" of various kinds.



The weaponisation of nature has **three different levels of impact** by having significant effects **on nature itself, on human society, and on Earth systems**. These impacts take different forms of severity depending on how widely weaponisation impacts all life, and how deeply and permanently it damages Earth systems tipping points. Calculating the cost of damage to nature is a difficult and nascent science. But repairing the destruction or degradation of nature locally and regionally can cost billions of GBP. Restoring ecosystems can take decades, and damage can be irreversible.

UK foreign and defence policy must work hard to ensure that the scale of the challenge is recognised and reduced in international military policy, international environmental policy, international law, and global counterterrorism efforts. The Environmental Modification Convention (ENMOD) treaty needs reawakening and new laws of ecocide and crimes against the Earth need urgent consideration. UK public diplomacy must raise awareness of the risks and make the worst excesses of the weaponisation of nature a global taboo.

At home the **weaponisation of nature in hybrid warfare is a significant risk** from state-directed saboteurs or disposable agents who can easily be recruited online to start serial fires or poison water supplies during new climate-related opportunities like heatwaves and droughts. UK water, wind and energy systems are also susceptible to digital and manual sabotage. Whole society preparedness and vigilance is essential to support UK security services, alongside a hardening of water, wind, air, and fire security.

The report makes four main recommendations to the UK government:

1. **Clarify key concepts** and a topline policy across government and society on risks from the weaponisation of nature.
2. **Adopt a new strategic posture** to "protect and prepare" that is an all-of-government and whole-of-society and nature-positive approach.
3. **Ensure the resilience** of the UK's vital supply chain that maximises strategic optionality.
4. **Use UK diplomacy** to cultivate new international norms and law around the weaponisation of nature.

Definitions and conceptual framework

Nature has been intentionally weaponised as a method of war for thousands of years. Using nature is central to Sun Tzu's fifth century BCE classic of military strategy, *The Art of War*. Metaphorically, nature is Sun Tzu's ideal for an army which should attack like water, strike like a hawk, and manoeuvre as swiftly as the wind. Practically, he recommends the strategic use of ground; the deployment of trees, reeds, rivers and sun for entrapment and cover, and "raising fires" to burn people, stores, equipment and arsenals[2].

China's ancient written and archaeological record from neolithic warfare onwards shows how the country's great river systems were routinely weaponised in attack by diverting rivers into besieged cities, and unleashing dams upon enemy positions, and in defence as moats and ditches. Trees, stones, earth, water, minerals and animals have forever been transformed into military infrastructure and used for military logistics[3].

Despite the deep history, there is no clear or universally accepted definition or typology of nature weaponisation (also sometimes referred to as environmental warfare[4]). Falk provides a good general description of the hostile use of nature: "all those weapons and tactics which either intend to destroy the environment per se or disrupt normal relationships between humans and nature on a sustained basis," [5]. This includes nature in all its forms - the potential weaponisation of all life, landscapes, and weather[4] and hydrocarbons and minerals[6].

Here we define the weaponisation of nature as the ***intentional use, manipulation, targeting, and destruction of environmental systems and natural resources in armed conflict and hybrid warfare by both state and non-state actors***.

Hybrid warfare and hybrid threats also lack a single widely accepted definition[7]. NATO's definition is *the coordinated use of military and non-military, covert and overt tools, including disinformation, cyberattacks, economic pressure, irregular armed groups, and regular forces, to blur the boundary between war and peace and undermine public confidence in targeted societies*[8].

The weaponisation of nature can be deployed in peacetime and during active conflict **coercively**, **offensively, defensively or incidentally**[9,10]. And it can be applied **topographically** by using natural landscapes; **biologically** by weaponising or destroying different forms of life; or **atmospherically** by leveraging pollution and extreme weather, or geoengineering climate and weather conditions. It can also weaponise nature-based **critical national infrastructure** designed to ensure human survival, such as dams, wind farms, and desalination plants[11].

The weaponisation of nature can be applied directly with **nature as a target** for destruction in attacks on nature, or by using **nature as a vector,** such as destroying cooling and heating systems to expose humans to increasingly severe weather conditions, or by infiltrating serious diseases and pests[12].

Intent is usefully nuanced in three main ways:

