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A System Working as Designed: Why Climate Change Has Not Entered NATO's Exercises

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Introduction

NATO's political commitment to climate change and security is not in question. The 2022 Strategic Concept names climate change a defining challenge of our time. The 2021 Climate Change and Security Action Plan commits the Alliance to incorporating climate considerations into resilience, defence planning, capability delivery, and explicitly into training and exercises. Successive summit communiqués have reinforced the point. At the political level, the direction is settled: climate change is an operational concern, and NATO's preparedness frameworks should reflect it.

Exercises are one primary mechanism through which 'preparedness' happens. They are where NATO's family of plans is rehearsed, Commands are certified, and operational readiness is assessed under pressure. If climate change is to make meaningful progress in the Alliance's preparedness frameworks, exercises are where it has to happen.

Over the past year, I conducted semi-structured interviews with exercise designers, operational planners, engineers, METOC officers, and training and warfare development staff across the Joint Warfare Centre (JWC), Supreme Headquarters Allied Powers Europe (SHAPE), and the joint force commands, asking a simple question: to what extent is climate change actually present in NATO's exercise ecosystem?

The research was a first assessment rather than a comprehensive audit because access constraints meant coverage was uneven, and the tactical level was largely out of reach. But on the central questions, the testimony converged so consistently that the pattern is difficult to dismiss.

The short answer is that climate change is present in NATO exercises only at the margins, and almost never in the exercises that matter most. The more interesting answer, and the argument of this article and the report I submitted as part of my CCASCOE fellowship (not yet published), is that this is not an oversight, a lag, or a failure of will. It is the exercise system functioning exactly as designed. Understanding why is the precondition for changing it.

Where climate appears, and where it does not

Climate-related content is not entirely absent from NATO's exercise ecosystem. It appears with some regularity in wargames and tabletop exercises, particularly in crisis management exercises, where grappling with climate effects has occasionally been the stated purpose, and in lower-intensity, out-of-area, and stabilisation scenarios, where climate change has served as a recognised driver of instability shaping both scenario and gameplay.

But the pattern breaks down precisely where the stakes are highest. In major Article 4 and 5 command post exercises (CPXs), the strategic and operational-level events through which NATO's actual plans are rehearsed and headquarters certified, climate-related content appears, if at all, as scene-setting background or isolated injects pushed by motivated individuals. Even the weather scripted into exercises is designed to serve the scenario rather than reflect meteorological reality. Where climate content does surface, it is played away quickly: resolved by participants, moved on from, and forgotten.

That last point deserves emphasis, because the gap is not simply one of frequency. It is that climate content, when it appears, produces no institutional residue. Injects are resolved and disappear. The same lessons are identified each cycle and lost before the next. Across all the testimony I gathered, no operational assumption was formally challenged, no training requirement generated, and no plan revised on the basis of a climate-related exercise finding. Climate content creates conditions; it does not generate learning.

Why the pattern exists: the system is working as designed

It would be convenient to attribute this to institutional inertia or insufficient awareness. The reality is more structural, and more interesting.

Begin with the institutional chain. NATO's exercise programme runs on a sequence: approved concepts and policy generate doctrine; doctrine generates operational requirements; requirements generate training categories; and training categories generate the standards against which exercises are evaluated. Climate change and security exists at the first stage since there is a named action plan and summit-level acknowledgement but at none of the subsequent ones.

There is no finalised operational concept (though one is currently being developed), therefore no doctrine, therefore no planning requirement, therefore no training category among NATO's twenty-nine strategic-level categories, and therefore no standard against which climate content could be assessed. The contrast with environmental protection is instructive: seven STANAGs give planners and evaluators a common basis for integrating it across the operational lifecycle. No climate-and-security equivalent exists. Without it, there is nothing to plan against, evaluate against, or report against, and an exercise programme built on requirements has no mandate to include content that no requirement names.

This matters because of the design logic of the exercises themselves. Major CPXs are certification machines. Scenarios are constructed to flow, conclude, and produce assessable results within a fixed window, often as little as ten days. The structure places a premium on content that is controllable, resolvable, and mappable to an existing standard. Climate-driven effects are none of these things. They cascade, compound, burn slowly, and cut across multiple functions and planning areas. From a planner's perspective, they are a problem to be managed away, not a feature to be designed in.

A second structural obstacle is the adversarial logic at the heart of exercise design. Exercises are built around an opposing force: a threat is imposed and the training audience responds. Climate change does not fit that frame. It does not arrive from an adversary, cannot be deterred, and does not respond to countermoves. Its pressure is internal rather than external, and ultimately, it erodes the assumptions plans rest on rather than confronting the forces that execute them.

The Alliance's necessary shift toward Article 5 and deterrence exercises has only narrowed the space further. Climate change is, in effect, a non-adversarial threat trying to enter a system built entirely around adversaries.

These structural conditions shape human behaviour in turn. Climate literacy among exercise designers and planners is thin, and even where the will exists, the tools do not. Interviewees described a persistent gap between climate data and modelling on the one hand and what operational planners can actually work from on the other. Data exists; it is simply not calibrated to planning decisions, and no standardised approach governs how climate information should feed into planning at all. One exercise designer who explicitly sought guidance on incorporating climate content found that nothing existed within the NATO exercise ecosystem to support her. Motivated individuals are left working from intuition, and the intuition goes unsupported. It should be noted that a 'companion guide' is currently being developed.

Framing compounds the problem. Within a military planning context, content labelled "climate change" is routed to meteorological staff who cannot act on it, or dismissed as a long-term concern irrelevant to the planning horizon. What lands is the operational consequence rather than the cause: infrastructure degradation, mobility constraint, sustainment risk. The mismatch between how climate change is framed in policy and how it must be framed to be actionable in planning is itself a barrier, and it has not been resolved. Finally, a cultural layer sits beneath all of this. Among some of those interviewed, staff across the commands were described as viewing climate change less as an operational concern than as a political imposition. This was not universal, and it would be wrong to overstate it. But where it exists, it suppresses engagement before integration is even attempted.

These conditions are not independent; they interlock. The upstream doctrinal gap means no mandate exists. Without a mandate, no one owns the problem. Without ownership, literacy does not develop, tools are not built, and the design logic of the system goes unchallenged.

And where motivated individuals push climate content through despite everything, the exercise culture absorbs it without learning. No single fix unlocks the pattern, because the pattern is self-reinforcing.

What continued omission costs

The consequences of this are not hypothetical. What the Alliance does not exercise, it does not learn; what it does not learn, it cannot adapt; and what it cannot adapt, it will eventually encounter in an actual operation, under pressure, for the first time.

The evidence that this is already happening surfaced repeatedly in interviews. In one NATO operation, dust storms intensified markedly over a two-to-three-year period, degrading helicopter operations, affecting personnel health, and forcing the curtailment of missions — none of which planning had anticipated. At a SHAPE headquarters building, drainage infrastructure designed against historical rainfall data now receives three times its expected load, causing structural damage. These are present-tense failures produced by planning assumptions that the climate has already overtaken. Plans are reviewed annually, but against current conditions rather than projections; without a climate lens, recurring events are not recognised as patterns requiring revision. Exercises are the only mechanism that could catch this drift systematically and they are not being used to do so.

The omission also breaks the capability development chain. Exercises are the primary vehicle through which capability gaps become visible and feed into development and procurement.

Climate-driven challenges that never appear in exercises never generate that evidence, and the gaps remain invisible not just to planners but to the processes that would resource a response.

Perhaps most seriously, an Alliance response to climate-driven operational disruption would demand coordinated action across commands, member states, and functions. Coordination depends on shared understanding built through collective exercise experience. None currently exists at the CPX level. A pattern already visible in exercises points to what this means in practice: climate and environmental injects are routinely deflected on the grounds that the response falls to a member state rather than to NATO. Under real conditions, that is not a coordinated alliance response; it is a vacuum filled by competing national instincts. The Arctic makes the stakes concrete: it is the environment where climate assumptions are breaking down fastest and where coordinated response would matter most. It is essentially unexercised from a climate perspective.

What needs to change

If the barriers are structural, the changes must be too. Three stand out.

First, the doctrinal chain has to be completed. Allied Command Transformation is currently developing an operational concept for climate change and security. Until it is finalised and adopted, the foundation for a formal training requirement simply does not exist. From concept must follow doctrine, and from doctrine a recognised place in planning frameworks, beginning with the documents operational staff actually work from, which today contain no climate planning consideration at all. Standards matter equally: without climate-related impact analogues to the architecture that exists for environmental protection, there will never be anything to evaluate against.