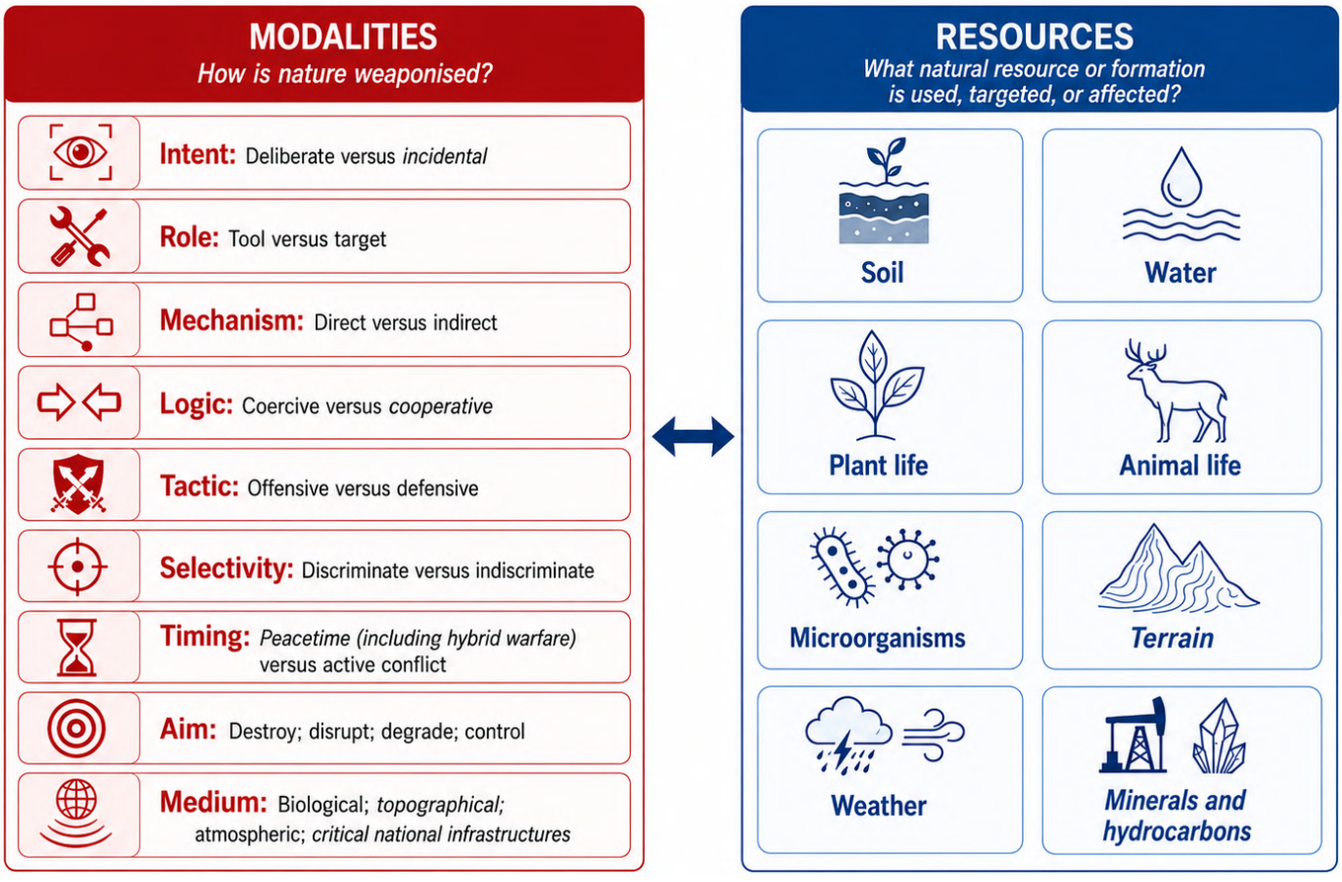
1. Weaponisation may intend **to deliberately harm nature** as the primary target.

2. Weaponisation may use natural systems but leave nature militarily unharmed by **intentionally leveraging natural forces and nature-based infrastructures to inflict harm on or impose control over combatants or civilians**[4,9,12].

3. **Environmental harm may be incidental or collateral but not intentional to military activity**[10,13]. Nature is then framed as the "silent casualty" of armed conflict - an innocent victim sadly "caught up" in warfare like non-participating civilians[14,15].

Existing international law, especially international humanitarian law (IHL), governs the methods and means of environmental warfare and aims to protect aspects of the environment from deliberate attack, subject to applicable rules on military necessity[1].

Conceptual framework: Nature weaponisation in conflict



Italics denote dimensions whose inclusion, in whole or in part, within a conceptual framework of the weaponisation of nature remains analytically unsettled in literature.

Different types of nature weaponisation

Q1

How can nature and weather be weaponised in current conflicts, including subthreshold and conventional warfare, and what insights can be drawn from the US/Israel-Iran, Ukraine/ Russia, Gaza and Sudan conflicts?

Summary

- A rich body of historical and contemporary scholarship examines nature weaponisation as an enduring method in both international and non-international armed conflicts.
- This multidisciplinary literature documents the deployment of scorched earth tactics, water weaponisation, deforestation, weaponisation of topography, weather modification, bioweapons, and natural resource mobilisation.
- Current conflicts, including the Russo-Ukrainian war, the Israel-Gaza war, the Sudanese civil war, and the US/Israel-Iran war, show belligerents conducting and combining several methods of nature weaponisation.

Military doctrine has always recognised the weaponisation of nature as a method of war. The historical record of European, American, African and Asian warfare shows a pattern of intentional weaponisation and deliberate degrading of nature by government forces and armed groups[16]. Modern technology from the 20th century onward has amplified the impact of nature weaponisation to unprecedented levels.

This section builds a partial framework for the weaponisation of nature from available literature.

Scorched earth

An enduring form of environmental warfare is the use of scorched earth strategies[16]. This is the deliberate destruction of nature to deny its use to opponents and render territory uninhabitable. Tactics include burning agricultural land, deforestation, poisoning water, destroying irrigation, and the targeted massacres and forced displacement of humans and animals.

Examples include ISIS campaigns in Iraq and Syria to raze agricultural fields and create extensive soil degradation[17] and military campaigns in Myanmar where similar tactics led to forced displacement and ethnic cleansing[18]. Israeli operations in Gaza reportedly destroyed around 40 per cent of northern Gaza's farmland by March 2024[19], with water contamination and ecological degradation compounding public health crises[20].