Second, climate change needs to be connected to frameworks that already exist. NATO's resilience architecture (i.e. the Seven Baseline Requirements, the Layered Resilience Concept) is well established and addresses precisely the categories of failure climate change drives. Climate has simply never been formally connected to it. That connection requires no new institution, only the recognition that climate change is a driver of the failures the resilience scaffolding is designed to prevent.

Third, the moment is more favourable than the diagnosis suggests, and it should be used. NATO's exercise system is itself in transition. Though exactly how remains in flux, exercises appear to be shifting from strict certification toward rehearsing and stress-testing the actual family of plans. That is potentially good news for climate-related security impacts because under a plan-rehearsal logic, a stressor that reveals where a plan breaks is exactly what exercises exist to surface, not a problem to be managed away.

None of this resolves the institutional gap — there is still no doctrine, no training category, no standard. But the conditions that made climate change structurally inadmissible to NATO's exercises are loosening for the first time. The system was working as designed but the design now appears to be changing. Whether climate change finds a place within it will depend on whether the Alliance treats this window as what it is: the best opportunity yet to test its plans against the world as it is becoming, rather than the world as it was when those plans were written.

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Prior to that, he published analytical work on climate and security risks across fragile contexts for adelphi, a Berlin-based think-and-do tank. He has also served as a civilian UN peacekeeper working on political and security affairs in the Central African Republic.

Naval Power in the Age of Climate Crisis

Arnaud Boehmann

The world's oceans have once again become a theatre of contestation and conflict but with a striking difference. As climatic stability dwindles, new challenges arise. Air and water temperature, humidity, salinity and acidity as well as weather intensity are heavily impacted by climate change, creating new conditions for naval power projection. Climate change is transforming every dimension of naval power - platforms, people, infrastructure and strategy. Now is the time to integrate adaptation into force design.

Climate impacts on the oceans as operational environments

The world's oceans have absorbed 90% of global warming since the 1950s, more than tripling the heat content of the oceans since 1990 (NASA 2026). Most of this heat is absorbed by the upper water layers (0-700 metres) which are most relevant to seafaring including the standard operating depths of submarines.

As a general trend, the climate crisis increases intensity and frequency of extreme weather events. Hotter surface water of the oceans serves as fuel for storms, as more water evaporates into the atmosphere. Hotter air in turn absorbs more moisture leading to stronger rainfall. Waves are getting higher and winds stronger. Additionally, the absorption of CO_2 by the oceans drives their acidification, destroying vital parts of the oceans' ecosystems. The Atlantic Meridional Overturning Circulation (AMOC) is slowing down, with an increasing risk of collapsing. Changing ocean currents like the Gulf Stream means to disrupt pillars of seafaring (Carrington 2018).

Consequences for military naval platforms

Naval platforms often have a lifespan of 30-40 years. Each boat, ship and submarine designed and built henceforth should be adjusted for the worst-case climate impacts we could be facing in the 2060s.

As weather patterns become more extreme, the stress put on the keel, hull and superstructures increases (Britannia Group 2026). Safety margins need to be adjusted accordingly. For existing units, lifecycle stability updates and refits could be considered.

Ships rely on seawater to cool the engines. Cooling efficiency is reduced the warmer the surface water becomes. The risk of overheating the propulsion systems directly translates into reduced operational effectiveness as ships cannot maintain technically possible speeds or only for reduced time windows, thereby increasing response time and shrinking the area of operations (AOO).

In 2016 the British House of Commons Defence Committee was informed that Type 45 destroyers were experiencing power outages in the Persian Gulf due to overheating of the main generator. The specifications for Britain's most advanced surface warships had not included the entire spectrum of environmental stressors encountered in its would-be AOO (House of Commons Defence Committee 2016).

Quarters, working stations and critical electronic components need to be temperature regulated. The electronic systems can be compromised and reduced to the point of decreased accuracy or malfunction.

Furthermore, hydraulic fluids reduce their viscosity under heat, which can lead to increased wear and tear on critical components.