The effects of scorched earth strategies are long lasting and typically create permanent social and environmental change, often ruining hotspots of ecological diversity and agriculturally productive regions.

Weaponisation of water

The weaponisation of water is the most extensively researched form of nature weaponisation, particularly in analysis of 21st century conflict[9,10,21–24]. This involves the strategic manipulation of water systems, infrastructure capture, and using hydrological conditions as instruments of coercion, territorial control, and military advantage[23,25]. It includes the intentional contamination of water sources, the capture or destruction of dams, reservoirs and desalination plants, intentional flooding, and the exploitation of maritime chokepoints and hydrological terrain. Of note, the inclusion of nature-related critical infrastructure (e.g., dams) within frameworks of nature weaponisation and/ or environmental warfare remains contested, with the ICRC, for instance, legally distinguishing the man-made elements of such infrastructure from the natural environment[1].

Recent examples of water weaponisation include contamination of the Persian Gulf from Iraqi oil spills during the Gulf War[26], the contamination of wells in Darfur[14], ISIS's seizure of dams during the Syrian civil war[10,27], and the destruction of the Kakhovka Dam during the Russo–Ukrainian war[28]. Many studies focus on non-state armed groups, particularly ISIS, and emerging forms of "hydro-insurgency"[24]. More recently, Iranian threats against Gulf desalination infrastructure illustrate water's growing strategic significance in war[29,30].

The key insight is that water weaponisation generates cascading effects far beyond hydrological systems because water underpins agriculture, energy, sanitation, and public health. Greenbaum and King[29] have demonstrated how, in Iran today, the weaponisation of water can rapidly evolve into a broader crisis of national resilience as water vulnerabilities threaten thermal power generation and domestic food production.

Weaponisation of Water Infrastructure in the Russo-Ukrainian War (2022-Present)

Russia's intentional destruction of the Nova Kakhovka Dam on 6 June 2023 shows how water weaponisation can use critical infrastructure to produce effects far beyond the battlefield and the conflict's duration. Floodwaters submerged hundreds of square kilometres and extensive reservoir and wetland ecosystems dried out[31]. The attack is widely viewed as a war crime and potential ecocide under Ukrainian domestic law[32].

Militarily, the flooding aimed to disrupt Ukrainian transportation routes, alter battlefield geography, and complicate operations in southern Ukraine[24]. It formed part of a wider pattern of Russian attacks on environmental and civilian systems, including fuel depots, water networks, forests, and energy infrastructure[32,33].

The impacts were severe: flooding polluted the Dnipro River with oil, waste, and landmines, killed tens of thousands of animals, and left 1.25 million people without reliable safe drinking water[33]. It also caused long-term damage and threatened global food security by leaving over 1.4 million acres/ 5650 km^2 of farmland without irrigation[34,35]. Earlier in the war, Ukraine weaponised water defensively, releasing water from Dnipro dams to flood areas near Kyiv and slow the Russian advance[28].

Deforestation

Weaponising deforestation is also well studied[36]. The classic case is US defoliation and deforestation in Vietnam that combined mechanical forest clearance, napalm and the herbicidal defoliant Agent Orange, to deny vegetation cover to the Viet Cong. Systematic environmental warfare, and the legal movement against it, emerged from Vietnam.

Forests and trees with significant cultural, economic, and symbolic value are targeted in many settings as part of a strategy of territorial control, economic deprivation, humiliation and cultural erasure[37]. Israeli settlers consistently destroy olive groves in Palestine (Ibid.). Turkish forces used intentional forest fires during the Turkey–PKK conflict to similar effect[38–40].

Deforestation and Defoliation as Counterinsurgency in the Vietnam War (1955–1975)

The Vietnam War marked a turning point in the relationship between environment and warfare. Forest and mangrove ecosystems central to civilian livelihoods[41,42] were deliberately and systematically destroyed by herbicides, napalm, and land-clearing as part of the US counterinsurgency strategy[43,44], exposing the long-term ecological and human consequences of weaponising nature. This spurred international debate on "environmental modification" in armed conflict, culminating in the Environmental Modification Convention (ENMOD) in 1976[36].

Operation Ranch Hand drenched nearly a tenth of South Vietnam's land with 20 million litres of herbicide, including Agent Orange, on the military logic that defoliation improved visibility and limited enemy forces' ability to hide, resupply, and attack[36,42]. US forces also used bulldozers and napalm fires to destroy a further 86,500 acres/ 3,500 km^2 of forest[45]. A third of South Vietnam's mangrove forest was destroyed, causing lasting damage to coastal ecosystems, livelihoods, and human health.



Weaponising terrain and water routes

The securitisation of terrain and waterways is often seen as militarily necessary in conventional warfare rather than the egregious weaponisation of nature. Land, air, water and now outer space are all "domains of war" and it is difficult to decide when the environment is a passive setting of conflict or an actively weaponised feature of warfare[13]. Terrain is not merely the backdrop to conflict but a dynamic and operational instrument through which movement, circulation, visibility, and access is controlled[46,47].

Using natural physical and environmental conditions is common to insurgent and counterinsurgent warfare. Guerrilla fighters in Korengal Valley in Afghanistan, for example, exploited mountainous terrain as a defensive and tactical asset to undermine US military superiority[47]. The long history of tunnel warfare, maximised in Hamas' tunnel networks in Gaza, is described as "technologies of occlusion" which exploit the material properties of the earth to evade Israeli surveillance and military control[48]. Today's maritime chokepoints show how straits, shipping corridors, and coastal geography can be operationalised as strategic bottlenecks in geopolitical and geoeconomic conflict[49,50].

Terrain can also be deliberately engineered into an obstacle through defensive rewilding[51]. The reinforcement of existing natural barriers, such as wetlands and forests, can deter an adversary or create a killing zone by trapping or otherwise obstructing infantry, armoured vehicles and logistical transports. Military units crossing boggy ground, for example, lose their momentum and situational awareness. The defensive rewilding approach informs the construction of the Baltic Defence Line, in parts of Estonia, Latvia and Lithuania, and Poland's East Shield[52–54]. Both projects combine military fortifications with the enhancement and restoration of natural terrain, such as marshes and peatlands. They recast landscape as a first line of defence against Russia and as such raise the prospect of weaponising nature. Nevertheless, the projects also serve a dual purpose in that they restore nature, trap carbon, enhance biodiversity, and retain water[51].

Environmental Warfare and Militarised Topography in the US-Israel War with Iran (2026-Present)

The ongoing US-Israel war with Iran shows Iran's deliberate weaponisation of the Strait of Hormuz as a geostrategic natural formation with clear economic leverage[49,55,56]. One of the world's most critical maritime chokepoints, the strait is deeply embedded in global energy trade, petrochemical production, food security, and high-technology manufacturing. Prior to the hostilities, it facilitated the transit of one-third of globally traded seaborne oil and artificial fertilizers[49,57].

Following US and Israeli strikes on Iran in February 2026, Tehran took effective control of the strait, severely disrupting global energy markets, supply chains, and food systems[49,56]. Its narrow geography and proximity to Iranian coastlines made its weaponisation militarily simple through mines, drones and missiles[58] in what has been referred to as a "soft" or "hybrid" blockade[57]. The conflict has demonstrated how coastlines and narrow straits can become extensions of military infrastructure, transforming physical geography into a weapon of war.

The full environmental impacts are yet to emerge[56], but chokepoint disruptions heighten risks of collisions, oil spills, and ecological damage in congested waterways[59], while prolonged rerouting increases fuel consumption and emissions and disrupts global food and energy systems[49,60].

Weaponising weather



In the Vietnam War, the US Operation Popeye experimented with cloud seeding to extend the monsoon over the Ho Chi Minh Trail and render supply roads impassable[61,62]. The 1976 ENMOD Convention saw states respond to this new threat with international law, but it is a "sleeping treaty" today[63].

The weaponisation of weather is moving fast from a speculative military experiment to a persistent strategic reality as geoengineering gathers pace. The dual-use nature of weather technologies brings complication and added vulnerability. Important civilian applications of weather technology, like drought early warning and relief, can easily be adapted for military purposes[64,65]. Weather radar stations can also be used for military purposes, such as surveillance and communication. National deployment of weather technology in peacetime can be perceived as environmental aggression with transboundary implications, as in China's use of military-grade drones for cloud seeding[66,67] and Iran's accusations that Turkey was "stealing rain clouds"[64].

The ambiguity of weather technology makes claims of "weather warfare" a slippery subject in national and global security[5,63].

Biological and chemical weapons

Biological and chemical weapons are not typically examined as a discrete subfield of environmental warfare. Instead, they are discussed in relation to environmental terrorism and/ or the weaponisation of water. However, they fall under nature weaponisation when such weapons are used to disperse toxins through soil, water, or other natural environments, or to deliberately generate atmospheric pollution[4,22]. They include (1) microorganisms such as bacteria, viruses and parasites, (2) inorganic and organic chemicals, (3) biotoxins, and (4) radiological contaminants[22]. These weapons can be deployed to harm human life and nature, with the stereotypical scenario involving the contamination of domestic water systems by chemical or biological agents. Related neuroscientific technologies can be weaponised to disrupt the physiology, cognition, emotion, behaviour, and motor function of humans[68].

Mobilizing nature as funding and logistics

Nature has always been mobilised as animal labour, equipment and funding in support of war. Research on "conflict resources" shows how timber/ charcoal, minerals, narcotics, wildlife products, water, and other natural assets are used to finance armed groups and states[6,10,69]. The Taliban manipulated irrigation systems along Afghanistan's Helmand River for opium cultivation and to coerce communities[27]. In Colombia, coca cultivation is linked to deforestation, paramilitary violence, and the expansion of extractive agricultural economies[70,71]. The US-led "war on drugs" responded with extensive aerial fumigation campaigns targeting coca plantations[72].

Debates around classification persist regarding to what extent the mobilisation of natural resources to fund or facilitate hostilities, including the extraction of hydrocarbons, critical minerals, agricultural produce, and wildlife products, constitutes nature weaponisation[6].

Gold as a Conflict Mineral in the Sudanese Civil War (2023–Present)

After South Sudan's independence in 2011 stripped Sudan of major oil revenue, gold became newly strategic[73] and fought over by rival armed factions to finance military operations and consolidate territorial control[74,75].