Anti-submarine warfare

Changes in water temperature, density and salinity impact the way soundwaves travel through water. Gilli & Gilli, taking into account climate-induced changes to oceanic sound propagation factors (temperature and salinity with a time horizon of 2070-2099), concluded that submarine detection range could decrease as much as 42% from 60km to 35km in the North-Atlantic. In the Sea of Japan, it could increase from 10km to 45km (Gilli and Gilli 2025). Sound propagation alterations are also relevant in sonar usage for mine countermeasure missions (Paul 2018).

Such changes in visibility require the alteration of our submarine concepts of operations, for nuclear posture and deterrence, as well as for coastal defence, area denial and infiltration. If climatic tipping points, such as the AMOC, are crossed, effects will be larger.

Aviation

As hotter air has a lower density, naval aviation is directly impacted. Lower air density means that a helicopter needs to burn more fuel to keep flying, if it is even powerful enough to compensate. Thus, pilots can only operate at shorter distances or maintain the distance but with reduced payload (troops, fuel, cargo and weapons).

Allied planes and helicopters in Afghanistan were challenged, where take-offs from high altitude airfields were compounded by the high temperatures. Consequently, payloads had to be significantly reduced. In Mali, German helicopters were grounded during heatwaves.

Given more intense and prolonged heatwaves, the deployment possibilities, particularly for naval helicopters, will be reduced. Pilots also require more preparation and specialised training, especially when high air temperatures and high altitudes occur in combination.

Lightning activity is modelled to increase by about 12% per degree Celsius of global warming (Neal 2021). Even with current protective measures, lightning strikes pose a high risk to aircraft and their operators (Whiteman 2022). In 2023, lightning strikes damaged three U.S. Navy E/A-18G Growlers in a single day (Ziezulewicz 2023).

The human dimension

Working under changed climatic conditions at sea brings about major health risks. Exposure to extreme heat risks dehydration and heat stroke, especially in the military profession.

Air conditioning on board may break down, temporarily or permanently. Even with functioning air conditioning, deployments along the equator are already challenging today. Adequate hydration must both be available and implemented rigorously, especially on duty stations where sailors may not feel extreme heat due to wind or where adrenaline and high-intensity tasks shift attention away from hydration. Special heat adaptation techniques and pre-deployment acclimatization exercises may become necessary, in new AOO to accommodate the 'new normal'.

High temperatures also correlate with increasing aggressiveness and violence (Gebhardt et al. 2023), creating new problems in already cramped up, high-stress, low-downtime environments such as warships.

Operating costs

Many of the aforementioned impacts increase wear and tear.

Units will therefore spend more time in dock, increasing cost and reducing operational readiness. Aside from inflation and costs for personnel, the mere climatic impacts will additionally strain governments budgets, putting into question the value of naval units. Where governments need to maintain or expand naval power, the cost will rise disproportionately compared to previous decades. Mind that maintenance and operating costs always exceed the purchasing price-tag when looking at the life cycle costs of naval vessels.

NATO warships are growing in size and thus fuel consumption. German and Dutch frigates doubled in size since the 1990s. For Germany from 4.900t (F123) over 7.200t (F125) to over 10.000t for the planned F127 type frigates. The Royal Navy's developments from the Type 42 to the Type 45 destroyers and the U.S. Navy's designs of the DDG X, follow the same path.

Combine these increases in size with the aforementioned increase in fuel consumption on board to compensate for cooling and heat induced drawbacks in efficiency as well as increased fuel demand for aviation due to worsened flight conditions, naval energy demand is bound to increase, thereby driving up costs.

Coastal bases & construction and supply

Danger not only looms at sea, but also in port. Heavy storms damage buildings as well as unprotected units. During a sudden storm that hit Norfolk Naval Base in July 2022, the U.S. Navy lost 10 helicopters. A terrible hit in peace time at home, catastrophic during war time.

So called "once-in-a-century-floods" will become up to 30 times more frequent by 2050 on the global scale (IPCC 2021).

Many coastal places will witness destruction from extreme weather events before the damage from the previous could be repaired. Rising sea levels further put naval infrastructure, worth billions at risk. Ports, bases and shipyards are often built so close to the waterline that they risk becoming unusable. Norfolk Naval Station is one case. Parts of the largest naval base in the world are already frequently under water. The home of the U.S. Atlantic Fleet is over 100 years old, but unlikely to see its bicentennial. Corresponding risk assessments have been made over a decade ago, but adaptation stalled and is unlikely to be revived in the current political climate (Kusnetz 2017). The construction of America's next generation SSBNs and thus continued nuclear deterrence is also at risk (Malloney 2025).