Arms procurement networks transform Sudanese gold from natural resource into geopolitical instrument of war. Since 2023, gold mining, smuggling, and trade have allowed both the Rapid Support Forces (RSF) and Sudanese Armed Forces (SAF) to acquire support and supplies from international sponsors[76], with the RSF using gold to finance its autonomous military-political order and violent expansion across Sudan[77,78]. Most gold is smuggled through Chad, Libya, Egypt and the UAE and a network of artisanal mining pits in Darfur and Kordofan[76,77,79].

The environmental and human consequences are severe and systemic. Wartime artisanal mining in Sudan uses mercury and cyanide, contaminating farmland, groundwater, and the Nile[80], while miners work in dangerously unregulated conditions[73].

Nature weaponisation: emerging trends and indicators

Q3

What indicators exist that might warn that states and non-state groups are taking steps to weaponise either nature or weather?

Summary

- Nature is **weaponised more frequently in the 21st century** because states and a growing number of non-state armed groups and proxy agents can inflict extensive damage to, and through, nature.
- There is speculatory evidence on the potential weaponisation of nature in hybrid warfare. In particular, **new forms of nature weaponisation** may emerge through dual-use technological innovations in geoengineering, artificial intelligence (AI), and biotechnology.
- Despite the evident increase in frequency, agency and innovation, **early warning systems and indicators of nature weaponisation are sparse and unsystematic**.

Emerging trends

Nature is being weaponised more frequently in the 21st century by states, armed groups and proxy agents who can all inflict extensive damage to and through nature[4,11,81].

Deliberate targeting of nature-based critical national infrastructure is on the rise[11,28]. Sowers and Weinthal[82], drawing on the work of Martha Mundy, show that the Saudi-led coalition in Yemen shifted from military to agricultural infrastructure. Nugee[83], Nuttall[84] and Gleick et al.[28] discuss Russia's targeting of Ukrainian power plants, dams and the Nord Stream pipeline as more recent examples. In particular, targeting water infrastructure is becoming "an acceptable tactic" in warfare due to low legal accountability[85].

The weaponisation of nature is increasingly deployed through supply chains, trade chokepoints and interdependence rather than direct attack. Verschuur et al.[86] find that armed conflict and terrorism tend to cluster at particular natural chokepoints like the Lombok Strait, the Bosporus Straits and the Bab el-Mandeb Strait. Conflict at a distant chokepoint can reverberate through global systems and affect faraway territories, as with the economic disruptions in the Strait of Hormuz[60]. Garner[87] argues that Western environmental regulations that offshored rare earth processing to China risk a midstream manufacturing bottleneck for frontier technologies.

Emerging evidence suggests that innovations in geoengineering, biotechnology and AI could be adapted to weaponise nature at scale and across borders because lower barriers to entry may embolden a more diverse range of adversaries[68,88,89].

New nature-based security risks are becoming clear. **Negative emissions technologies** may expose carbon reservoirs to sabotage or coercion and enable ecological, political and social destabilisation[90]. **Solar geoengineering** could turn infrastructure and control systems into strategic targets to disrupt climate and ecosystems and provoke counter-geoengineering scenarios (Ibid.). **Advances in biotechnology**, including gene editing and modified microorganisms, may enable targeted forms of harm in both conventional conflict and hybrid warfare[68].

The extent to which these **dual-use techniques** may be deployed in future armed conflicts is not yet clear, and new technology is seldom a sufficient condition for kinetic escalation[91]. But the dual-use quality of these nature-based technologies makes it easier to flip from peacetime geoengineering to the weaponisation of nature as a form of hybrid warfare. Because hybrid warfare and covert sabotage are defined less by absolute secrecy than by operational ambiguity and non-acknowledgement, civilian environmental modification techniques can readily serve hybrid purposes by **disguising hostile use as peaceful**[7,92]. Deniability may not deter reciprocal escalation, however[93]. Bathe[94], for instance, calls for the creation of an intergovernmental weather warfare cell within India's Ministry of Defence, citing the security risks posed by China's extensive civilian use of cloud seeding and, to a lesser extent, similar developments in Pakistan.

Indicators

Despite the increase in frequency, actors and new forms of weaponisation, **early warning indicators and signal systems are few and unsystematic.** Data collection challenges during active conflict hinder the documentation of environmental war crimes, complicating the assessment of nature weaponisation, the attribution of harm to specific belligerents, and the construction of early warning systems grounded in such data[95,96]. Public monitoring of environmental harms during active conflict may also furnish valuable intelligence to adversaries[84]. There is marked primacy of in-conflict and post-conflict analysis over pre-conflict vigilance and preparedness.

UK security doctrine on nature weaponisation is difficult to observe, as it is in other states. Many armed forces and security establishments recognise environmental systems as strategically significant operational domains, particularly in the context of climate-related instability, infrastructure vulnerability and resource security[97–99]. Climate change is doctrinally entrenched as a "threat multiplier"[100,101], but the concept does not publicly extend to the deliberate weaponisation of nature. Much operational doctrine, strategic planning and technical capability associated with environmental warfare remains classified or otherwise inaccessible to researchers; wargaming on geoengineering, for instance, is being conducted confidentially[88].

Public discussion of environmental modification techniques for military purposes has historically been treated as controversial or taboo. Weather modification, herbicidal warfare, the use of napalm, and attacks on hydrological infrastructure such as dams have fallen within this zone of public contention or reticence[102]. This has held back development of open-source scholarship on the subject, leaving existing analyses to rely heavily on fragmented or historical military disclosures, think tank reports, investigative journalism and conflict-specific documentation rather than on systematic doctrinal material.

Forward looking anticipatory tooling is emerging. The EU has developed the Dynamic Conflict Risk Model and the Global Conflict Risk Index[103]. Analysts recommend integrated resilience signalling, including AI-based multi-hazard early warning systems that take account of climate change indicators, investment in geothermal energy, rare-earth dependence, the stockpiling and innovation of domestic and allied critical minerals processing, and strengthened regional environmental cooperation over transboundary basins[83,87,104,105].

Environmental impacts and critical national infrastructure interdependencies

Q3

What are the environmental impacts and critical national infrastructure interdependencies that affect our ability to protect the UK from attempts to weaponise nature and weather?

Summary

- Weaponisation of nature today can produce transboundary, cascading and sometimes irreversible damage across three levels: nature itself, human society, and earth systems.
- The most severe cases may spread widely and deeply enough around the world to increase the risk of irreversible Earth-system tipping-points. Less extreme cases may still require billions of GBP in restoration costs and decades of nature recovery.
- These impact risks are increased by the escalating ecological stress in many Earth systems and by the growing interdependence of global trade.
- The scale, duration, and reversibility of the impacts of nature weaponisation are difficult to establish. It can be difficult to disentangle the magnitude, timing, and interaction of climate-driven hazards from deliberate environmental harm.
- The UK's planetary vulnerability means environmental damage in one place can quickly become food insecurity, energy disruption, environmental change, migration pressure, and biodiversity loss in the UK and its strategic geography.



Understanding the impacts of the weaponisation of nature

Weaponising nature has significant impacts on nature itself, on human society, and on Earth systems. These three areas of impact differ in the severity of their breadth and depth depending on how widely weaponisation impacts all life. Some impact may be **narrow and shallow** where weaponising nature can be locally contained and eventually repaired. Other impacts may be **wide and deep** by creating permanent damage to the Earth as we need it. Such damage is planetary and effects deep change in Earth system tipping points which are beyond repair.

This section presents a causal pathway diagram to start pulling together the variety of possible impacts of nature weaponisation and their downstream consequences for UK national security. We then look at the legal debate that calibrates the extent of intentional damage with the proposal for a new crime of ecocide.

Several studies have begun to categorize and catalogue **the impact of war on nature**[106,107]. These show some of the major pathways through which war damages the environment by targeting nature or strategically using nature.

- **War causes direct physical destruction** of ecosystems from bombing, artillery, troop movements, fortifications, deforestation, fires, and destruction of agricultural land. This kills life across many species, fragments habitats, reduces biodiversity, and weakens ecosystem recovery.
- **War produces long lasting pollution**. Munitions, explosives, mines, heavy metals, fuels, lubricants, destroyed industrial sites, and damaged and abandoned military equipment contaminate soil, air, rivers, wetlands, and groundwater.
- **War damages water systems** (including treatment plants and pipelines) and explosions release untreated sewage, industrial waste, pathogens, and hazardous chemicals into rivers, lakes and seas.
- **War increases greenhouse gas emissions** and worsens climate change. Military activity accounts for around 5.5% of global greenhouse gas emissions which increases in active hostilities.
- **War harms protected areas and biodiversity hotspots**. Some 20% of Ukraine's protected areas have been negatively affected by the ongoing war, including Ramsar and Emerald Network sites.
- **War distracts government from conservation and increases resource competition** between humans and nature leading to increases in deforestation of 34% and soil erosion by 23%. Human displacement reduces indigenous knowledge and conservation skills.

The weaponisation of nature **destroys and degrades** the natural systems that support human wellbeing, prosperity, and long-term adaptation[5,106,107]. It also weakens nature-based solutions that protect communities from floods, droughts, wildfire, disease and extreme heat[107–110] and is compounded by conflict-related pollution.

Wartime environmental degradation and budget diversions to defence also reduce society's capacity to adapt to future climate change, forming a long-term threat to human security, prosperity, and national resilience[108–110].

Causal Pathway/ Risk Chain: Weaponisation of Nature and UK Security

From methods of weaponisation to environmental harm, cascading impacts and UK security consequences



Destroying and degrading nature also affects the resilience of Earth systems[111]. This makes the weaponisation of nature a planetary risk. Most environmental attacks are still local or regional in their immediate effects, but they take place against the backdrop of accelerating climate change, biodiversity loss, freshwater depletion, and land degradation. All weaponisation, therefore, works cumulatively to reduce the planetary capacity of ecosystems to absorb shocks and recover, and increases the risk to Earth systems and the probability of passing dangerous tipping points[112–114].

There is currently no evidence that individual acts of environmental warfare have triggered Earth system tipping points. But deliberate environmental degradation from nature weaponisation should be understood as interacting with a planet that is already under dangerous environmental stress[115]. Serial destruction of ecologically important landscapes, carbon-rich ecosystems, or globally significant biodiversity will erode earth system resilience and increase the risk of crossing ecological thresholds.