Possible adaptation measures for coastal military installations are twofold:

1. Keep the water out: dykes, seawalls, surface and sub surface flood obstacles
2. Keep the head up: measures aimed at raising infrastructure further above sea level

Both come with prohibitive costs.

Mission profiles, HADR & critical Infrastructure

The armed forces are frequently called for help in emergency situations, particularly when specialised equipment is limited, or the size of the emergency exceeds civil capacities. 2024 saw 251 military deployments in 63 countries to tackle climate hazards (Center for Climate and Security 2025).

Navies are uniquely suited to step in at coastal emergencies. Amphibious units offer irreplaceable logistical capabilities, especially when airfields are inaccessible.

Since 10% of the world's population (748 Mio. People) live within 5km of a coast (Cosby 2024), seaborne humanitarian aid and disaster relief (HADR) operations will only increase in frequency and scale. Recently Australia, New Zealand, the United Kingdom, the USA, China and Brazil deployed naval units in HADR operations. Australia has deployed over 35,100 personnel to domestic disaster relief operations between 2019 and 2024 (Parliament of Australia 2024), roughly 38% of its total force. The call to prepare for more HADR missions was therefore included in NATO's 2022 *Climate Change and Security Impact Assessment* (NATO 2022).

HADR is not only about who needs help, but also who is able to show up. In a global wrestle for presence, perception, power and sympathies – the ability to help increasingly becomes a political game card. Dual use HADR & hospital ships can provide help fast but are also valuable assets in peer-to-peer conflicts.

Protection of critical infrastructure

Critical maritime infrastructure has become a key target of hybrid aggression, from pipelines and windfarms to data cables. NATO's *Baltic Sentry* (NATO 2025) has been established to ward off and deter hybrid aggression, but in the medium to long term, the need will outpace allied naval capacities. Uncrewed systems offer a solution.

Continued and comprehensive surveillance at sea poses a core challenge. Denmark is already deploying USV for this purpose and Singapore has been deploying armed USV to protect its geopolitically sensitive waters (Arthur 2025). Integrating protective uncrewed systems is key in protecting our efforts to transition to clean energy.

Navigational challenges

The military's longstanding restraint in the Arctic has vanished and Russia has been reopening old Soviet bases along its northern coast. China has designated the Arctic as one of four "strategic new frontiers", playing a highlighted role in Chinese security conceptualisation. The year 2025 has seen a wide array of NATO members' military training and testing systems above the Arctic circle (Defence Industry Europe 2025).

Deployments remain challenging despite the retreating ice. Data for naval operations is lacking, seabed and coasts are insufficiently mapped (Uryupova 2024). Repair facilities are scarce and the great distances pose challenges not only to resupply and maintenance, but also to search and rescue operations (Ted Stevens Center for Arctic Security Studies, n.d.).

Further south, droughts lowered the water supply of the Panama Canal. Authorities cut daily canal transit from 36 to 27 ships (Schade et al. 2025). Meanwhile Germany is already investing heavily in the expansion of its Kiel Canal, connecting the Baltic Sea to the North Sea. Measures include adaptation sea level rise.

Conclusion

The climate crisis will not disable naval forces overnight (except for extreme weather damages). But it is a fierce challenge, slowly creeping closer. As "the urgent beats the important," we risk finding ourselves exposed to conflicting strategic priorities at times when our navies will not be able to perform tasks like they used to.

The time requirements for planning and construction of complex naval units distinguishes them from the armies' faster scalable systems.

Path dependencies in shipbuilding weigh heavier and risk lasting longer, making climate inclusive planning decisions even more relevant, than perhaps in other domains. We must embed climate-informed naval capability planning in every ship class design and mission planning process. Otherwise, mission failures are predetermined. Our infrastructure requires mandatory stress-testing for environmental impacts and early adaptation to reduce larger costs further downstream. When the armed forces inevitably are called upon for more HADR missions, they need to be prepared. Other mission alterations will follow suit.

A navy of today will not be able to perform its mission objectives to the same degree in a climatically altered world. In order to preserve a versatile fighting force, it needs to have started adapting yesterday. At the very least, it must begin planning today.

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Cover image: USS Jason Dunham (DDG-109) encounters heavy seas. DVIDS/U.S. Navy.

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