Calculating damage and restoration costs

Recovery from the weaponisation of nature varies considerably between ecosystems and the ecological function being measured. A recent global study found that approximately 87% of burned vegetation regained its pre-fire productivity within two years, although these numbers vary substantially by climate and vegetation type[110]. Vegetation productivity is only one measure of recovery. Evidence from the 2019-2020 Australian megafires shows that wider biodiversity recovery is much slower, with the greatest impacts occurring in areas affected by repeated fires, high-severity burns, extensive burn scars, and extreme drought. While some species and resprouting eucalypt forests showed early signs of resilience within one-year, ecological succession and the recovery of habitat structure may continue for decades or even centuries[109].

Recovery trajectories are even longer for some ecosystem types. A global metanalysis of 621 restored wetlands found that, even after a century, biological structure and biogeochemical functioning remained, on average, 26% and 23% below reference conditions. Many wetlands recover only slowly or transition to alternative ecological states rather than returning to their original condition[108]. Evidence from peri-urban fire environments similarly indicates that vegetation recovery may be limited during the first post-fire year, and hydrological impacts can persist well beyond the immediate disturbance.

These studies demonstrate that there is no universal recovery time for nature. Recovery depends on the ecosystem affected, the severity of the damage, climatic conditions, and the ecological processes being considered. This has important implications for policymakers: the impacts of environmental warfare should be assessed by the **scale of immediate destruction,** by the **duration of ecological recovery**, by the **persistence of degraded ecosystem services**, and **the long-term costs of restoration**. Investing in ecological resilience is a more effective and less costly strategy than relying on post-conflict restoration.

One of the central challenges in governing environmental warfare is the **quantification, monitoring, and attribution of environmental harm and repair**. No universally accepted methodology exists for measuring environmental damage during armed conflict despite the important legal precedent established through post-Gulf War compensation mechanisms relating to Iraq[33]. These difficulties are particularly acute during active conflict, where insecurity and restricted access complicate direct observation and rely on satellite imagery, drones, and geospatial analysis.

Most impact estimates, therefore, rely on post-conflict methodologies. Satellite data has traced the intentional burning of farmland in Islamic State-controlled territories[17] and spatiotemporal remote sensing in Iraq has identified anomalous fire patterns inconsistent with climatic conditions[39]. Similar approaches have been used to analyse conflict-driven deforestation in Colombia[70].

Ukraine is pioneering real-time ecocide monitoring efforts and wartime documentation practices. Emerging frameworks, such as the Geographic Information System for Environmental Monitoring in Wartime proposed by Mobaied and Rudant[116], alongside ecosystem services approaches advanced by Francis and Krishnamurthy[117], reflect broader efforts to systematise environmental assessment during conflict itself.



The challenge extends beyond monitoring to attribution, cost and accountability. Environmental harm is often diffuse and interconnected, making it difficult to delineate the precise spatial and temporal boundaries of environmental damage in armed conflict or determine the extent of perpetrator accountability. While direct damage may be observable, broader effects on ecosystem services and socio-ecological systems are much harder to quantify, project and price[18,118]. As a result, assessments often default towards tangible economic and material metrics that are easier to quantify and legally operationalise than biodiversity loss, ecosystem degradation, and intangible cultural and emotional losses[33,117].

Difficulties in the delineation, quantification and attribution of environmental harm caused by nature weaponisation, coupled with opportunities for deniability, enable states and armed groups to evade responsibility[119].

Recommended policy action

The literature on the weaponisation of nature shows gaps and confusion in current policy thinking in the UK and internationally. These need to be addressed in UK security policy in four main ways: greater conceptual clarity; a more strategic posture of readiness across UK government and society; improved supply chain resilience; and more determined diplomatic influence of international norms and law.

Conceptual consolidation

Scholarship, public policy, legal instruments, and military doctrine on the weaponisation of nature are conceptually outdated and fragmented across government and society. Certain subjects, like water weaponisation, have received up to date attention but wider literature remains backward focused on the Cold War, rudimentary environmental warfare technologies, and overt practices that increasingly diverge from present and future covert and subthreshold threats. Scholars are also divided on whether to include critical natural infrastructure like nuclear power plants, oil, gas and mineral extraction, and the aggressive manipulation of environmental policy ("polfare") and international, environmental and corporate law ("lawfare") in the weaponisation of nature.

Policymaking in the UK and internationally is unfocused around the weaponisation of nature. Internationally, policymaking and action has been limited to the legal sphere with calls for new international law on ecocide. Domestically, public policy in the UK is hard to see and seems nested within wider national policies of improved resilience and adaptation to climate-related hazards, countering foreign threats, and hardening of security around national infrastructure on land, at sea, and on the ocean floor.

This lack of UK topline policy coherence is dangerous in a national security environment in which ecosystems and nature-based infrastructure are treated as legitimate targets[23] and climate change offers new climate-related opportunism for hybrid warriors to start fires, cut cooling systems, exacerbate flooding and exploit newly accessible areas of melting ice[55,81].

UK national security is deeply dependent on wider Earth security[111]. This gives UK policy planetary *Earth interests* alongside *national interests*. One country's environmental war is another country's food shortage, energy crisis, migration emergency, and biodiversity extinction risk. This is seen clearly in conflicts and threats over the Arctic, the South China Sea, the Panama Canal or the Straits of Hormuz[49]. The UK's planetary vulnerability is rightly marked by an uptick in the prefix "geo" as UK policymakers become acutely aware of the geostrategic, geopolitical, geoeconomic, geophysical and geotechnological dimensions of every policy they make[120]. The whole-Earth effects of local and regional conflicts may create harmful geo-cascades and *all-life disasters* for humans and nature far beyond the conflict epicentre. These cascades bake in self-perpetuating links between environmental warfare and UK national security.

The potential weaponisation of nature by UK enemies is moving fast up the hybrid warfare agenda. In the 1960s, NATO recognised that environmental warfare possessed unique strategic utility as asymmetric warfare precisely because it could be conducted in subtle, ambiguous, difficult-to-attribute, and deniable ways[119]. Hostile manipulation of environmental systems can produce coercive and destabilising effects but remain below conventional thresholds of armed aggression. Tactics like poisoning water, starting fires, or disrupting cooling systems are easy, low-cost and attractive to hybrid adversaries.

An immediate UK cross-government effort should consolidate key concepts and policy on the weaponisation of nature, led by the Cabinet Office and drawing on relevant expertise, including from the Met Office, Defra, Ministry of Defence and FCDO. It should establish a shared definition of the weaponisation of nature (intent, means and effects) and agree which practices fall within or beyond the current scope of international humanitarian law and environmental treaties, with some perhaps demanding the development of new ecocide law.

Strategic posture

The UK should adopt a strategic "protect and prepare" posture across government. This should strengthen the protection of UK nature, improve water regulation, safeguard critical national infrastructure[111], and invest deeply in ecological resilience. National preparedness should adopt a whole-of-society approach that raises risk awareness and mobilises public institutions, business, local authorities, and communities, supported by scenario planning and regular preparedness exercises. Public understanding of the risks needs to be sharpened to ensure political support and, as required, societal vigilance and response.

Over two to five years, an integrated nationwide early-warning system should be installed that is capable of alerting UK citizens and institutions to domestic risks of the weaponisation of nature within UK nature, and wider planetary risks across geographically dispersed nature-based supply networks for food, energy and vital materials.

Supply chain resilience

The UK's approach to supply chain resilience acknowledges that total self-sufficiency is neither feasible nor compatible with maintaining current domestic living standards in the country. The focus is on strategic optionality: preserving sufficient diversity, redundancy, and flexibility across energy, food, water and industrial systems to withstand major disruptions.

An immediate priority over the next two years is to undertake a comprehensive mapping of the UK's direct and indirect dependencies within global trade, including exposure to planetary vulnerabilities in energy, critical minerals, food, transport, and intermediate goods. This must look beyond proximate vulnerabilities, like Dover Straits, to distant but systemically important topography like the Strait of Hormuz, the Arctic and Antarctica[121].

The UK should also establish measurable reliability standards and minimum strategic thresholds for food and critical minerals security, comparable to those already used in energy security[122]. These should set formal resilience metrics and require critical systems to withstand points of failure.

Immediate measures could include minimum supplier-diversification requirements for agricultural imports and greater investment in domestic and allied recycling, stockpiling, and sustainable processing capacity for critical minerals. These should avoid technological and institutional lock-in.

If the UK's energy strategy includes a more substantial role for nuclear power, this must be accompanied by clear-eyed assessment of the security risks of concentrating critical energy infrastructure in high-value facilities. Russia's actions around the Zaporizhzhia nuclear power plant in Ukraine (see Froggatt and Lewis[123]) demonstrate that longstanding assumptions about the inviolability of such sites are misplaced.

Legal and normative codification

A central priority for UK diplomacy should be to revive and strengthen the ENMOD Convention (see also Murphy and Obregón Gieseken[124]). This could begin by building a coalition of at least ten States Parties, as required under ENMOD Article VIII(3), to trigger a review conference – the first since 1992. When the UN Secretary-General last canvassed States Parties on this question in 2013, fewer than ten responded affirmatively, indicating the diplomatic groundwork still required. Should a review conference remain politically unfeasible, a single State Party could invoke Article V(2) and request that the Secretary-General convene a Consultative Committee of Experts, which must then be established within one month.

In parallel, UK diplomacy should test support and feasibility for recognizing ecocide as a fifth international crime before the International Criminal Court, perhaps cooperating with Ukraine. The proposal of a new crime of ecocide has a long and consistent pedigree that is now gathering momentum[5,36,42,125]. If ecocide diplomacy fails, the UK could promote wider recognition of ecological reverberating effects and Earth systems tipping points in military policy and in new additions to international law. UK diplomacy could also increase the focus on the weaponisation of nature at the climate COP and the biodiversity COP, and encourage domestic legislation against ecocide, which already exists in Vietnam, Ukraine, and Russia[126].

Even if the legal recognition of ecocide as a new crime is a good idea, there are three obstacles to making it work[106]. First, there is no universally accepted legal definition. Second, there is political resistance because states often prioritise national security and military autonomy over environmental accountability. Third, enforcement is challenging; courts and investigators may lack the scientific expertise, monitoring systems, or jurisdiction needed to prove environmental harm in conflict zones.

Any UK legal diplomacy to protect nature in war will face differences of legal opinion. Lawyers have long noted that the distinction between using the environment instrumentally to achieve military objectives and targeting the environment as an end in itself is difficult to sustain in practice because most instances of environmental weaponisation involve elements of both[12]. As with human life in the laws of war, so the life of nature also clashes with the legal principle of "military necessity" in IHL[13,127].



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